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EU regional policy and the neighbour's curse

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Breidenbach, Philipp; Mitze, Timo; Schmidt, Christoph M.

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EU Regional Policy and the neighbour’s curse: Analysing the income convergence effects of ESIF funding in the presence of spatial spillovers

Philipp Breidenbach[+], Timo Mitze[++,1], Christoph M. Schmidt[+++]

[+]RWI [++]University of Southern Denmark, RWI & RCEA

[+++]RWI, Ruhr-University Bochum & CEPR London

Abstract: The European Structural and Investment Funds (ESIF) constitute the prime instrument of EU Regional Policy. We study ESIF effectiveness in terms of fostering intra-EU income convergence through investment support to lagging regions. Our empirical results for the period 1997-2007 indicate, however, that the ESIF contribution to income growth is insignificant or even negative for several peripheral EU regions. We argue that the negative link between funding and regional growth is mainly attributable to spatial spillovers. While the latter may reflect the intensified competition among highly funded regions in geographical vicinity for scarce production factors, we also discuss the role played by structural backwardness in a macro-regional context to explain this sobering result. As such, we show that negative funding effects significantly correlate with lower levels of regional institutional quality. Taken together, our findings indicate that unintended distortionary effects restrain EU Regional Policy from working effectively in fostering income convergence.

JEL Classification: C21, R12, R58

Keywords: EU Regional Policy, ESIF, Regional Economic Growth, Income Convergence, Spatial Spillovers

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[1] Contact for correspondence: Timo Mitze, Department of Business & Economics, University of Southern Denmark, Alsion 2, DK-6400 Sønderborg; Tel.: +45 6550 1770; E-mail: tmitze@sam.sdu.dk.

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Philipp Breidenbach[+], **Timo Mitze**[++] , **Christoph M. Schmidt**[+++]

[+]RWI [++]University of Southern Denmark, RWI & RCEA

[+++]RWI, Ruhr-University Bochum & CEPR London

Philipp Breidenbach, RWI – Leibniz-Institut für Wirtschaftsforschung, Hohenzollernstr. 1-3, 45128 Essen, Germany; Tel.: +49 201 8149 328; E-Mail: philipp.breidenbach@rwi-essen.de.

Timo Mitze (**corresponding author**), Department of Business and Economics, University of Southern Denmark, Alsion 2, 6400 Sønderborg, Denmark; Tel.: +45 6550 1770; E-Mail: tmitze@sam.sdu.dk; RWI and Rimini Centre for Economic Analysis (RCEA).

Christoph M. Schmidt, RWI, Hohenzollernstr. 1-3, 45128 Essen, Germany; Tel.: +49 201 8149 227; E-Mail: Christoph.Schmidt@rwi-essen.de; Ruhr-University Bochum and Centre for Economic Policy Research (CEPR).

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Introduction

The European structural and investment funds (ESIF) constitute the most important supranational policy instruments at the European Union (EU) level.[1] As an integral part of EU regional policy, the funds provide a comprehensive investment framework to meet the goals of the Europe 2020 strategy for smart, sustainable and inclusive growth in the EU. Their budgetary importance has grown steadily over time, currently accounting for roughly 450 out of 960bn euros in the multiannual financial framework (MFF) 2014-20. Given the persistent nature of the economic differences in the EU and the slow pace of economic recovery in the aftermath of the global economic crisis of 2008, regional policy has been at the heart of a vivid political debate on proper policy solutions for Europe's economic challenges (Moro, 2014). While the instruments of regional policy have thus served as a blueprint for the design of new, growth-oriented policy initiatives,[2] the policy has, at the same time, come under budgetary pressure to keep the contributions of net payers within acceptable limits and under general pressure to justify its value in relation to the EU's political objectives (Bachtler and Polverari, 2017).

This study is in particular concerned with the latter aspect. Assessing the policy effectiveness of regional policy is a difficult task, though, given the potential trade-off between allocative efficiency and equity related to ESIF funding (Farole et al., 2011) and the distinct non-experimental nature of funding (Gripaios et al., 2015). Correspondingly, empirical studies devoted to the analysis of EU regional policy in general and ESIF funding in particular have come to multiple and ambiguous conclu-

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[1] While the term ESIF has been introduced during the funding period 2014-20, the prevailing EU bureaucratic diction prior to this date was European structural funds (SF).

[2] For instance, this is highlighted by the Commission's legislative proposal for a new European fund for strategic investment (ESFI), implemented by the European Investment Bank. With a volume of about 315bn euros, the ESFI aims at launching growth stimulating investment projects similar to the ESIF by supporting strategic investments in key areas, such as infrastructure, education, research and innovation as well as risk finance for small businesses (European Commission, 2015).

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sions about their actual impacts.[3] This has led to a large scientific debate regarding the proper scope and methodical scrutiny of these studies (Bachtler and Wren, 2007). With regard to the scope of the evaluation task, a main distinction can be made between, on the one hand, studies dealing with ex-ante and mid-term evaluations focusing primarily on the analysis of fund allocation, implementation and fine-tuning, and studies primarily conducting ex-post analyses of funding effectiveness, on the other hand (Molle, 2007). Ex-post analyses thereby range from qualitative case study work (e.g., Milio, 2007, Technopolis, 2008) to small- and even large-scale quantitative modelling approaches, such as HERMIN (Bradley, 2006).

From a methodical perspective, the spectrum of quantitative ex-post analyses, which are most closely related to the evaluation approach taken here, can be broadly classified as being theory-driven or experimentalist in nature (Holmes, 2010). The theory-based approach thereby essentially aims at converting theoretical models into empirically testable functional forms with explicit prior expectations about the path by which an initial policy stimulus translates into changes in the outcome variable. Estimated model results are then assessed against observed outcomes in order to assess the explanatory power of certain theories and associated policy actions (see, e.g., Mohl and Hagen, 2010; Dall'Erba and LeGallo, 2008; Beugelsdijk and Eijffinger, 2005, for empirical analyses of EU regional policy using theoretically founded growth model specifications). In contrast, (quasi-)experimentalist methods aim to keep the use of theory for causal inference at a minimum; for example, because of the fact that researchers are assumed to have only imperfect theoretical knowledge about the underlying functional form of empirical models. Accordingly, the modelling focus is on empirical estimation problems relat-

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[3] A recent meta study by the ‘What Works Centre for Local Economic Growth’ (2016) shows that roughly half of the reviewed empirical studies report a positive effect of EU programmes on GDP per capita, while others have found zero or significantly negative effects.

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ed to self-selection into treatment and on the endogeneity of the policy variable (see, e.g., Becker et al., 2012, Becker et al., 2010, for applications in the EU Regional Policy context).

While experimentalist methods have particular merits in terms of analysing ‘if’ a certain policy works, they do not allow providing answers to the question of ‘how’ the policy affects regional output indicators through various transmission channels. Having a particular interest in shedding light on the latter question, we adopt a theory-driven identification strategy here: that is, we seek to comprehensively assess the convergence enhancing effects of ESIF funding (using annual ‘objective1’- and ‘convergence’-payments, respectively) to lagging regions using growth theoretical foundations to model the transmission from investment support to regional output through various channels including spatial spillovers.[4] The link between a growth-oriented regional policy strategy with investment support to lagging regions and cross-regional income convergence in the EU can be drawn on the basis of the neoclassical growth model. Under the assumption of decreasing returns to capital input, the model predicts that returns to investment opportunities are the largest in poor regions and that investment support consequently triggers a convergence process with funded regions growing faster than the rest of the EU.

However, overall our empirical results on the convergence effects of ESIF funding are disappointing. We do not find evidence that policy support under the objective of ‘convergence’ has enhanced the income per capita growth of funded regions compared to non-funded regions in 1997-2007. Calculating the associated rate of return of ESIF funding with regard to per capita income, we obtain effects ranging between zero and -0.5 per cent. Most importantly, funded regions whose spatial neighbourhood is characterized by high ESIF funding intensities show a significantly worse growth performance. These nega-

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[4] Research on spatial spillovers investigates if public expenditure of a jurisdiction generates positive or negative effects spreading across its boundaries, thereby affecting the welfare of residents in neighboring jurisdictions (Costa et al., 2015).

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tive spatial spillovers may reflect a dismal causal link in the sense that regions increasingly poach scarce input factors (such as physical investments) from neighbouring regions upon the receipt of ESIF funding. Yet, as we will discuss more explicitly below, the interpretation of this sobering result is also compatible with negative spillover channels linked to institutional, structural and technological backwardness in the macro-regions receiving the highest ESIF funding volumes. In this context, ESIF funding might purely serve as an equity-oriented transfer to recipient regions without fostering administrative efficiency and economic growth.

Empirical Model

Our empirical identification strategy, which is focused on the estimation of an augmented income convergence equation in the spirit of the widely used Mankiw-Romer-Weil (MRW, 1992) approach, is summarized in Figure 1.[5] As the figure shows, we conduct a comprehensive analysis of ESIF funding effects using a 'specific-to-general' modelling approach. That is, as a baseline, we start estimating non-spatial convergence equations, where the ESIF funding intensity enters as a regressor among the set of $k=1,\ldots,K$ explanatory variables $\left(\mathrm{X}^{(k)}\right)$ either in an additive or interactive manner. These model specifications are then sequentially extended to incorporate spatial effects. The latter shall ensure well-behaved residuals and serve as a means to add a further explanatory element to the empirical modelling strategy.

Figure 1: Empirical strategy for comprehensive analysis of ESIF funding effects

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[5] See Appendix A for further information on the theoretical foundations of the empirical growth model specification.

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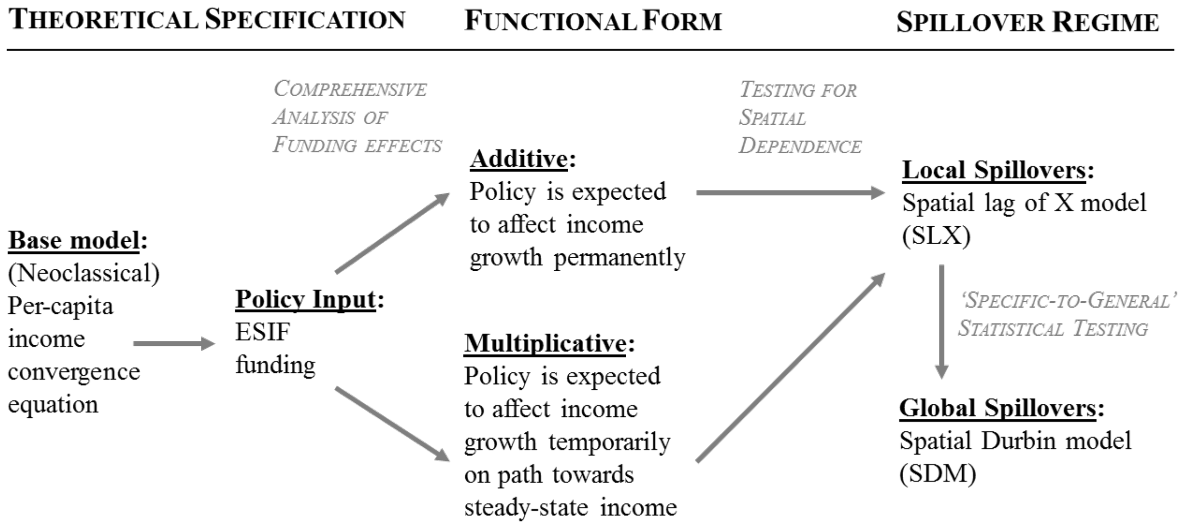

Source: Own figure.

In all cases, we use a dynamic panel data perspective, where GDP per capita ($\mathrm{Y}_{i,t}$) in region i=1,…,N in time period t=1,…,T serves as the model's dependent variable. Next to the ESIF funding intensity the set of regressors includes physical investment and human capital intensities, population growth and the labor force as further inputs of the regional production function (Mohl and Hagen, 2010). The two alternative regression specifications shown in equations (1a - additive) and (1b - multiplicative) also include time- (λ_t) and region-specific effects (α_i) to scale down the risk of omitted variable biases stemming from latent factors, such as regional amenities, or from time-varying shocks common to all sample regions:

$$\ln(\mathrm{Y}_{i,t}) = \alpha_i + \delta \ln(\mathrm{Y}_{i,t-1}) + \sum_{k=1}^{K} \varphi_k \ln(\mathrm{X}^{(k)}_{i,t-1}) + \gamma \ln(\mathrm{ESIF}_{i,t-1}) + \lambda_t + u_{i,t} \tag{1a}$$

$$\ln(\mathrm{Y}_{i,t}) = \alpha_i + \delta \ln(\mathrm{Y}_{i,t-1}) + \sum_{k=1}^{K} \varphi_k \ln(\mathrm{X}^{(k)}_{i,t-1}) + \gamma \ln(\mathrm{ESIF}_{i,t-1}) + \xi\left[\ln(\mathrm{Y}_{i,t-1}) \cdot \ln(\mathrm{ESIF}_{i,t-1})\right] + \lambda_t + u_{i,t}. \tag{1b}$$

As shown in the two equations, all explanatory variables enter with a one-period lag structure indicating a potential delay in the underlying transmission process from regional inputs to output (with *ln*

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denoting logarithmic transformations). Given the inclusion of the lagged dependent variable $(\mathrm{Y}_{i,t-1})$ as a right-hand-side regressor, we need to apply specific estimators for dynamic panel data models in order to account for the so-called 'Nickell bias' in the estimation of δ (Nickell, 1981). We do so by utilizing widely-used extensions to the static fixed effects model (FEM), such as i) a bootstrap-based bias corrected FEM (Kiviet, 1995), and ii) the Blundell and Bond (1998) system generalized method of moments (SYS-GMM) estimator. Once the model properly controls for serial correlation through the inclusion of $\mathrm{Y}_{i,t-1}$, the model's error term, $u_{i,t}$, is assumed to be distributed as $u_{i,t} \sim N(0,\sigma^2)$.

In equation (1a), the coefficient of interest is $\gamma = \frac{\%\Delta \mathrm{Y}_{i,t}}{\%\Delta \mathrm{ESIF}_{i,t-1}} = \left[\frac{\partial \mathrm{Y}_{i,t}}{\partial \mathrm{ESIF}_{i,t-1}} \cdot \frac{\mathrm{ESIF}_{i,t-1}}{\mathrm{Y}_{i,t}}\right]$, which can be interpreted as the output elasticity of funding (with %Δ denoting percentage changes).[6] From a growth-theoretical perspective, the additive inclusion of the policy variable in equation (1a) implies that ESIF funding influences long-run steady-state income levels. While this argument may hold for some elements of ESIF funding (such as public infrastructure or human capital investments) along the argumentative lines of the neoclassical growth model, private sector investment subsidies are only expected to have a transitory growth effect on the income path towards the long-run steady state (Alecke et al. 2013, Baldwin and Wyplosz, 2015). This transitory effect is mainly assumed to work through a reduction in the user costs of capital thereby affecting regional differences in the marginal return of capital in favour of funded regions. Neglecting to account for this policy-induced change in the regional rate of return to physical investment in funded regions would accordingly result in biased estimates of the 'speed of convergence' towards long-run steady-state income in these regions. We

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[6] We will also test for differences between the parameter estimates for γ in equation (1a) and an alternative growth equation where the ESIF funding effects are assumed to phase in gradually over time (with a cumulative maximum lag period of four years for the ESIF variable). One example of such gradual phasing-in effects is infrastructure investments (Bradley, 2006). This inclusion of lagged funding intensities can help to identify mid-run effects of ESIF funding.

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accommodate the possibility of a transitory policy effect in equation (1b), which includes an interaction term between the ESIF funding intensity and lagged GDP per capita $\left[\ln(\mathrm{Y}_{i,t-1})\cdot\ln(\mathrm{ESIF}_{i,t-1})\right]$. The coefficient ξ then measures if ESIF funding enhances the relative speed of convergence in funded regions on their path towards long-run steady-state income or not.[7]

As Everaert and De Groote (2016) point out, the panel data literature has recently stressed the importance of cross-sectional or spatial dependence given $Cov(u_{i,t}u_{j,t})\neq 0$ for some t and $i\neq j$. In the context of regional policy analysis, De Castris and Pellegrini (2012), among others, have shown that disregarding underlying spatial spillover effects associated with investment subsidies may lead to a substantial bias in the overall empirical assessment of policy effectiveness. Zubek and Henning (2016) argue for the case of EU structural funding that significant spatial spillovers may, for instance, reflect interdependencies among local governments in the geographical proximity (i.e., associated with yardstick competition or joint applications for common infrastructure projects). As Costa et al. (2015) further point out, these spillovers can either be beneficial or negative: for instance, if local expenditures refer to local public goods that are complementary (such as infrastructure or environmental services), it is likely that positive spillovers occur. However, for local public goods that are substitutable (e.g., higher education facilities), reverse external effects may emerge. Similar arguments also hold for private-sector investments, which may either support economic growth and development in neighbouring regions through positive spillovers or create negative external effects through intensified competition and poaching for scarce production factors.

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[7] Equation (1b) presents the special case of a more general regime-switching model between funded and non-funded regions, for instance, to test for different convergence clubs (Durlauf and Johnson, 1995).

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We address spatial dependence by extending equations (1a) and (1b) to space-time-dynamic growth equations. For the additive case in (1a) we can write

$$\begin{aligned}\ln(\mathrm{Y}_{i,t}) = {} & a_i + \delta \ln(\mathrm{Y}_{i,t-1}) + \rho \sum_{j=1}^{N} w_{ij} \ln(\mathrm{Y}_{j,t-1})) + \sum_{k=1}^{K} c_{1,k} \ln(\mathrm{X}^{(k)}_{i,t-1}) + \sum_{k=1}^{K} c_{2,k} \sum_{j=1}^{N} w_{ij} \ln(\mathrm{X}^{(k)}_{j,t-1}) \\ & + \gamma_1 \ln(\mathrm{ESIF}_{i,t-1}) + \gamma_2 \sum_{j=1}^{N} w_{ij} \ln(\mathrm{ESIF}_{j,t-1}) + \lambda_t + e_{i,t},\end{aligned} \tag{2a}$$

where γ_1 measures the direct output elasticity of ESIF funding as outlined above and γ_2 measures the spatial indirect output elasticity of ESIF funding resulting from a change in the funding intensity in region j: $\gamma_2 = \frac{\%\Delta \mathrm{Y}_{i,t}}{\%\Delta \mathrm{ESIF}_{j,t-m}} = \left[\frac{\partial \mathrm{Y}_{i,t}}{\partial \mathrm{ESIF}_{j,t-1}} \cdot \frac{\mathrm{ESIF}_{j,t-1}}{\mathrm{Y}_{i,t}}\right]$. Taken together, these two effects (γ_1 and γ_2) measure the overall impact of ESIF funding on output in region *i*. By construction, the included spatial lags measure the average value of a variable in the geographical neighbourhood of region *i*. To give an example, The spatial lag of $\mathrm{Y}_{i,t}$ is calculated as $\mathbf{W}\mathrm{Y}_{i,t} = \sum_{j=1}^{N} w_{ij} \ln(\mathrm{Y}_{j,t})$, where w_{ij} denotes the respective element of a row-standardized spatial weighting matrix **W** with dimension $(N \times N)$ capturing spatial linkages among the set of *N* regions. It fulfils the following properties: the matrix is non-negative, non-stochastic and finite, matrix elements are bound to $0 \leq w_{ij} \leq 1$ and $w_{ij}=0$ if $i=j$. Spatial linkages are constructed using inverted geographical (straight line) distances between the centroids of regions *i* and *j* (DIST_{ij}) as input for the elements w_{ij} of **W**. Spatial lags for the other regressors will be calculated accordingly.

In equation (2a), the parameter ρ measures the spatial connectivity of the model's dependent variable as a 'catch all' term for spatial dependence. Equation (2a) hence represents a spatial Durbin model (SDM), which nests a spatial lag of X (SLX) model as a special case. As outlined above, we will test for the proper empirical specification in terms of SLX versus SDM in a 'specific-to-general' manner. That is, we first test for the significance of spatial lag terms for the set of regressors (including

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ESIF funding) and then further test whether spatial spillovers are not only local ($\rho = 0$) but also global ($\rho \neq 0$) in nature. In the case of significant global spillovers, the more general SDM will be preferred over the SLX model.[8] As Halleck Vega and Elhorst (2015) point out, the SLX model is a suitable point of departure for the estimation and interpretation of spatial effects given its main focus on local spillovers. In comparison, global spillovers include system-wide spatial feedback effects. One distinct advantage of the SLX model compared to the SDM is that spillovers in the SLX specification only work through exogenous interaction effects and are thus less sensitive to identification problems and misspecifications of the underlying spatial weighting matrix (Gibbons and Overman, 2012).

The space-time dynamic convergence equation with multiplicative interaction terms is shown in equation (2b). We follow the approach outlined in Alecke et al. (2013) and include interaction terms composed of the policy variable, its spatial lag and the lagged dependent variable. The regression coefficient (ξ_3) for the interaction term of all three constitutional variables then measures how much the region's own speed of convergence conditional on ESIF funding $\left[\ln(\mathrm{Y}_{i,t-1}) \cdot \ln(\mathrm{ESIF}_{i,t-1})\right]$ is also influenced by the observed funding intensity in the region’s spatial neighbourhood. It thus captures underlying spatial agglomeration/crowding effects of funding:

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[8] Note that the SDM also nests the spatial autoregressive (SAR) model, which assumes that all spatial effects only arrive from the inclusion of a spatial lag of the dependent variable while ignoring other sources of local spatial spillovers. We will implicitly test for the presence of a SAR specification by significance testing for the coefficients of all spatial lags included in equation (2a).

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$$
\begin{aligned}
\ln(\mathrm{Y}_{i,t}) &= a_i + \delta \ln(\mathrm{Y}_{i,t-1}) + \rho \sum_{j=1}^{N} w_{ij} \ln(\mathrm{Y}_{j,t-1}) + \sum_{k=1}^{K} c_{1,k} \ln(\mathrm{X}_{i,t-1,k}) + \sum_{k=1}^{K} c_{2,k} \sum_{j=1}^{N} w_{ij} \ln(\mathrm{X}_{j,t-1,k}) \\
&+ \gamma_1 \ln(\mathrm{ESIF}_{i,t-1}) + \gamma_2 \sum_{j=1}^{N} w_{ij} \ln(\mathrm{ESIF}_{j,t-1}) + \xi_1 \sum_{j=1}^{N} w_{ij} \ln(\mathrm{ESIF}_{j,t-1}) \times \ln(\mathrm{ESIF}_{\mathrm{i},t-1}) \\
&+ \xi_2 [\ln(\mathrm{Y}_{i,t-1}) \times \ln(\mathrm{ESIF}_{i,t-1})] + \xi_3 \sum_{j=1}^{N} w_{ij} (\ln(\mathrm{ESIF}_{j,t-1}) \times [\ln(y_{i,t-1}) \times \ln(\mathrm{ESIF}_{\mathrm{i},t-1})]) + \lambda_t + e_{i,t}.
\end{aligned}
\tag{2b}
$$

For the estimation of equations (2a) and (2b) we extend the SYS-GMM estimator to a spatial system GMM (SpSYS-GMM) approach as proposed by Bouayad-Agha and Védrine (2010).[9]

To sum up, our intention behind using four alternative model specifications as shown in equations (1a), (1b), (2a) and (2b) is to develop and present a robust measure of the effectiveness of ESIF funding by providing a range of estimates of the marginal effect of the ESIF-policy variable on regional income growth, which reflects the complex nature of actual transmission channels of ESIF funding. One should finally note that the computation of marginal effects for ESIF funding, particularly in the case of interaction term models, is complex. Table A.1 in Appendix B provides further computational details.

Institutional framework of EU regional policy and data description

For the period of our empirical analysis from 1997 to 2007, ESIF funding has been allocated to three major objectives and a broader class of minor ones. As outlined above, we focus on the 'convergence' objective (or 'objective1' in the terminology before 2007). This objective explicitly targets intra-EU income convergence by stimulating growth in lagging regions through regional investment and infrastructure projects – mainly financed through the European Regional Development Fund

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[9] We restrict our analysis to a space-time dynamic model, which includes a time lag of the dependent variable and its spatial lag (see Anselin et al., 2008, for a discussion of different specifications).

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(ERDF) and the European Social Fund (ESF). For the purpose of analyzing policy effectiveness it is an advantage that the ‘convergence’ objective is clearly codified in conjunction with explicit criteria for funding eligibility (European Commission, 2015). That is, NUTS2 regions with a per capita GDP level below 75 percent of the EU average are eligible for receiving funds, irrespective of their current GDP growth performance or any form of growth expectations.[10] This helps to reduce the potential problem of reverse causality when we analyze the impact of funding on income growth. It is also advantageous for our analysis that the legislative framework has stayed nearly unchanged over the three multiannual funding periods covered by our data (European Council, 2015).

For our empirical analysis we build up a data set covering 127 (NUTS2) regions in the EU-15.[11] We restrict the time dimension of our data set to the period 1997-2007 in order to avoid biases in the estimation of structural growth determinants arising from strong business cycle movements in the course of the global economic crisis of 2007/08. Data before 1997 (up until 1993) are nonetheless included to construct a sufficient lag structure for the ESIF funding variable. We use de facto ESIF disbursements taken from the commission's annual report for the years 1994–99 (European Commission, 1995, 1996, 1997, 1998, 1999, 2000) and from on-site access at the EU Directorate-General for Budget (DG Budget) for the years 2000–07.[12] An overview of variables and their main summary statistics is given in Table 1.[13]

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[10] See Figure A.1 in Appendix C for an overview of the spatial distribution of per capita GDP levels and ESIF funding intensities for sample regions.

[11] As the underlying funding data are not consequently provided at the NUT2 level, we use NUTS1-level information if necessary. Regions in the new Member States are not taken into account due to limited data availability. Additionally, there is no information about provisions from other EU schemes before their access to the union. Appendix G lists all regions covered in the sample.

[12] Actual financial payments for the period 1994–99 are calculated on the basis of the N+2-rule. We thus equally spread the differences between the sum of commitments and payments for the year 1999 on the actual spending for the subsequent years 2000 and 2001.

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Table 1: Variable definitions and summary statistics

Variable	Measured as	Mean	Std. Dev.
Per-capita income (Y)	GDP per capita (in PPP)	21537.31	8328.19
Investment intensity (INV)	Gross fixed capital formation (GFCF) in manufacturing sector per capita (in €)	2063.92	18250.86
Human capital (HC)	Workforce in technical and science jobs in relation to the total employment (in %)	10.45	3.64
Labor force participation (LFS)	Total employment in relation to population (in %)	45.07	4.87
Population growth (POP)	Annual change of the population level (in %)	1.00	0.01
ESIF funding intensity (ESIF)	‘Convergence’ payments per capita (in €)	39.53	67.18

Notes: Variables enter the empirical model in logarithmic transformations (except for population growth). *Source:* All economic variables are taken from the Eurostat regional database, data on ESIF payments are obtained from DG Budget unit A.2.

Empirical results

Table 2 reports the results for the additive regression specifications as in equations (1a) and (2a). The estimated coefficients for the non-spatial model specifications in columns I to III are largely in line across the different estimators applied (FEM, FEMc, SYS-GMM). This can be taken as a first sign of the robustness of our results. In the following description, we focus on the SYS-GMM results, as the estimator can be straightforwardly extended to cover spatial effects. Since the SYS-GMM estimator relies on the use of proper internal instruments (Blundell and Bond, 1998), we report several post-estimation tests for instrument validity. These tests indicate neither instrument invalidity nor serially correlated errors.[14] However, as shown in Table 2, all non-spatial estimators are subject to cross-

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[13] We use GFCF in the manufacturing sector rather than total regional investments for two reasons: first, the major share of ESIF funding in 1997-2007 has been directed towards the manufacturing sector; second, total GFCF volumes at the NUTS2 level are subject to a high number of missing values in the period 1997-2007.

[14] Table 2 reports the results of the Hansen *J*- and *C*-statistics which test for instrument quality. We deliberately chose a small number of IV candidates based on a maximum lag length restriction of four periods and collapsed instruments in order not to

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sectional dependence in the error terms as indicated by the residual-based space-time Moran's *I* statistics (STMI) (Lopez et al., 2011).[15] This renders the set of non-spatial estimators inconsistent. With regard to the spatially augmented convergence equations in columns IV and V, the SLX model is found to be the preferred empirical specification. This model shows no evidence for the presence of global spatial spillovers stemming from the spatial lag of the dependent variable.

The estimated coefficients for the set of regressors are mostly in line with theoretical considerations: that is, we find a persistent, positive link between the human capital intensity and per-capita income levels. Similarly, an increase in the physical investment intensity is found to be positively related to higher per-capita income levels in most regression specifications. Moreover, in the case of the SLX model, positive direct effects of the physical investment and human capital intensity are accompanied by positive spatial spillover effects for these variables. We do not find additional effects stemming from an increase in labour force supply to per capita income, and the results for population growth are mixed. Finally, the included lagged per capita GDP variable has a coefficient of less than one which is in line with the convergence prediction of neoclassical growth theory.[16] With regard to the growth impact of ESIF funding, the empirical results predominantly indicate negative direct effects. Moreover, both the SLX and SDM find negative spatially indirect effects of funding that are highly statistically significant.

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weaken the test results (Roodman, 2009). Based on a Diff-in-Hansen *C*-test we also explicitly check whether the use of the level equation in the SYS-GMM approach may cause trouble and whether the internal instruments for the policy variable can be regarded as exogenous. Furthermore, AR2 tests for second-order autocorrelation in the residuals (Arellano and Bond, 1991).

[15] Further evidence for spatial dependence in the data is given in Figure A.3 (Appendix F). The figure highlights the degree of spatial dependence in per capita GDP for different sample years.

[16] As Arbia et al. (2008) point out, the regression parameter has to be interpreted carefully conditional on the chosen econometric method (e.g., including fixed effects implies that regions converge towards a region-specific steady state level).

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Table 2: Alternative specifications for convergence equation with additive policy variable

Dep. Var.: *ln*(Y$_{t}$)	(I) FEM Non-spatial	(II) FEMc Non-spatial	(III) SYS-GMM Non-spatial	(IV) SYS-GMM Spatial (SLX)	(V) SYS-GMM Spatial (SDM)
ln(Y$_{t-1}$)	0.7839***	0.9314***	0.8534***	0.7679***	0.8892***
	(0.0355)	(0.0205)	(0.0311)	(0.0296)	(0.0740)
ln(INV$_{t-1}$)	0.0031***	0.0022	0.0040***	0.0062	0.0099
	(0.001)	(0.0013)	(0.0013)	(0.0047)	(0.0091)
ln(HC$_{t-1}$)	0.0508***	0.00384***	0.0275*	0.0274**	0.0443**
	(0.0161)	(0.0102)	0.0153	(0.0126)	(0.0174)
ln(LFS$_{t-1}$)	0.0362	0.0151	-0.0176	-0.0084	-0.0249
	(0.0274)	(0.0284)	(0.0367)	(0.0375)	(0.0369)
ln(POP$_{t}$)	-0.1465	-0.6661**	0.0140**	0.0147**	0.0077
	(0.2852)	(0.3291)	(0.0057)	(0.0059)	(0.0051)
ln(ESIF$_{t-1}$)	-0.0016**	-0.0017***	-0.0007	-0.0011	0.0013*
	(0.0006)	(0.0005)	(0.0006)	(0.0010)	(0.0008)
W *ln*(Y$_{t-1}$)				—	-0.0350
					(0.2469)
W *ln*(INV$_{t-1}$)				0.0390**	-0.0220
				(0.0177)	(0.0314)
W *ln*(HC$_{t-1}$)				0.1359***	-0.2609*
				(0.0514)	(0.1384)
W *ln*(LFS$_{t-1}$)				-0.5644**	0.7858***
				(0.2853)	(0.2464)
W *ln*(POP$_{t}$)				-0.069*	0.0376
				(0.0359)	(0.0292)
W *ln*(ESIF$_{t-1}$)				-0.0120***	-0.0158***
				(0.0047)	(0.0045)
Regions	127	127	127	127	127
Observations	1211	1211	1211	1211	1211
Year dummies	Yes	Yes	Yes	Yes	Yes
Instruments			15	27	46
Hansen *J*-statistic			22.15* (15)	35.99 (27)	29.51 (22)
Diff-in-Hansen for lev. eq.			8.77 (6)	14.62 (11)	9.86 (12)
Diff-in-Hansen for *ln*(ESIF$_{t-1}$)			1.48 (2)	1.07 (2)	4.69 (3)
AR2 (serial correlation)			1.53	0.98	1.53
Residual-based STMI	0.160***	0.175***	0.181***	0.008	-0.007

Notes: ***,**,* denote significance at the 1%, 5% and 10% critical level. SLX=Spatial lag of X model; SDM=Spatial Durbin Model. Results reported for 127 EU regions. Robust standard errors clustered by regions are given in parentheses. SYS-GMM estimators are computed as efficient two-step GMM estimation. Numbers in brackets for the Hansen *J*-statistic and Diff-in-Hansen tests indicate the degrees of freedom for χ^2-tests. *Source*: Data obtained from Eurostat, DG Budget unit A.2.

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Table 3 computes the associated rates of return of these two funding components with respect to per capita income levels.[17] As the results show, the total rate of return stemming from the direct and spatially indirect ESIF funding effects ranges from zero to -0.5 per cent. Thus, at best, ESIF funding does not have any significant effect; however, in the majority of the cases shown in Table 3, the rate of return is negative (our results are thereby in line with earlier contributions stressing the role of spatial effects, such as Dall'Erba and LeGallo, 2008).[18]

Since the estimates of indirect effects may be sensitive to the construction of **W**, we carefully assess the robustness of our findings. While we use a row-standardized specification of **W** with inverted geographical (straight line) distances as default specification, we alternatively construct **W** using squared inverted distances and a binary weighting matrix based on the principle of the ten nearest neighbours of region *i* (see, e.g., Alecke et al., 2013 or Mohl and Hagen, 2010). The results obtained using these alternative specifications do not differ substantially from the estimated spatial effects using our baseline matrix **W**. ‘Placebo’ estimates based on an artificially created spatial weighting matrix containing randomly generated matrix elements show no significant spatial spillovers (see Appendix F). We take these results as an indication of the robustness of the estimated spatial spillover effects.

The multiplicative specifications according to equations (1b) and (2b) give further insights on the spatial spillovers of ESIF funding. We focus on a graphical illustration since the results from a multiplicative interaction term model can hardly be interpreted plainly on the basis of regression tables (Brambor et al., 2005). Part A of Figure 2 shows the marginal funding effect for the non-spatial model

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[17] We report the rate of return (rather than elasticities) here since the scaling of the two included funding intensities (the original ESIF variable and its spatial lag) may differ from each other. Additional estimation results and associated rates of return for model specifications with multiple lags of the ESIF funding intensity are shown in Table A.2 of Appendix D.

[18] Appendix E shows that empirical results remain unaffected when we account for the problem of “bad controls” (Angrist and Pischke, 2009) specifying an auxiliary equation for the investment intensity.

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according to equation (1b) expressed as a function of the region's income gap to steady state (dashed lines indicate 95 per cent confidence intervals).[19] If ESIF funding enhances the speed of convergence towards steady-state income in line with the 'convergence' objective, then the marginal funding effect would be positive and of larger size for regions farther away from steady-state income. However, Part A of Figure 2 shows exactly the opposite. That is, for regions with a larger initial gap to steady-state income the contribution of ESIF funding to income convergence is negative (up to an income gap of 50 per cent relative to steady-state income; thereafter it turns out to be statistically insignificant).

Table 3: Direct, indirect and total rates of return to ESIF funding

Estimates from:	Table 2 (I)	Table 2 (II)	Table 2 (III)	Table 2 (IV)	Table 2 (V)
Direct	-0.31%	-0.33%	(-0.13%)	(-0.21%)	0.25%
Indirect	—	—	—	-0.33%	-0.43%
Total	-0.31%	-0.33%	(-0.13%)	-0.54%	-0.18%

Notes: () indicate statistically insignificant results. For calculation of direct and spatially indirect rates of return, see main text. Total rate of return is calculated as the sum of the direct and indirect return rates.

For the spatially extended interaction term model in equation (2b), Part B of Figure 2 decomposes the ESIF funding effect by expressing it as a function of the region's income gap to steady state in the 5th, 10th, 20th, 80th and 90th percentiles of spatially weighted funding intensities in neighbouring regions. As the results show, for low to moderate levels of indirect ESIF funding, the marginal effect is insignificant. However, the effect becomes significant starting from the 80th percentile of the spatially weighted funding variable. This threshold level is also emphasized by the lower right graph (Panel

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[19] Following Pfaffermayr (2009), we assume that all regions approach their steady state from below and set the steady-state income level ('zero gap') equal to the maximum value of the income distribution in the sample.

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E in Part B of Figure 2) plotting the associated *t*-values (one-sided) for a test of the statistical significance of the mean marginal ESIF funding effect (averaged over the regions' own gap to steady-state income) for each percentile of spatially weighted ESIF funding intensities as the conditioning factor.

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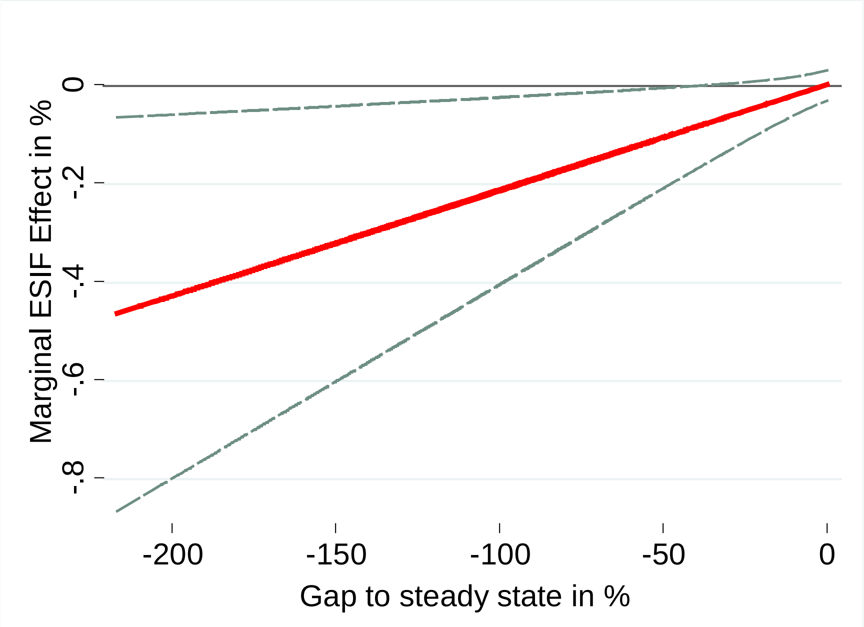
Figure 2: Marginal growth effects of ESIF funding in multiplicative regression specification

Part A: Non-spatial estimation results (equation (1b))



Part B: Spatially augmented estimation results (equation (2b))

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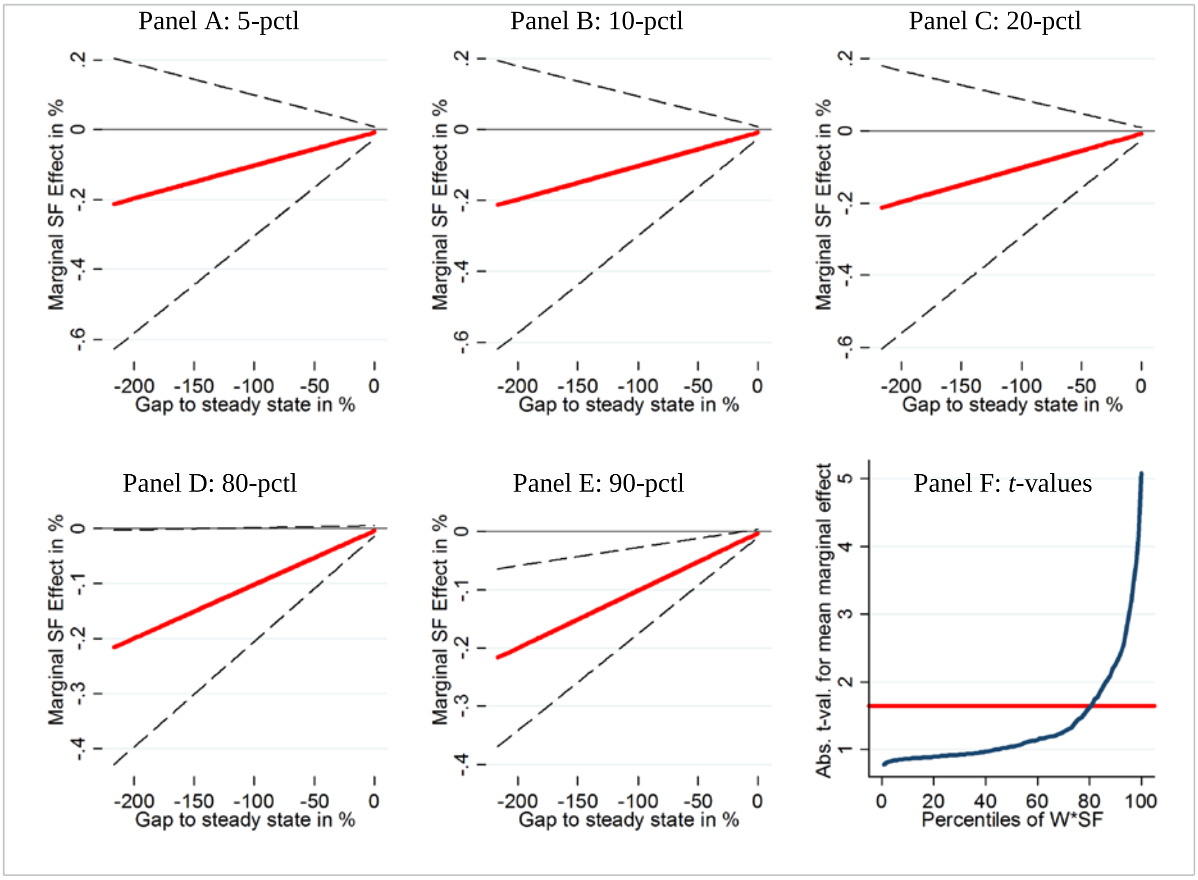

Notes: In Part B, spatially weighted ESIF funding intensities are displayed for selected percentiles of the variable distribution. Panel E in Part B shows the results of a *t*-test for the statistical significance of the mean marginal ESIF funding effect (averaged over the regions' gap to maximum GDP per capita level) for each percentile of the distribution of **W** *ln*(ESIF_{t-1}). Regression outputs for interaction model specifications can be found in the appendix. Dashed lines provide the 95 per cent confidence interval. Details on the calculation of the marginal effect of ESIF funding see Table A.1 in Appendix B. *Source:* Data from Eurostat, DG Budget unit A.2.

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Discussion of results

The presented results do not show evidence for convergence enhancing effects of ESIF funding given that we find negative direct and spatially indirect funding effects. Whereas the former effects diminish when we control for spatial spillovers of funding, the latter effects appear to be highly significant and substantial in size. One explanation for this sobering result may relate to an intensified poaching on factor markets: accordingly, the detriment of a region which is located in geographical proximity to a highly funded region can be explained by the reduction of mobile resources, such as physical investments, moving into the region. In this logic, the pre-funding distribution of investment intensities constitutes an efficient market outcome, which is distorted by ESIF funding.

The results of the spatial interaction term model additionally indicate that the observed negative spatial effects of ESIF funding are in particular dominated by certain macro-regional clusters with high funding intensities, where the latter may be interpreted as an indicator for institutional, technological and structural backwardness in these macro-regions.[20] Part A of Figure 3 provides an overview of regions with a significantly negative ESIF funding effect conditional on their gap to steady-state income and the funding intensities in their spatial neighbourhood. The role of structural backwardness as a hampering factor to economic growth and the functioning of regional policy relates to earlier contributions, such as Ederveen et al. (2006), Di Liberto and Sideri (2015) and Rodríguez-Pose and Garcilazo (2015). These studies particularly refer to the importance of the institutional setup in funded regions as a pre-condition for funding effectiveness and associated regional growth. For our sample this link is drawn graphically in Part B of Figure 3 highlighting a clear correlation between estimated mar-

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[20] See Pfaffermayr (2009) for prior evidence on a conditional spillover mechanism related to the level of technological advancement in neighbouring regions.

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ginal ESIF funding effects and regional government quality in 2013 constructed by Charron et al. (2015).

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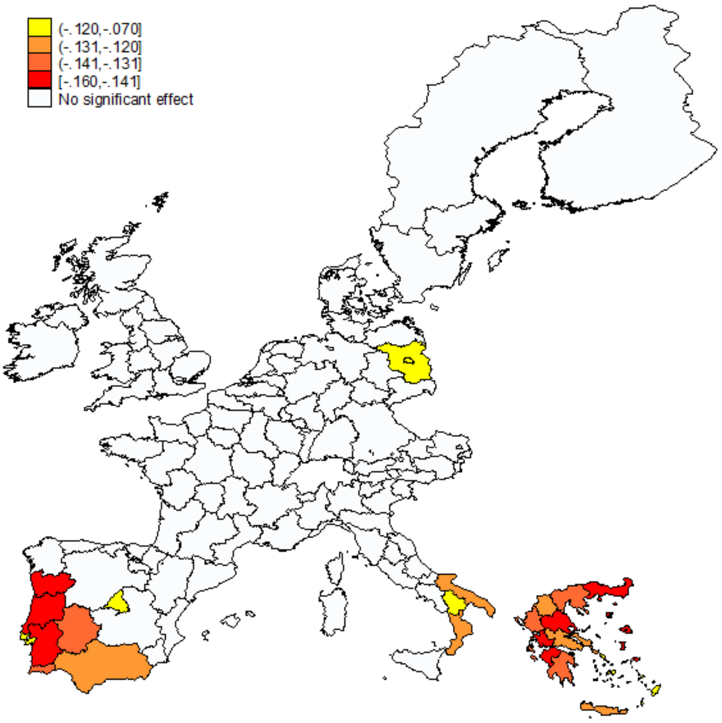
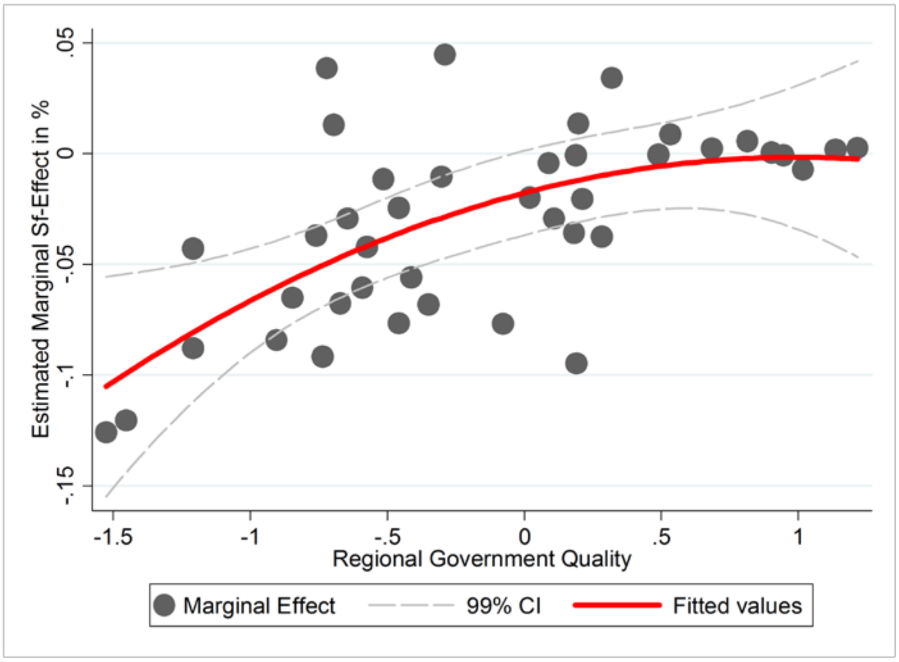
Figure 3: Spatial pattern of ESIF funding effects and correlation with regional government quality

Part A: Estimated ESIF funding effect on economic growth



Part B: Estimated ESIF funding effects and regional government quality



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Notes: Part A plots the quartile distribution of the (statistically significant) marginal ESIF funding effect based on the spatial interaction model estimation results in Table A.3 in Appendix D. Fitted values in Part B are computed as quadratic predictions together with a 99% confidence interval. Estimated funding effects are based on estimation results from Table A.3. Due to the limited availability of data on regional government quality in 2013, NUTS2 regions in Greece have been aggregated to the NUTS1 level (scatter plot shown for a total of 41 funded EU regions). *Sources:* Eurostat (2010), DG Budget unit A.2 and Charron et al. (2015) for survey data on regional government quality [higher scores indicate higher government quality].

Although data on regional government quality are unfortunately only available for the years after 2007 and can thus not be included as a regressor in the empirical convergence equations, the revealed positive correlation clearly hints at a significant link between these variables. The revealed correlation between the estimated ESIF funding effect and institutional quality can also be brought in line with earlier empirical evidence dealing with crowding-out effects of public investments (González Alegre 2012) as well as the role of political influence, federalism and lobbyism in the ESIF allocation and absorption process (Bouvet and Dall’Erba, 2010; Chalmers, 2013; Tosun 2014). Finally, Asatryan et al. (2017) report that higher ESIF funding volumes are not associated with a measurable higher public administration reform activity in these regions indicating that ESIF spending mainly serves as a compensation for higher costs rather than fostering public administration efficiency.

Conclusion

We have analyzed the effectiveness of EU regional policy (specifically ESIF funding under the ‘convergence’ objective) in fostering economic growth in lagging regions and thus supporting intra-EU income convergence. Different from the policy objective, however, our results indicate that ESIF funding has not supported income growth in EU-15 regions. Calculating the associated rate of return to ESIF funding with regard to per capita income, we obtain quantitatively similar rates for alternative econometric specifications ranging from zero to -0.5 per cent. Our econometric analysis further shows that the negative funding effect is in particular driven by spatial spillovers. This latter result is found to be robust for alternative measures of spatial association among regions and different model specifica-

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tions which incorporate transmission channels from policy input to per-capita income either in an additive or a multiplicative manner. In the latter case, regions characterized by a larger distance to steady-state income and higher average ESIF funding intensities in neighbouring regions are found to have the most negative funding effect.

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Two possible explanations may be given for this negative link: first, ESIF funding, mainly implemented through private-sector investment subsidies, induces a market distortion related to substitutive effects of investment projects or intensified poaching among neighbouring regions of scarce production factors. Future designs of EU regional policy should then aim at reducing this ‘neighbour’s curse’ by extending the notion of additionality of funded projects. Since we find that the estimated negative effect is mainly driven by funded regions with relatively high funding intensities in their spatial neighbourhood, it would be advisable to jointly consider larger macro-regions as potential recipients of ESIF funding, which would allow to better address complementarities, absorptive capacities and interventions tailored to the contexts and needs of specific macro-regions (Farole et al., 2011).

Alternatively, high intensities of ESIF funding in neighbouring regions may be regarded as an indicator of institutional, structural or technological backwardness in a macro-regional context. Earlier findings in the literature confirm this view – thereby pointing at the role played by missing trade and input-output linkages as well as ill-functioning institutions for missing regional growth and funding ineffectiveness. Accordingly, the results suggest that substituting necessary fundamental and long-lasting structural reforms in such macro-regions, e.g., related to the bottleneck of deficient administrative capacities (Asatryan et al., 2017) by enormous funding-based, short-termed investment projects, is not a promising recipe for overcoming the poor economic growth performance in the EU.

The EU commission should thus continue to place greater emphasis on creating proper institutional conditions for development as an important prerequisite for receiving funding (European Commission, 2010) and otherwise be very careful in offering standardized funding programmes, as in particular southern European regions are shown to suffer from structural backwardness and are caught in persistent growth traps. In the context of the growing budgetary importance of EU regional policy and its increasing political importance as a means to tackle Europe’s economic challenges, these consid-

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erations should be taken seriously in the designing of new funding priorities and associated regulations in order to obtain long-lasting growth stimuli in key areas, such as education, innovation and risk finance for small businesses.

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