Do EU structural funds promote regional growth? Evidence from various panel data approaches

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Abstract

This paper analyses the growth effects of EU structural funds using a new panel dataset of 124 NUTS-1 / NUTS-2 regions over the time period 1995–2005. We extend the current literature with regard to at least three aspects: First of all, we extend the time period of investigation, using structural funds payments of the last Financial Perspective 2000–2006 that have not been analysed before. Second, we use more precise measures of structural funds by distinguishing between Objective 1, 2 and 3 payments and by investigating the impact of time lags more carefully. Third, we examine the robustness of our results by comparing different econometric approaches highlighting specific methodological problems. Apart from "classical" panel data methods like system GMM, we apply spatial panel econometric techniques.

The empirical evidence indicates that the Objective 1 payments in particular have a positive and significant impact on growth, whereas Objective 2 and 3 payments negatively affect the regions' growth rates. Furthermore, our results show that the growth impact occurs with a time lag of up to five years.

Keywords: EU structural funds, economic growth, spatial econometrics

JEL classification: R11, R12, O47, C21

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1 Introduction

More than one third of the EU's total budget is spent on so-called Cohesion Policy via the structural funds. Its main purpose is to promote the "overall harmonious development" of the EU, to reduce disparities between the levels of development, and to strengthen its "economic and social cohesion" (Art. 158 TEC).

Investigating the impact of European structural funds on the economic growth and convergence process is a wide research topic. Nevertheless, the empirical evidence has provided mixed, if not to say, contradictory results. While some authors do find evidence of a positive impact of structural funds on economic growth (Eggert, von Ehrlich, Fenge, and König, 2007; Bouvet, 2005; Cappelen, Castellacci, Fagerberg, and Verspagen, 2003), others find weak (Percoco, 2005; Bussoletti and Esposti, 2004; Esposti and Bussoletti, 2008) or even no impact at all (Dall'erba and Le Gallo, 2008; de Freitag, Pereira, and Torres, 2003; García-Milá and McGuire, 2001). There are many reasons for these mixed results, among others, the low quality of structural funds data at the regional level and a number of methodological problems.

Against this background, this paper addresses these issues by using a new structural funds dataset of 124 NUTS-1 / NUTS-2 regions over the time period 1995–2005. We extend the current literature with regard to at least three aspects: First of all, we investigate the impact of structural funds payments of the last Financial Perspective 2000–2006, which have not been analysed before. Second, we use more precise measures of payments of structural funds by distinguishing between Objective 1, 2, and 3 payments and by investigating the time lag of effectiveness in greater detail. Finally, we examine the robustness of our results by comparing a wide range of different panel econometric approaches highlighting specific methodological problems. In doing so, we control for heteroskedasticity, serial and spatial correlation as well as for endogeneity.

Our results indicate that Objective 1 payments in particular do in fact promote growth, whereas both Objective 2 and Objective 3 payments have a negative influence on the regions' growth rates. Furthermore, we find that time lags affect the results significantly, so that the growth impact does not occur immediately, but with a time lag of up to five years.

This paper is structured as follows. Section 2 briefly reviews the literature on the impact of structural funds on economic growth and the economic convergence process, respectively. Section 3 discusses the econometric challenges. Subsequently, the dataset is described in section 4, followed by the presentation of the econometric analyses in section 5. Finally, section 6 concludes.

2 Literature review

This section briefly reviews the literature on the impact of structural funds on economic growth and convergence, respectively. While some papers use country data (e.g., Bähr, 2008; Ederveen, de Groot, and Nahuis, 2006; Beugelsdijk and Eijffinger, 2005), this review focuses exclusively on papers using regional data. The main aspects of the previous papers are summarised in Table 1.

Generally, the literature review does not lead to clear-cut results. Some authors do find empirical evidence for a positive impact of European structural funds. The conclusions are based on different sample sizes: Bussoletti and Esposti (2004) use an EU-15 sample, whereas smaller samples are used by Cappelen, Castellacci, Fagerberg, and Verspagen (2003) (EU-9) or Bouvet (2005) (EU-8). Some studies even concentrate on single country studies such as Eggert, von Ehrlich, Fenge, and König (2007) (Germany) or Antunes and Soukiazis (2005) (Portugal). Furthermore, some authors do not find a statistically significant impact of structural funds on the regional growth rates (García-Milá and McGuire, 2001; Dall'erba and Le Gallo, 2008). Moreover, in some cases the findings are conditioned on certain aspects. Rodriguez-Pose and Fratesi (2004) conclude that only structural fund expenditures for education and investment have a positive effect in the medium run, whereas expenditures for agriculture do not. Ederveen, Gorter, de Mooij, and Nahuis (2002) condition the key results on the assumptions of the convergence model. Assuming that all regions finally catch up to the same level, they find positive evidence. By contrast, assuming that the convergence process is limited to convergence within countries, they do not find a positive effect. Finally, Puigcerver-Peñalver (2004) find the structural funds to have a positive impact on the growth rates for the period 1989–1993, but not for 1993–1999.

The literature review clarifies that there are a number of issues requiring further investigation. First of all, the current literature has concentrated on the time period before 2000. Hence, the effectiveness of the last Financial Perspective 2000–2006 has not yet been evaluated. Moreover, the existing papers have not investigated in detail the impact of the different Objectives defined by the European Commission. In addition, some studies do not distinguish between payments and commitments. Furthermore, one might criticise that the time lag of the effectiveness has not yet been analysed. Finally, some papers are limited concerning the econometric approaches applied, so that the robustness of the results might be questioned. In this respect, the aspect of endogeneity and the potential bias resulting from spatial correlation have hardly been controlled for (one notably exception is Dall'erba and Le Gallo, 2008).

3 Econometric challenges

When estimating the effects of structural funds payments on economic growth at the regional level, several methodological challenges have to be considered.

First of all, there is the danger of a biased estimate due to reverse causality. The allocation criteria of the structural funds are likely to be correlated with the dependent variable "economic growth". First and foremost, the allocation of structural funds is based on the ratio of the regional GDP (in PPS) and the EU-wide GDP. If this ratio is below 75 per cent, the region is a so-called "Objective 1" region, implying that this region is eligible to the highest transfers relative to GDP. Furthermore, allocation depends, inter alia, on the regional unemployment rate, the employment structure, and the population density. The effective payments by the Commission to the regions depend on the regions' abilities to initiate and co-finance projects. This ability may depend on the wealth of the regions.

Second, there may be endogeneity of the structural funds, i.e., there may be unobserved variables simultaneously affecting structural funds payments and growth. If these are constant over time they are eliminated by fixed-effects or by first differences. If these unobserved variables are not constant, methods such as instrumental variable (IV) estimators are necessary.

Third, there may be regional spillover effects. For example, structural funds payments may increase one region's growth which, in turn, may affect neighbouring regions' growth rates positively. If these spillover effects cannot be separated from the "original" impulse, the estimated effect of structural funds payments might be biased.

In order to deal with the first and the second problem, an IV estimator combined with fixed-effects or first-differences seems to be the right choice. However, no suitable external IV is available. Hence, identification will be based on internal instruments via a two-step system GMM estimator (Blundell and Bond, 1998). The third problem is addressed by applying a spatial regression model, where we use a weight matrix containing information on the k-nearest neighbours of each region in order to remove spatial autocorrelation as recently proposed inter alia by Anselin, Florax, and Rey (2004).

Obviously, given the available data, we are not able to deal with all problems mentioned above simultaneously. However, by applying different methods, we hope to get a general idea about the methodological problems and the range of the true effect of structural funds payments on growth.

4 Variables and data

Unfortunately, data availability at the European regional level is limited with regard to both structural funds data and economic variables. Consequently, the choice of the time period of investigation and the choice of regions are pre-determined by the availability of suitable data.

The annual reports on structural funds published by the European Commission (1995, 1996a,b, 1997, 1998, 1999, 2000) only comprise regional commitments / payments for the period 1994–1999. Unfortunately, since 2000, these reports only contain data at the country level. However, we were given access to the annual regional payments and commitments by the European Commission in Brussels. This dataset contains payments for the time period 2000–2006 that has, to the best of our knowledge, not yet been analysed before.

It has to be taken into account that only payments of the period 2000–

2006 are available in this dataset, i.e. remaining payments from the previous Financial Perspective 1994–1999 are excluded. In order to avoid an underestimation of the total amount of European structural funds, we allocate those commitments from the Financial Perspective 1994–1999 that have not been paid out by 1999 to the years 2000 and 2001. In doing so, we calculate the residual amount of structural funds by subtracting the aggregated payments for 1994–1999 from the aggregated commitments for 1994–1999. Assuming that all commitments finally lead to payments and taking into account the N+2 rule, which basically states that payments can be called up two years after they have been allocated as commitments, we allocate the remaining amount at a rate of 2:1 to the years 2000 and 2001, respectively.

In our analysis we concentrate on Objective 1, 2 and 3 payments. These have different aims which can be classified under three topics (see Table 2): (i) The highest share of structural funds payments (approximately two-third of total structural funds) are spent for Objective 1 projects, which shall promote development in less prosperous regions. The remaining part is shared almost equally among (ii) Objective 2 payments for regions in structural decline and (iii) Objective 3 payments to support education and employment policies. As these Objectives each consisted of two Objectives in the Financial Perspective 1994–1999, we add the Objective 6 payments to Objective 1, the Objective 5b payments to Objective 2 and the Objective 4 payments to Objective 3. Note that there is a clear-cut definition concerning which regions qualify as an Objective 1 receiver (regional GDP has to be lower than 75% of the EU average), while a strict definition is missing in the case of the latter two Objectives. Moreover, we are only interested in the impact of structural funds on the regional growth rates, so that we only use those payments that we are able to allocate to the regional level. Therefore, multi-regional programmes aiming at the national level (e.g. structural funds expenditures for education) are not considered. As a consequence, we can extend the period of investigation to the time period 1995–2006.

To present an overview of the regional distribution of the payments of structural funds, Figures 1–3 show quantile maps of the structural funds for each Objective. These maps display the distribution of the funds over nine intervals by assigning the same number of values to each of the nine categories in the map. The payments are expressed in per cent of nominal GDP and are displayed for the two subperiods (1995–1999, 2000–2005) that mainly correspond to the two previous Financial Perspectives, as well as for the entire time period of observation (1995–2005). The darker the area, the higher the share of the region's payments of structural funds per GDP. The figures show that Ireland, Eastern Germany, Greece and Spain benefit most from Objective 1 payments, whereas France, the UK and Northern Spain show particularly high gains from Objective 2 payments. The payments of Objective 3 have a similar regional distribution pattern to those of Objective 2. Finally, the bottom right corner of the panel shows the distribution pattern of the sum of Objective 1, 2 and 3 payments. As this pattern is clearly similar to that of Objective 1 payments, it reveals that Objective 1 payments comprise the largest share of total structural funds.

Moreover, Figure 4 displays the distribution pattern of the GDP per capita variable, showing darker areas to indicate regions wealthier compared to the EU-15 average. Following the logic of the European Cohesion Policy to reduce disparities among the European regions, regions with a lower GDP relative to the EU average should receive more structural funds, enabling these countries to catch up. A comparison of Figure 4 with Figures 1–3 indicates that the real GDP per capita variable is a good proxy for Objective 1, but a rather bad proxy for Objective 2 and 3 payments. Furthermore, it becomes clear that the receivers of Objective 1 payments often do not receive an equally large sum from Objectives 2 and 3 and vice versa.

The economic data we use is taken from the Regio database by Eurostat. Due to recent modifications in the accounting standards (from the European System of Accounting (ESA) 1979 to ESA 1995), we only use variables available in ESA 1995.

For the spatial econometrics analysis, we were given access to the Gisco Eurostat dataset containing spherical coordinates measured in latitudes and longitudes of the European Union and of the candidate countries (see Eurostat, 2007). We adjust the data according to the selection of our dataset which comprises 124 NUTS-1 and NUTS-2 regions. As mentioned above, the selection of NUTS regions is mostly predetermined by the allocation of structural funds.[1] For a detailed description of the choice of the NUTS level, see section A of the Appendix. Furthermore, all variables are described in Table 3 in the appendix.

5 Empirical analyses

This section presents the econometric analysis of the paper by using the new panel dataset for the time period 1995–2005 and by addressing the methodological challenges discussed above. Beginning with the "classical" panel regression approaches (Least Square Dummy Variable estimator (LSDV), Newey and West, Prais-Winsten, system GMM) in section 5.1, the influence of spatial spillovers are investigated in greater detail in section 5.2. Finally, section 5.3 comprises further robustness checks.

5.1 "Classical" panel regression approaches

Derived from a neoclassical Solow-Swan-type growth model (Solow, 1956; Swan, 1956) and similar to the empirical approach of Ederveen, de Groot, and Nahuis (2006) and Bähr (2008),[2] we estimate the following growth model:

$$\begin{aligned} ln(y_{i,t}) - ln(y_{i,t-1}) = &\beta_0 + \beta_1\, ln(y_{i,t-1}) + \beta_2\, ln(inv_{i,t-1}) + \beta_3\,(n_{i,t-1} + g + \delta) \\ &+ \beta_4\, ln(innov_{i,t-1}) + \beta_5\, ln(sf_{i,t-1}) + \mu_i + \lambda_t + u_{i,t} \end{aligned} \tag{1}$$

where the subscript $i = 1, ..., 124$ denotes the region and t indicates the time index of our sample ranging from 1995–2005. Moreover, $y_{i,t}$ is the log of GDP per capita (in PPS) of region i at time t, $inv_{i,t-1}$ indicates the gross fixed capital formation (in % of nominal GDP). $n_{i,t-1}$ is the population growth rate, g and δ stand for the technological progress and the time discount factor. Similar to Mankiw, Romer, and Weill (1992), we assume that δ and g are constant over time and region and jointly amount to 5%.

[1] There are only six regions for which we have structural payments, for which, however, the control variables are missing (see Appendix section A).

[2] However, in contrast to our analysis, Ederveen, de Groot, and Nahuis (2006) and Bähr (2008) use country data.

Finally, we include fixed-region effects (μ_i) as well as fixed (annual) time effects (λ_t), while $u_{i,t}$ is the i.i.d. error term of the specification. The summary statistics and the correlation matrix comprising all variables are listed in Tables 4 and 5.

Unfortunately, data availability of our explanatory variables is limited at the regional level. There are, to the best of our knowledge, no high-quality education data like those proposed at the country level by De La Fuente and Doménech (2006), Barro and Lee (2001) or Cohen and Soto (2007). Hence, we must assume that education is proxied by the innovation variable, $innov_{i,t-1}$, that measures the number of patents per million inhabitants. To test for robustness, we also ran the regressions using the number of hightech innovations per million inhabitants. However, the results did not change substantially.

Our main variable of interest is the structural funds payments variable ($sf_{i,t-1}$), which is expressed as a share of nominal GDP. We do not only analyse the growth impact of total regional structural funds payments, but we also distinguish between Objective 1, 2 and 3 paymeents. Moreover we analyse in greater detail the impact of time lags. It may be argued that structural funds projects, such as infrastructure investments, only become effective after some time lag. Thus, we first start with a regression excluding the structural funds variable as a reference and we then successively add the payments of structural funds variable beginning with a lag of one year and ending with a specification comprising structural funds variables with a one- and up to a five-year lag, i.e., the regression includes the following term $\sum_{j=1}^{5} ln(sf_{i,t-j})$. Due to multicollinearity the coefficients and standard errors of the structural funds variable cannot be interpreted if the variable is included into the regression with several lags. As a consequence, we calculate the sum of coefficients (Obj. joint significance (sum)) and test with a simple Wald test whether this sum is statistically different from zero (Obj. joint signif. (p-value)).

Surprisingly, the existing literature mainly discusses the sign and the significance of the estimated (short-run) coefficients when evaluating the effectiveness of EU Cohesion Policy, while a detailed interpretation of the size of the effects is missing. In addition, note that the estimated specification displayed in equation (1) implicitly equals a dynamic approach. Hence, it is more convincing to interpret the long-term impact of the structural funds by calculating the long-term elasticities.[3] We do so in the following and list the size (Obj. long-term elasticity) and the significance level (Obj. long-term elasticity (p-value)) of the long-term elasticities in the regression output tables. The estimated long-term elasticity can be interpreted as such that a one percent increase of structural funds (in % of GDP) leads to a rise of the real GDP per capita by $X\%$.

In order to increase the robustness of our results and due to the great influence of the estimation procedure, we estimate our model with various econometric approaches. We begin with the LSDV estimator using White-Huber heteroskedasticity robust standard errors, followed by two estimation approaches controlling for serial correlation (Newey and West (1987) and Prais-Winsten). Subsequently, we adjust the standard errors for heteroskedasticity, serial and spatial correlation as proposed by Driscoll and Kraay (1998). Finally, we run two-step system GMM regressions following Blundell and Bond (1998) in order to control for endogeneity.

The regression results displayed in Tables 6–25 are mostly consistent with the predictions of the neoclassical growth theory. We find – independently of the empirical estimation approach – that the initial GDP variable is negative and strongly significant in most cases. In empirical investigations for longer time periods (e.g. cross-section estimations for 20–100 years as can be found in Barro and Sala-I-Martin (2004) or for several 5-year averages as shown in Ederveen, de Groot, and Nahuis (2006)), the lagged initial GDP variable gives evidence for the conditional beta convergence, i.e., after controlling for other explanatory variables, this variable indicates whether poorer regions are likely to catch-up with richer ones. Note that from theoretical considerations this is only valid for more or less similar economies on their convergence pathes (Barro and Sala-I-Martin, 1995). This condition might be fulfilled as our sample consists of Western European regions. However, the time period of investigation is too short to derive solid predictions about the convergence

[3] $ln\, y_{i,t} = \beta_1 ln\, y_{i,t-1} + \beta_2 ln\, sf_{i,t} + ... \Leftrightarrow ln\, y_{i,t} - ln\, y_{i,t-1} = (\beta_1 - 1) ln\, y_{i,t-1} + \beta_2 ln\, sf_{i,t} + ... \Leftrightarrow ln\, y_{i,t} - ln\, y_{i,t-1} = \alpha\, ln\, y_{i,t-1} + \beta_2 ln\, sf_{i,t} + ...$ Hence, the long-term elasticity can be calculated as: $\beta_2/(1-\beta_1) = \beta_2/-\alpha$.

process. Nevertheless, the initial GDP is an important control variable in our panel, as it determines the allocation of Objective 1 payments.

Furthermore, the investment variable is – apart from some system GMM specifications – positive throughout the estimation approaches and in many cases it is statistically significant. The coefficients of the population growth rate follow the predictions of the Solow growth model, as it is negative and, in most cases statistically significant. Finally, the proxy for education, the innovation variable, is positive but it is in most cases only significant in the system GMM specifications.

The key variable of interest, however, is the structural funds variable. Beginning with the results of the LSDV estimator (Table 6), we find a positive and significant impact of structural funds on economic growth. The Objective 1 variables are jointly statistically significant with a lag of two years and up to a lag of four years, i.e., they are not significant with a lag of one (column (1)) and a lag of five years (column (6)). However, as stressed above, these tests evaluate the significance of the short-term elasticity, whereas it is more convincing to interpret the long-term elasticity. Table 6 shows that the Objective 1 payments have a positive impact which is statistically significant independently of the number of lags analysed. To be more precise, the results indicate that increasing the structural funds payments by one percent significantly rises the real GDP per capita by at least 0.407% and up to 0.801% depending on how many lags are included in the specification.

The LSDV approach assumes that all explanatory variables are strictly exogenous and that the error term is not serially correlated. The latter assumption affects the efficiency of the estimator and it is checked with the Wooldridge test of first-order autocorrelation (Wooldridge, 2002). The results in Table 6 show that the H0 of no first-order autocorrelation has to be rejected (Table 6). As a consequence, standard errors are specified as being robust not only to heteroskedasticity but also to first-order autocorrelation using the approach proposed by Newey and West (1987). The results displayed in Table 7 show that the standard errors of the structural funds variable are slightly increased in most cases, however, the significance levels hardly change. Moreover, we also use the Prais-Winsten transformation matrix to transform the AR(1) disturbances in the error term into serially uncorrelated classical errors. This method slightly reduces the coefficients of the joint significance, whereas it increases the long-term elasticity of Objective 1 payments by a small extent (Table 8). Overall, the results and the significance levels remain very similar to those of the previous specifications. Most importantly, the long-term elasticity of structural funds is still positive and highly significant from the first to the fifth lag.

Moreover, we repeat the analysis using standard errors that are robust to general forms of spatial dependence. Our set of regions is a non-random sample, which is possibly subject to common influences affecting our variables of interest. Thus, we estimate standard errors employing a non-parametric covariance matrix estimation procedure as proposed by Driscoll and Kraay (1998) (for a recent discussion, see Hoechle, 2007). The results displayed in Table 9 further strengthen our previous findings. The long-term elasticities of the Objective 1 variables are still positive and significant, independently of the number of lags included.

Finally, as discussed in section 3, our results might be biased due to endogeneity of the explanatory variables. Hence, we estimate equation (1) using the two-step system GMM estimator proposed by Blundell and Bond (1998), assuming that the initial GDP level, the structural funds, and the gross fixed capital formation variables are endogenous, while only the population growth rate, the innovation variable and the time dummies are assumed to be strictly exogenous. The standard errors are finite-sample-adjusted using the approach by Windmeijer (2005). In order to guarantee a parsimonious use of instruments, we use less instruments than number of regions included in our regression. The reason for this is that using too many instruments can overfit instrumented variables (Roodman, 2007), reduce the power properties of the Hansen test (Bowsher, 2002) and lead to a downward-bias in two-step standard errors (Windmeijer, 2005). As a robustness check we also run the system GMM regressions without limiting the number of instruments. However, the results do hardly change and they are available upon request.

Given this parsimonious specification the estimation results in Table 10 show that the Hansen test of over-identifying restrictions is not statistically significant, i.e., its null hypothesis which states that the instruments are not correlated with the residuals cannot be rejected. Apart from the Hansen test, we also report the p-values for the tests of serial correlation. These tests are based on first-differenced residuals and we expect the disturbances $u_{i,t}$ to be not serially-correlated in order to yield valid estimation results. The regression output in Table 10 shows no second-order serial correlation (AR(2) (p-value)). As a consequence, these test statistics indicate that the model is correctly specified.

Concerning the main variable of interest, the structural funds variable, Table 10 provides clear evidence that the Objective 1 variables are jointly significant with up to three lags. Moreover, focussing on the long-term elasticity it becomes clear that they are only statistically significant different from zero with a lag greater than four years. In addition, the effectiveness is substantially reduced compared to the previous specifications: A one percent increase of Objective 1 payments now results in a rise of the real GDP per capita by approximately 0.13%.

We repeat this estimation procedure using the payments of structural funds of Objective 2 (Tables 11–15), 3 (Tables 16–20), and the total sum of Objectives 1, 2, and 3 (21–25) instead. The results reveal stable results for all explanatory variables implying a good fit of the neoclassical growth model. However, there are clear differences concerning the sign and the significance level of the single Objectives. Our results indicate that the long-term elasticities of Objective 2 payments are statistically significant with a lag from one to up to four years independently which estimation approach is chosen. However, the coefficients now have a negative sign implying a negative impact on growth. A one percent increase of Objective 2 payments decreases the regional GDP per capita by approximately 0.2% given a one year lagged variable. Similarly, Objective 3 payments have a negative impact as well, implying that a one percent increase of Objective 3 payments results in a reduction of the GDP per capita which is rather similar to the one of Objective 2.

This negative impact may be explained by two points: First, in contrast to Objective 1 payments, Objective 2 and 3 payments are not solely based on clear criteria. Hence there is more room for political bargaining and/or side payments. Second, de jure the structural funds payments have to be co-financed. However, recent panel studies using country data provide evidence that the is some crowding out of national public investment. This, in turn, might have negative impact on the regional GDP. Third, our simple neoclassical growth model implicitly assumes full-employment. If Objective 2 and 3 payments directly affect the labour markets and if these effects are not mirrored in the development of the real GDP per capita variable, we cannot measure the impact of these consequences.

Finally, the results for the total sum of Objectives 1+2+3 payments are not as clear-cut as those for the single Objectives. In most cases, we find evidence that Objectives 1+2+3 have a positive impact on the regions GDP per capita. However, when including up to 5-years lagged structural funds variables, the sign turns negative.[4]

5.2 Spatial analysis

The results of our "classical" panel regression approaches might be biased, because apart from adopting the standard errors according to the Driscoll and Kraay (1998) approach, we neglect any sort of spatial correlation. Hence, one might argue that part of our significant results are explained by regional spillover effects. Moreover, in our sample of 124 Western European regions, those regions which are located next to each other might disclose a stronger spatial dependence than regions at a greater distance.

In order to take these considerations into account, we apply spatial econometric techniques, where the key task is to specify a weight matrix W containing information about the connectivity between regions. This square matrix has N rows / columns corresponding to our sample of 124 regions. Its diagonal consists of zeros, whereas each w_{ij} specifies the way region i is spatially connected to region j. To standardise the external influence upon each region, the weight matrix is normalised such that the elements amount to one. We follow the approach by Le Gallo and Ertur (2003) and Ertur and Koch (2006) and use a weight matrix consisting of the k-nearest neighbours computed from the distance between the centroids of the NUTS regions.[5]

[4] In case of the system GMM specification of Table ?? the negative impact starts when using more than three lags.

[5] We use the Matlab toolbox "Arc_Mat" (LeSage and Pace, 2004) to determine the centroids of the polygons (regions) expressed in decimal degrees. These are converted to

This weight matrix is purely based on geographical distance, which has the big advantage that exogeneity of geographical distance is unambiguous. Generally, the k-nearest neighbours weight matrix $W(k)$ is defined as follows:

$$W(k) = \begin{cases} w^*_{ij}(k) = 0 \text{ if } i = j \\ w^*_{ij}(k) = 1 \text{ if } d_{ij} \leq d_i(k) \text{ and } w_{ij}(k) = w^*_{ij}(k)/\sum_j w^*_{ij}(k) \\ w^*_{ij}(k) = 0 \text{ if } d_{ij} > d_i(k) \end{cases}$$

where w^*_{ij} is an element of the unstandardised weight matrix W and w_{ij} is an element of the standardised weight matrix, $d_i(k)$ is smallest distance of the k^{th} order between regions i and j such that each region i has exactly k neighbours. Following Ertur and Koch (2006), we set $k = 10$.[6]

Generally speaking, there are two possibilities to integrate this weight matrix into the regression model. One can either include a spatially-weighted dependent variable (the so-called "spatial lag model") or a spatially autocorrelated error ("spatial error model") into the regression model. We follow the first route and estimate the following model, which includes the sample of 123 regions:

$$\begin{aligned} ln(y_{i,t}) - ln(y_{i,t-1}) = & \beta_0 + \rho W\big(ln(y_{i,t}) - ln(y_{i,t-1})\big) + \beta_1 ln(y_{i,t-1}) \\ & + \beta_2 ln(inv_{i,t-1}) + \beta_3 ln(innov_{i,t-1}) \\ & + \beta_4 (n_{i,t-1} + g + \delta) + \beta_5 ln(sf_{i,t-1}) + \mu_i + \lambda_t + u_{i,t} \end{aligned} \tag{2}$$

Apart from the inclusion of the lagged and spatially-weighted dependent variable as an independent variable, the selection of variables remains the same as in equation (1).

Generally, including a spatially-lagged dependent variable into a panel fixed effects model generates an endogeneity problem because the spatially-weighted dependent variable is correlated with the disturbance term (Elhorst,

lattitude and longitude coordinates and listed in Table 26. The 10 nearest neighbours of each region are then calculated with the help of the Spatial Statistics Toolbox 2.0 (Pace, 2003).

6 For example, the elements of the row / column vector of the weight matrix (W) for the region "Region de Bruxelles-capitale" (be) are all zeros with the exception of the ten nearest neighbours (be2, be3, fr10, fr21, fr22, fr30, fr41, nl2, nl3 and nl4) whose elements are 0.1.

2009). In order to control for this simultaneity, the following results are based on a fixed effects spatial lag setup using the maximum likelihood (ML) estimator proposed by Elhorst (2004, 2009). Unfortunately, it is currently not possible to estimate a spatial lag model and to control simultaneously for endogeneity of other independent variables, e.g. within a system GMM approach. The reason for this is that introducing a spatial weight matrix creates a non-zero log-Jacobian transformation from the disturbances of the model to the dependent variable, while the system GMM procedure by Blundell and Bond (1998) is based on the assumption of no Jacobian term involved.[7]

The results are reported in Tables 27–30. One indicator which tests if spatial effects are present is given by the coefficient of the weight matrix (ρ). The results show that ρ is positive throughout and highly significant. Furthermore, it becomes clear that the use of the spatial weight matrix slightly decreases the coefficients of the explanatory variables. Thus, it emerges that the explanatory power of these variables that was attributed to their in-region value is really due to the neighbouring locations, which is now allowed for by the coefficient of the spatially weighted dependent variable. Generally, the results of the coefficients again follow the neoclassical growth predictions. We find a negative and significant impact of initial GDP and population growth. The investment variable has a positive and predominantly significant impact on the GDP growth rate. Only the innovation variable switches signs as it is now negative.

Most importantly, the results confirm our previous conclusions concerning the effectiveness of the single Objective payments. The results show that the long-term elasticity of Objective 1 payments is positive and significant throughout (Table 27). According to the estimations, a one percent rise of Objective 1 increases the real GDP per capita by 0.11–0.47%. Furthermore we find again evidence for a negative impact of Objective 2 (long-term elasticity between -0.26 and -0.63%) and of Objective 3 (from -0.005 to -0.18%). The long-term elasticity of Objective 1+2+3 is highly significant but it switches signs so that no clear results are possible.

[7] We thank James LeSage for this helpful advice.

5.3 Further robustness checks

One might argue that the results presented above are influenced by the noise of the annual growth rate, which is, e.g., strongly affected by business cycle effects. As our time period of investigation is rather short due to data availability, we cannot follow, e.g., Islam (1995), and use 5-year averages, as this would reduce our sample to two periods only. Furthermore, we do not wish to rely on a simple cross-section approach, as the unobservable time-invariant effects could not be cancelled out then, which might lead to biased estimates.

Instead, we re-run our regressions using 2-year, 3-year, and 4-year averages, thereby reducing our total number of periods to 5, 3, and 2.[8] Of course, we then have to reduce the maximum number of lags according to the dataset used, i.e., we use structural funds payments with lags of up to four periods in the 2-year dataset (corresponding to a maximum time lag of 8-years), whereas we only use payments with lags of two periods in the dataset comprising 3-year-averages and we restrict on payments with one period lag with regard to the dataset including 4-year-averages.

In most cases, the results of the Wooldridge test do not show any evidence of serial correlation. Hence, we stick to the LSDV estimator. Analogously to the previous subsections, we first implement the results for the restricted model, i.e., we exclude structural funds from our regression equation in columns (1). We then list the estimation results for the Objective 1, 2, 3, and the total sum of Objective 1+2+3 payments.

The results are reported in Tables 31–34. Once again, the control variables are mostly in line with the predictions of the Solow model.[9] Focussing on the structural funds payments, we also find confirming evidence for our main results. The long-term elasticity of Objective 1 payments has still a

[8] To be more precise, in order to generate the averaged datasets we need twelve time periods, whereas our original dataset only covers the period 1995–2005 with T equals eleven. Hence, the averaged datasets are generated between 1994–2005, whereas the last period is shorter, since data for 1994 is not available.

[9] The results show that regardless of which dataset is used, we find a negative and strongly significant impact of the initial GDP variable. At the same time, the investment and the innovation variable are largely positive but they are not always statistically different from zero. Finally, we find robust empirical evidence that the population growth rate has a negative impact on growth.

positive and highly significant impact on the regional GDP per capita independently of which dataset is used. In contrast, both Objective 2 and 3 payments have a negative effect which is statistically different from zero. Finally, the total sum of Objective 1+2+3 does not allow for unambiguous results.

6 Conclusion

The aim of this paper is to evaluate the growth effects of European structural funds payments at the regional level. Using a new panel dataset of 124 NUTS regions for the time period 1995–2005, we extend the current literature by (i) extending the time period of investigation to the years 1995–2005, (ii) using more precise measures of structural funds, and by (iii) comparing the robustness of our results by means of various econometric panel data techniques.

Our empirical results are based on panel methods controlling for heteroskedasticity, serial and spatial correlation as well as for endogeneity. In particular, using a spatial panel approach, we find that regional spillovers do have a significant impact on the regional growth rates independently of which Objective and time lag is analysed. In addition, the robustness of our results is strengthened by using a 2-, 3-, and 4-years averaged dataset.

We find empirical evidence that the effectiveness of structural funds in promoting growth is strongly dependent on which Objective is analysed. The main results of the long-term elasticities are summarised in Table 35. We find that Objective 1 payments in particular have a positive and statistically significant impact on the regions' GDP. By contrast, payments of Objective 2 and 3 have a negative effect on GDP, which is in many cases statistically significant. Our estimations do not allow for clear cut results for the total sum of Objectives 1, 2, and 3 as there are sign switches and the coefficients are not statistically significant in all cases. Broadly summmarising, we find that a one percent increase in structural funds leads to a positive/negative impact on the regional GDP level by approximately 0.2%. structural funds. Moreover, our results show that time lags play a key role in influencing the effectiveness. We find that the growth impact does not appear immediately, but that it occurs with a time lag of up to five years.

As mentioned above one explanation for the negative impact of Objective 2 and 3 payments might be the fact that these Objectives are clearly influenced by political bargaining and/or side-payments. Furthermore, one drawback of the current analysis is that we do not control for labour market effects ir this impact is not reflected in the initial GDP variable. This might be a strong assumption as given the goal of economic and social cohesion and given that Objectives 2 and 3 explicitly aim at promoting labour market related programmes. Hence, further research should investigate the employment effects of EU structural policy more carefully.

Acknowledgements

Special thanks go to Jose Madeira and Christian Weise (both European Commission) for their helpful support in acquiring the EU structural funds payments for 2000–2006. Moreover, we would like to thank Friedrich Schneider, François Laisney, the participants of the IIPF Annual Congress in Maastricht (23 August 2008) and those of the Annual Meeting of the German Economic Association (25 September 2008) for their helpful and inspiring comments and advice. Finally, we would like to thank Florian Mayer for his excellent research assistance.

Appendix

A Construction of the dataset

This section illustrates in more detail the construction of our database. The European regions are classified by the European Commission into three different groups called "Nomenclature des unités territoriales statistiques" (NUTS). These units refer to the country level (NUTS-0) and to three lower subdivisions (NUTS-1, NUTS-2 and NUTS-3) which are classified according to the size of population. Our dataset consists of both NUTS-1 and NUTS-2 regions. In order to guarantee the highest degree of transparency, this section lists the abbreviations of the NUTS code in brackets following the classifications of the European Commission (2007).

The choice of the NUTS level follows the data availability of structural funds payments. Generally, we try to use data on NUTS-2 level whenever possible. This is the case for France, Greece, Italy, Portugal, Spain, and Sweden. However, there are some countries (e.g. Germany) where we have to use NUTS-1 level because the annual reports do not contain more detailed information. Moreover, in other countries, there is no clear-cut distinction in the sense that in the annual reports the structural funds are partly allocated to the NUTS-1 and partly to the NUTS-2 level. Finally, the annual reports of structural funds for 1995 and 1996 (European Commission, 1996b, 1997) for some countries only contain data at the NUTS-1 level. Consequently, we chose the NUTS-1 level for Austria, Belgium, Finland, the Netherlands, and the United Kingdom.

For Denmark and Luxembourg, subdivisions do not exist, so that NUTS-0, NUTS-1 and NUTS-2 codes are the same. We regard those cases as NUTS-2 regions. In Ireland the labels of NUTS-0 and NUTS-1 level are identical, so that we classify Ireland as a NUTS-1 region.

Please note that we did not consider the overseas regions of France (Départments d'outre-mer (fr9) consisting of Guadeloupe (fr91), Martinique (fr92), Guyane (fr93) and Réunion (fr94)), Portugal (Região Autónoma dos Açores (pt2, pt20), Região Autónoma da Madeira (pt3, pt30)), and Spain (Canarias (es7, es70)).

As a consequence, our dataset consists of 130 NUTS-1 and NUTS-2 regions for which we have structural funds payments. However, we have to exclude six regions for which the economic control variables of Eurostat are not completely available. These regions are Saarland (dec0), Ionia Nisia (gr22), Voreio Aigaio (gr41), Ciudad Autónoma de Ceuta (es63), Ciudad Autónoma de Melilla (es64) and Luxembourg (lu). Thus, our dataset consists of the following 124 NUTS-1 and NUTS-2 regions:

Belgium (3 NUTS-1 regions): Région de Bruxelles-capitale (be1), Vlaams Gewest (be2), Région Wallonne (be3);

Denmark (1 NUTS-2 region): Denmark (dk);

Germany (15 NUTS-1 regions): Baden-Württemberg (de1), Bayern (de2), Berlin (de3), Brandenburg (de4), Bremen (de5), Hamburg (de6), Hessen (de7), Mecklenburg-Vorpommern (de8), Niedersachsen (de9), Nordrhein-Westfalen (dea), Rheinland-Pfalz (deb), Sachsen (ded), Sachsen-Anhalt (dee), Schleswig-Holstein (def), Thüringen (deg);

Greece (11 NUTS-2 regions): Anatoliki Makedonia, Thraki (gr11), Kentriki Makedonia (gr12), Dytiki Makedonia (gr13), Thessalia (gr14), Ipeiros (gr21), Dytiki Ellada (gr23), Sterea Ellada (gr24), Peloponnisos (gr25), Attiki (gr30), Notio Aigaio (gr42), Kriti (gr43);

Spain (16 NUTS-2 regions): Galicia (es11), Principado de Asturias (es12), Cantabria (es13), País Vasco (es21), Comunidad Foral de Navarra (es22), La Rioja (es23), Aragón (es24), Comunidad de Madrid (es30), Castilla y León (es41), Castilla-La Mancha (es42), Extremadura (es43), Cataluña (es51), Comunidad de Valenciana (es52), Illes Balears (es53), Andalucía (es61), Región de Murcia (es62);

France (22 NUTS-2 regions): Île de France (fr10), Champagne-Ardenne (fr21), Picardie (fr22), Haute-Normandie (fr23), Centre (fr24), Basse-Normandie (fr25), Bourgogne (fr26), Nord-Pas-de-Calais (fr30), Lorraine (fr41), Alsace (fr42), Franche-Comté (fr43), Pays-de-la-Loire (fr51), Bretagne (fr52), Poitou-Charentes (fr53), Aquitaine (fr61), Midi-Pyrénées (fr62), Limousin (fr63), Rhône-Alpes (fr71), Auvergne (fr72), Languedoc-Roussillon (fr81), Provence-Alpes-Côte d'Azur (fr82), Corse (fr83);

Ireland (1 NUTS-1 region): Irland (ie);

Italy (21 NUTS-2 regions): Piemonte (itc1), Valle d'Aosta/Vallée d'Aoste (itc2), Liguria (itc3), Lombardia (itc4), Provincia autonoma Bolzano (itd1), Provincia autonoma Trento (itd2), Veneto (itd3), Friuli-Venezia Giulia (itd4), Emilia-Romagna (itd5), Toscana (ite1), Umbria (ite2), Marche (ite3), Lazio (ite4), Abruzzo (itf1), Molise (itf2), Campania (itf3), Puglia (itf4), Basilicata (itf5), Calabria (itf6), Sicilia (itg1), Sardegna (itg2);

The Netherlands (4 NUTS-1 regions): Noord-Nederland (nl1), Oost-Nederland (nl2), West-Nederland (nl3), Zuid-Nederland (nl4);

Austria (3 NUTS-1 regions): Ostösterreich (at1), Südösterreich (at2), Westösterreich (at3);

Portugal (5 NUTS-2 regions): Norte (pt11), Algarve (pt15), Centro (P) (pt16), Lisboa (pt17), Alentejo (pt18);

Finland (2 NUTS-1 regions): Manner-Suomi (fi1), Åland (fi2);

Sweden (8 NUTS-2 regions): Stockholm (se11), Östra Mellansverige (se12), Småland med öarna (se021), Sydsverige (se22), Västsverige (se23), Norra Mellansverige (se31), Mellersta Norrland (se32), Övre Norrland (se33);

UK (12 NUTS-1 regions): North East (ukc), North West (ukd), Yorkshire and the Humber (uke), East Midlands (ukf), West Midlands (ukg), East of England (ukh), London (uki), South East (ukj), South West (ukk), Wales (ukl), Scotland (ukm), Northern Ireland (ukn).

B Tables and Figures

Table 1: Main results of previous papers on the impact of SF on economic growth

Paper by	Central results: Impact of sf on economic growth	Operationalisation of structural funds	Time period	Units	Econometric methods used
Esposti and Bussoletti (2008)	Positive impact of Obj. 1; however not significant in all estimations	Obj. 1 payments (in PPS)	1989-2000	206 NUTS-2 regions (EU-15)	Panel: differenced GMM, one-step & two-step system GMM
Eggert, von Ehrlich, Fenge and König (2007)	SF accelerate regions' convergence, but they reduce the average growth rate	SF payments (% GDP)	1989-1993, 1994-1999	16 NUTS-1 regions (Germany)	Pooled OLS: Regress aver. growth of 1994-1999 (2000-2004) on total SF of 1989-1993 (1994-99)
Dall'erba and Le Gallo (2007)	SF have no statistically significant impact on the regional growth rates	SF (% GDP)	1989-1999	145 NUTS-2 regions (EU-12)	Cross section: Spatial lag model
Antunes and Soukiazis (2005)	SF promote convergence. They are more effective in coastal regions than in the interior	Expenditures for the Eur. Development Fund (ERDF) per capita	1991-2000	30 NUTS-3 regions (Portugal)	Panel: pooled OLS, LSDV, Random Effects GLS
Bouvet (2005)	SF have a small but positive impact on regional growth rates	ERDF payments per capita	1975-1999	111 NUTS-1/-2 regions (EU-8)	Panel: OLS, Fuller-modified limited-information Maximum Likelihood
Percoco (2005)	SF are not effective in all regions	Obj. 1 (% GDP)	1994-2001	6 Obj. 1 regions (Italy)	Panel: GMM-IV
Bussoletti and Esposti (2004)	Small conditional impact of SF	Obj. 1 payments	1989-1999	206 NUTS-2 regions (EU-15)	Panel: First differences GMM, system GMM

Table 1: Main results of previous papers on the impact of SF on economic growth

Paper by	**Central results: Impact of sf on economic growth**	**Operationalisation of structural funds**	**Time period**	**Units**	**Econometric methods used**
Puigcerver-Peñalver (2004)	SF have an impact on growth rates of Obj. 1 regions in 1989-1993, but not in 1994-1999	SF (% GDP), Total SF, SF of region i over total SF received by all regions	1989-1999, 1989-1993, 1994-1999	41 NUTS-2 regions (EU-10)	Panel: pooled OLS, country dummies (LSDV)
Rodriguez-Pose and Fratesi (2004)	SF expenditures for inv. & educ. have a pos. & significant effect in the medium run; SF for agriculture do not.	Obj. 1 commitments	1989-1999	152 NUTS-2 regions (EU-8)	Cross-section & Panel: OLS, pooled GLS LSDV
Cappelen, Castellacci, Fagerberg and Verspagen (2003)	SF have a pos. & significant impact on the growth rates in Europe, especially since 1988	SF (% GDP)	1980-1988, 1989-1997	105 NUTS-1/-2 regions (EU-9)	Cross-section: OLS
de Freitas, Pereira and Torres (2003)	Obj. 1 regions do not show faster convergence than the other regions	Dummy for Obj. 1 regions	1990-2001	196 NUTS-2 regions (EU-15)	Cross-section: OLS
Ederveen, Gorter, de Mooij and Nahuis (2002)	Results depend on the assumptions underlying the convergence model	SF + Cohesion Fund, (% GDP)	1981-1996	183 NUTS-2 regions (EU-13)	Panel: pooled OLS
García-Milá and McGuire (2001)	SF are not effective in stimulating private investment	Change of various variables Pre-financial perspective – post financial perspective	1977-1981, 1989-1992	17 NUTS-2 regions (Spain)	OLS and Diff-in-Diff

Table 2: Objectives of the structural funds, 1994–2006

1994-1999		2000-2006	
Definition	**share of total SF**	**Definition**	**share of total SF**
Obj. 1: To promote the development and structural adjustment of regions whose development is lagging behind the rest of the EU	67.6%	**Obj. 1**: Supporting development in the less prosperous regions	69.7%
Obj. 6: Assisting the development of sparsely-populated regions (Sweden & Finland only)	0.5%		
Obj. 2: To convert regions seriously affected by industrial decline	11.1%	**Obj. 2**: To support the economic and social conversion of areas experiencing structural difficulties	11.5%
Obj. 5b: Facilitating the development and structural adjustment of rural areas	4.9%		
Obj. 3: To combat long-term unemployment & facilitate the integration into working life of young people & of persons exposed to exclusion from the labour market **Obj. 4**: To facilitate the adaptation of workers to industrial changes and to changes in production systems	10.9%	**Obj. 3**: To support the adaptation and modernisation of education, training & employment policies in regions not eligible under Obj. 1	12.3%

Source: European Commission.

Table 3: Variables and data sources

Variable	Definition	Source
Real GDP p.c. growth	Real GDP (PPS) per capita growth rate from t to t-1	Eurostat Regio statistics
Ln real GDP p.c.	Ln of real GDP (PPS) p.c.	
Ln investment	Ln of gross fixed capital formation, as a share of nominal GDP	
Ln pop. growth	Ln of population growth rate from t to t-1	
Ln innovation	Ln of patents (per million inhabitants) (interpolated)	
Ln Objective 1	Ln of Objective 1 payments, as a share of nominal GDP	Data for the period 1994–1999: European Commission (1995, 1996a, b, 1997, 1998, 1999, 2000); Data for the period 2000–2006 were accessed at the European Commission in Brussels on 24/25 November 2007
Ln Objective 2	Ln of Objective 2 payments, as a share of nominal GDP	
Ln Objective 3	Ln of Objective 3 payments, as a share of nominal GDP	
Ln Objectives 1+2+3	Ln of Objectives 1+2+3 payments, as a share of nominal GDP	

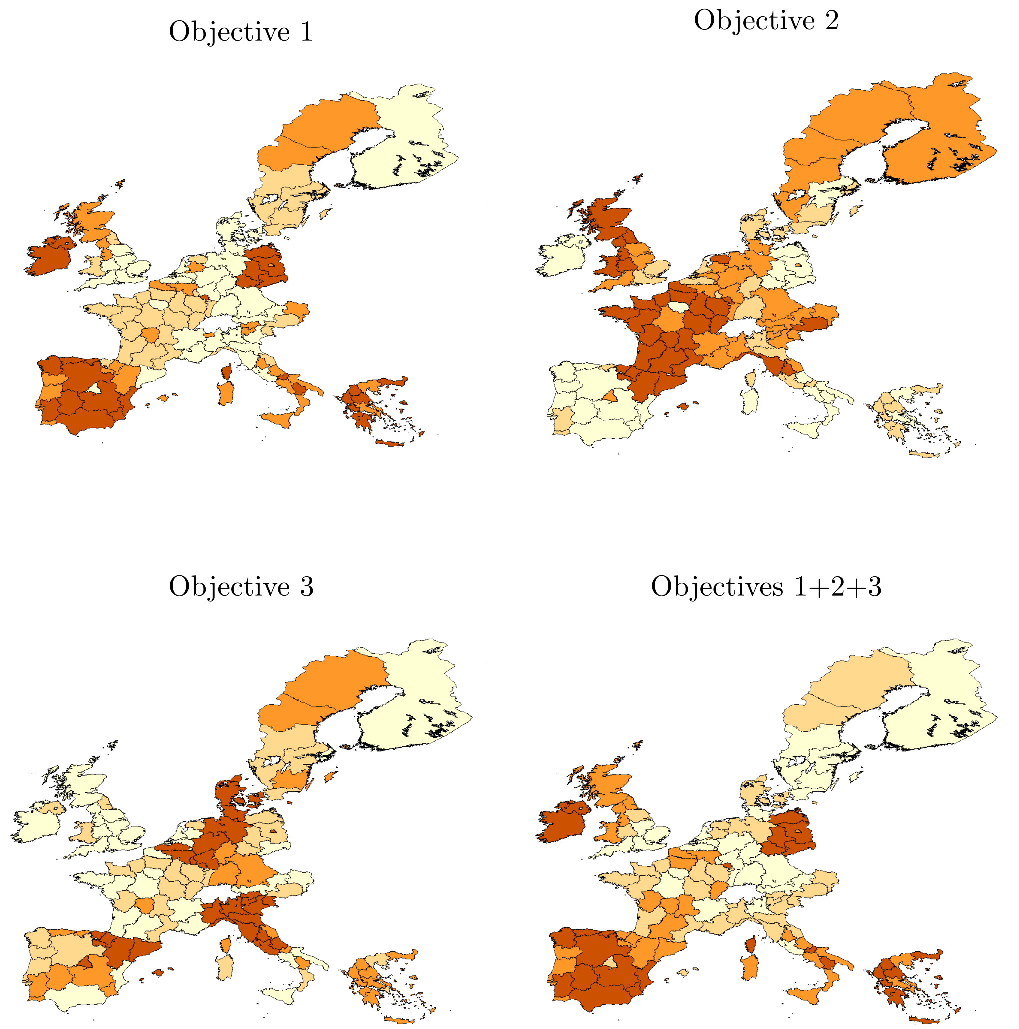
Table 4: Summary statistics

Variable		**Mean**	**Std. Dev.**	**Min.**	**Max.**	**Observations**
Real GDP p.c. growth	overall	0.021	0.031	-0.207	0.255	N = 1300
	between		0.011	-0.006	0.060	n = 130
	within		0.028	-0.204	0.216	T = 10
Ln real GDP p.c.	overall	9.961	0.276	9.248	10.989	N = 1430
	between		0.263	9.449	10.839	n = 130
	within		0.085	9.612	10.299	T = 11
Ln gross fixed capital formation, as a share of GDP	overall	-1.601	0.344	-3.742	-0.581	N = 1166
	between		0.308	-2.718	-1.024	n = 128
	within		0.207	-2.625	-0.693	T = 9.1
Ln pop. growth + 0.05	overall	-2.931	0.115	-3.681	-2.488	N = 1484
	between		0.092	-3.219	-2.590	n = 129
	within		0.070	-3.705	-2.558	T = 11.5
Ln patents (per million inhabitants)	overall	3.685	1.618	-3.586	6.715	N = 1067
	between		1.521	-1.918	6.095	n = 125
	within		0.760	-4.442	5.059	T = 8.5
Ln patents (per million inhab.) (interpolated)	overall	3.630	1.648	-3.586	6.715	N = 1118
	between		1.513	-1.773	6.095	n = 125
	within		0.744	-4.497	5.004	T = 8.9
Ln hightech (per million inhabitants)	overall	1.148	2.418	-7.131	5.915	N = 1035
	between		2.338	-4.826	5.014	n = 125
	within		1.057	-4.478	6.142	T = 8.3
Ln hightech (per million inhab.) (interpolated)	overall	1.029	2.474	-7.131	5.915	N = 1104
	between		2.307	-4.831	5.014	n = 125
	within		1.047	-4.597	6.287	T = 8.8
Ln Objective 1 payments, as a share of GDP	overall	-16.632	9.536	-26.913	-3.434	N = 1419
	between		9.259	-26.842	-3.821	n = 129
	within		2.412	-33.995	-5.508	T = 11
Ln Objective 2 payments, as a share of GDP	overall	-14.433	7.874	-26.742	-4.327	N = 1419
	between		7.176	-25.310	-5.828	n = 129
	within		3.297	-31.297	-3.231	T = 11
Ln Objective 3 payments, as a share of GDP	overall	-17.041	7.957	-26.742	-4.327	N = 1419
	between		5.625	-25.310	-6.679	n = 129
	within		5.648	-33.081	-2.278	T = 11
Ln Objectives 1+2+3 payments, as a share of GDP	overall	-7.558	4.549	-26.742	-3.434	N = 1419
	between		3.176	-24.306	-3.821	n = 129
	within		3.269	-24.921	3.501	T = 11

Table 5: Correlation matrix

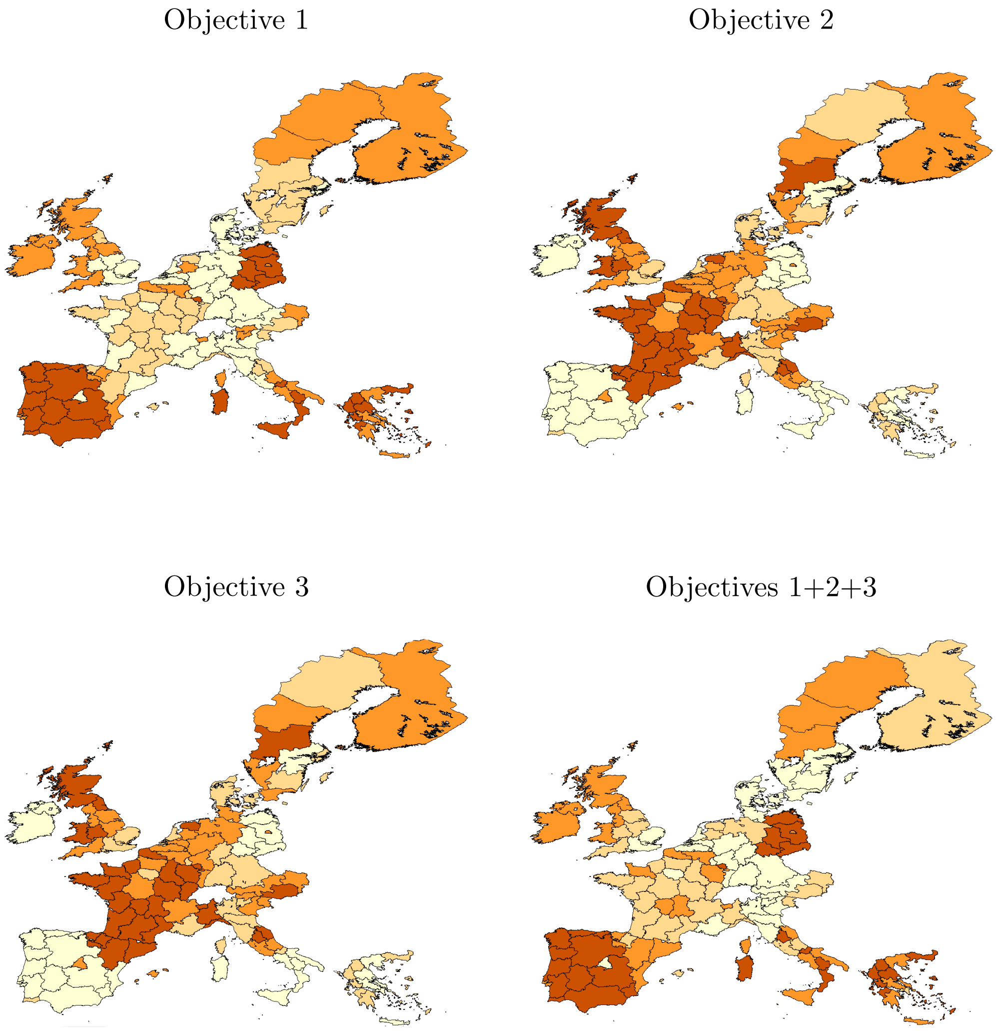
	GDP growth	**Ln GDP p.c.**	**Ln cap. form.**	**Ln pop. growth**	**Ln patents**	**Ln pat. (int.)**	**Obj. 1**	**Obj. 2**	**Obj. 3**	**Obj. 1+2+3**
GDP p.c. growth	1									
Ln real GDP p.c.	-0.0546	1								
Ln gross cap. formation	-0.1028	-0.2446	1							
Ln pop. growth + 0.05	-0.05	0.21	0.0183	1						
Ln patents	-0.0679	0.5782	-0.2594	-0.0197	1					
Ln patents (int.)	-0.0515	0.5901	-0.242	-0.0118	1	1				
Ln Objective 1	0.0877	-0.6354	0.3844	-0.16	-0.6328	-0.6474	1			
Ln Objective 2	-0.0483	0.4346	-0.3217	0.0861	0.4831	0.4887	-0.6993	1		
Ln Objective 3	-0.1506	0.5018	-0.0138	0.1347	0.2923	0.3099	-0.4793	0.6638	1	
Ln Objective 1+2+3	0.0993	-0.3908	0.2502	-0.0827	-0.331	-0.3398	0.4345	0.1359	0.1393	1

Figure 1: Quantile map, Ln of structural funds payments per GDP, 1995–1999



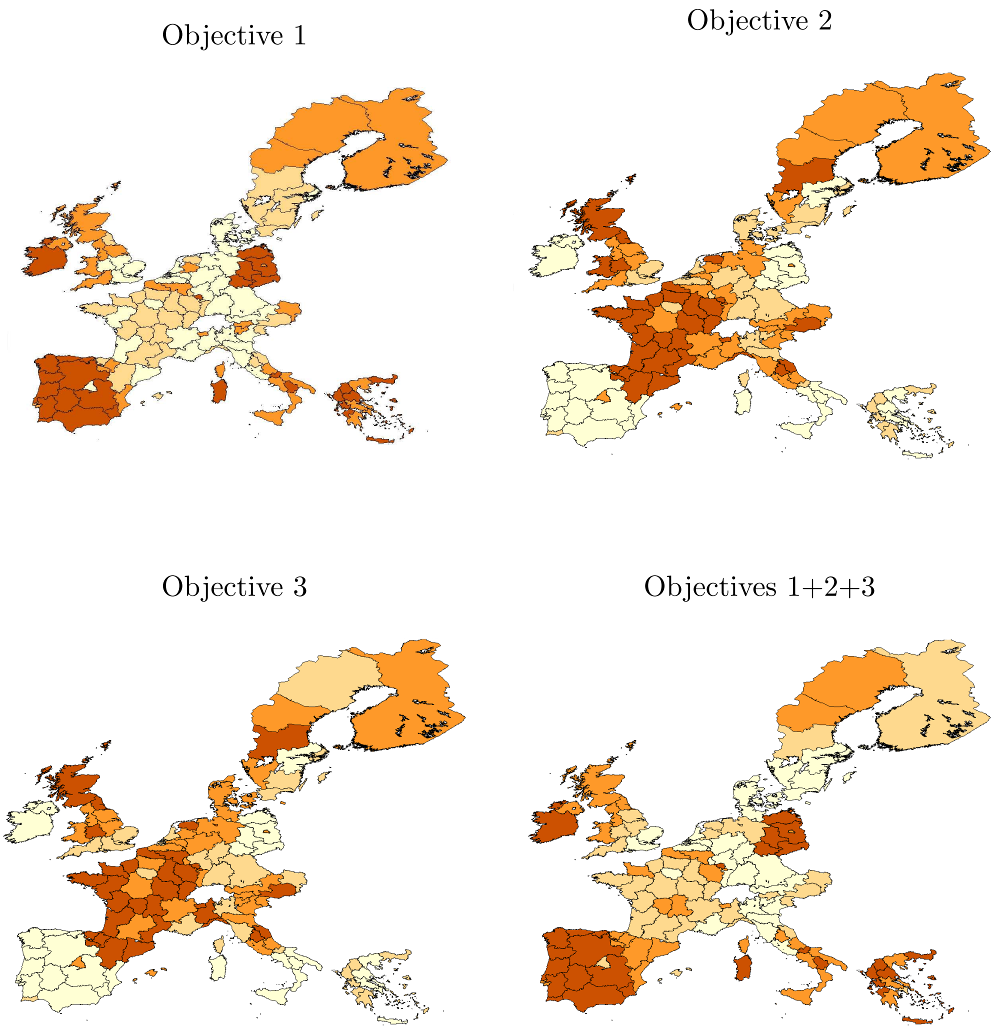
Notes: Own illustration. The payments of structural funds do not include multiregional funding programmes. The darker the area, the higher the relative share of regions' payments of structural funds per GDP.

Figure 2: Quantile map, Ln of structural funds payments per GDP, 2000–2005



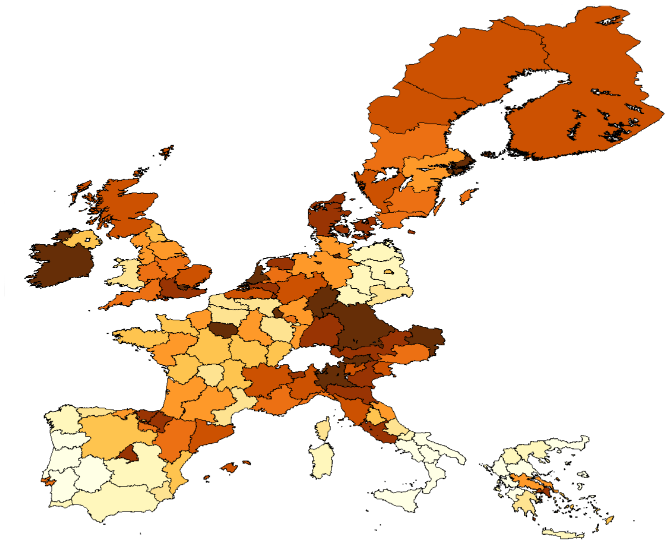
Notes: Own illustration. The payments of structural funds do not include multiregional funding programmes. The darker the area, the higher the relative share of regions' payments of structural funds per GDP.

Figure 3: Quantile map, Ln of structural funds payments per GDP, 1995–2005



Notes: Own illustration. The payments of structural funds do not include multiregional funding programmes. The darker the area, the higher the relative share of regions' payments of structural funds per GDP.

Figure 4: Quantile map, GDP per capita (in PPS), 1995–2005



Source: Own illustration. The darker the area the wealthier is the region compared to the EU-15 average.

Table 6: Objective 1: LSDV Estimator

	(1)	(2)	(3)	(4)	(5)	(6)
Ln real GDP p.c. (t-1)	-0.176***	-0.179***	-0.232***	-0.280***	-0.366***	-0.553***
	(0.0305)	(0.0302)	(0.0364)	(0.0439)	(0.0574)	(0.0626)
Ln investment (t-1)	0.00308	0.00367	0.00564	0.0147***	0.0263*	0.0438**
	(0.00375)	(0.00376)	(0.00421)	(0.00521)	(0.0135)	(0.0189)
Ln pop. growth + 0.05 (t-1)	-0.0130	-0.00703	-0.0180	-0.0262*	-0.0305**	-0.0437**
	(0.0108)	(0.0109)	(0.0124)	(0.0141)	(0.0153)	(0.0201)
Ln innovation (t-1)	0.00137	0.00149	0.00159	0.00124	0.00325	0.00335
	(0.00204)	(0.00203)	(0.00227)	(0.00284)	(0.00292)	(0.00317)
Ln Objective 1 (t-1)		0.000875	8.44e-05	-0.000262	-5.51e-05	-0.000119
		(0.000532)	(0.000513)	(0.000488)	(0.000512)	(0.000592)
Ln Objective 1 (t-2)			0.00113	-4.76e-05	-0.000349	0.000246
			(0.000772)	(0.000791)	(0.000875)	(0.000834)
Ln Objective 1 (t-3)				0.00255***	0.00201*	0.00136*
				(0.000942)	(0.00114)	(0.000707)
Ln Objective 1 (t-4)					0.000459	4.94e-05
					(0.000943)	(0.000717)
Ln Objective 1 (t-5)						0.000712
						(0.00134)
Obj. joint signif. (sum)			0.00122	0.00224	0.00207	0.00225
Obj. joint signif. (p-value)			0.0844	0.00931	0.0310	0.138
Obj. long-term elasticity		0.00489	0.00525	0.00801	0.00564	0.00407
Obj. long-term elasticity (p-value)		4.56e-09	3.40e-10	3.52e-10	3.84e-10	0
Wald test time dummies (p-value)	0	0	0	0	0	7.83e-11
Wooldridge test AR(1) (p-value)	0	0	0	0	0	0
Observations	1062	1062	943	826	705	584
Number of regions	124	124	124	124	124	124
R-squared	0.361	0.366	0.408	0.442	0.474	0.542
Adj. R-squared	0.353	0.357	0.399	0.432	0.463	0.531

Notes: White-Huber heteroskedasticity robust standard errors in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%; constant and time dummies are not shown.

Table 7: Objective 1: Newey and West (1987)

	(1)	(2)	(3)	(4)	(5)	(6)
Ln real GDP p.c. (t-1)	-0.176***	-0.179***	-0.232***	-0.280***	-0.366***	-0.553***
	(0.0317)	(0.0310)	(0.0365)	(0.0434)	(0.0485)	(0.0638)
Ln investment (t-1)	0.00308	0.00367	0.00564	0.0147***	0.0263**	0.0438**
	(0.00397)	(0.00398)	(0.00437)	(0.00532)	(0.0124)	(0.0196)
Ln pop. growth + 0.05 (t-1)	-0.0130	-0.00703	-0.0180	-0.0262*	-0.0305*	-0.0437*
	(0.0119)	(0.0116)	(0.0135)	(0.0150)	(0.0160)	(0.0229)
Ln innovation (t-1)	0.00137	0.00149	0.00159	0.00124	0.00325	0.00335
	(0.00204)	(0.00202)	(0.00228)	(0.00280)	(0.00280)	(0.00292)
Ln Objective 1 (t-1)		0.000875	8.44e-05	-0.000262	-5.51e-05	-0.000119
		(0.000556)	(0.000418)	(0.000486)	(0.000475)	(0.000547)
Ln Objective 1 (t-2)			0.00113	-4.76e-05	-0.000349	0.000246
			(0.000728)	(0.000640)	(0.000844)	(0.000750)
Ln Objective 1 (t-3)				0.00255**	0.00201	0.00136*
				(0.00106)	(0.00129)	(0.000723)
Ln Objective 1 (t-4)					0.000459	4.94e-05
					(0.000841)	(0.000712)
Ln Objective 1 (t-5)						0.000712
						(0.00130)
Obj. joint signif. (sum)			0.00122	0.00224	0.00207	0.00225
Obj. joint signif. (p-value)			0.0983	0.0175	0.0188	0.139
Obj. long-term elasticity		0.00489	0.00525	0.00801	0.00564	0.00407
Obj. long-term elasticity (p-value)		1.01e-08	3.77e-10	2.12e-10	0	0
Wald test time dummies (p-value)	0	0	0	0	0	0
Wald test region dummies (p-value)	0	0	0	0	0	0
Observations	1062	1062	943	826	705	584
Number of regions	124	124	124	124	124	124

Notes: Serially-adjusted standard errors according to Newey and West (1987) are reported in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%; constant, region and time dummies are not shown.

Table 8: Objective 1: Prais-Winsten

	(1)	(2)	(3)	(4)	(5)	(6)
Ln real GDP p.c. (t-1)	-0.168***	-0.170***	-0.214***	-0.253***	-0.334***	-0.590***
	(0.0300)	(0.0296)	(0.0353)	(0.0425)	(0.0543)	(0.0601)
Ln investment (t-1)	0.00277	0.00331	0.00558	0.0155***	0.0269**	0.0454**
	(0.00370)	(0.00371)	(0.00417)	(0.00541)	(0.0135)	(0.0183)
Ln pop. growth + 0.05 (t-1)	-0.0143	-0.00852	-0.0210*	-0.0289**	-0.0347**	-0.0413**
	(0.0108)	(0.0109)	(0.0124)	(0.0138)	(0.0151)	(0.0197)
Ln innovation (t-1)	0.00131	0.00143	0.00145	0.00104	0.00310	0.00377
	(0.00204)	(0.00202)	(0.00226)	(0.00281)	(0.00302)	(0.00317)
Ln Objective 1 (t-1)		0.000893*	1.62e-05	-0.000255	-7.16e-06	-0.000114
		(0.000525)	(0.000513)	(0.000499)	(0.000523)	(0.000557)
Ln Objective 1 (t-2)			0.00121	-0.000102	-0.000337	0.000243
			(0.000783)	(0.000809)	(0.000920)	(0.000789)
Ln Objective 1 (t-3)				0.00246***	0.00180	0.00136**
				(0.000937)	(0.00115)	(0.000665)
Ln Objective 1 (t-4)					0.000405	0.000115
					(0.000914)	(0.000710)
Ln Objective 1 (t-5)						0.000804
						(0.00133)
Obj. joint signif. (sum)			0.00122	0.00210	0.00186	0.00241
Obj. joint signif. (p-value)			0.0703	0.00692	0.0348	0.114
Obj. long-term elasticity		0.00525	0.00571	0.00831	0.00557	0.00408
Obj. long-term elasticity (p-value)		1.29e-08	2.08e-09	4.04e-09	1.42e-09	0
Wald test time dummies (p-value)	0	0	0	0	0	0
Wald test region dummies (p-value)	0	0	0	0	0	0
Observations	1062	1062	943	826	705	584
Number of regions	124	124	124	124	124	124
R-squared	0.479	0.485	0.528	0.563	0.606	0.643
Adj. R-squared	0.402	0.408	0.448	0.476	0.511	0.534

Notes: Serially adjusted standard errors according to the Prais-Winsten method are reported in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%; constant, region and time dummies are not shown.

Table 9: Objective 1: Driscoll and Kraay (1998)

	(1)	(2)	(3)	(4)	(5)	(6)
Ln real GDP p.c. (t-1)	-0.176**	-0.179**	-0.232***	-0.280**	-0.366***	-0.553***
	(0.0773)	(0.0759)	(0.0870)	(0.115)	(0.125)	(0.108)
Ln investment (t-1)	0.00308	0.00367	0.00564	0.0147**	0.0263**	0.0438***
	(0.00629)	(0.00613)	(0.00671)	(0.00683)	(0.0101)	(0.0165)
Ln pop. growth + 0.05 (t-1)	-0.0130	-0.00703	-0.0180	-0.0262	-0.0305	-0.0437*
	(0.0242)	(0.0251)	(0.0236)	(0.0225)	(0.0202)	(0.0253)
Ln innovation (t-1)	0.00137	0.00149	0.00159	0.00124	0.00325***	0.00335*
	(0.000930)	(0.000945)	(0.00125)	(0.00145)	(0.00116)	(0.00182)
Ln Objective 1 (t-1)		0.000875**	8.44e-05	-0.000262	-5.51e-05	-0.000119
		(0.000381)	(0.000347)	(0.000486)	(0.000449)	(0.000497)
Ln Objective 1 (t-2)			0.00113	-4.76e-05	-0.000349	0.000246
			(0.000716)	(0.000567)	(0.000876)	(0.000844)
Ln Objective 1 (t-3)				0.00255***	0.00201***	0.00136***
				(0.000784)	(0.000768)	(0.000510)
Ln Objective 1 (t-4)					0.000459	4.94e-05
					(0.000444)	(0.000419)
Ln Objective 1 (t-5)						0.000712**
						(0.000309)
Obj. joint signif. (sum)			0.00122	0.00224	0.00207	0.00225
Obj. joint signif. (p-value)			0.0177	3.48e-07	0	0.000921
Obj. long-term elasticity		0.00489	0.00525	0.00801	0.00564	0.00407
Obj. long-term elasticity (p-value)		0.0199	0.00876	0.0164	0.00408	1.20e-06
Wald test time dummies (p-value)	0	0	0	0	0	0
Observations	1062	1062	943	826	705	584
Number of regions	124	124	124	124	124	124

Notes: Standard errors are adjusted according to Driscoll and Kraay (1998) and are reported parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%; constant and time dummies are not shown.

Table 10: Objective 1: Two-step system GMM

	(1)	(2)	(3)	(4)	(5)	(6)
Ln real GDP p.c. (t-1)	-0.0266	-0.0216	-0.0226	-0.0186	-0.0393**	-0.0397*
	(0.0170)	(0.0180)	(0.0196)	(0.0204)	(0.0191)	(0.0223)
Ln investment (t-1)	-0.00379	-0.00731	-0.00688	-0.000565	0.00196	0.00754
	(0.00391)	(0.00489)	(0.00518)	(0.00692)	(0.0189)	(0.0204)
Ln pop. growth + 0.05 (t-1)	-0.0167**	-0.0314***	-0.0330**	-0.0271**	-0.0342**	-0.0273*
	(0.00835)	(0.0105)	(0.0128)	(0.0129)	(0.0145)	(0.0145)
Ln innovation (t-1)	0.00130	0.00543**	0.00534*	0.00621**	0.00525**	0.00420
	(0.00208)	(0.00254)	(0.00302)	(0.00272)	(0.00249)	(0.00349)
Ln Objective 1 (t-1)		0.00120*	0.00215***	0.00166**	0.00263***	0.00247**
		(0.000624)	(0.000829)	(0.000659)	(0.00101)	(0.00108)
Ln Objective 1 (t-2)			-0.000991	-0.00117*	-0.00187**	-0.00170**
			(0.000622)	(0.000632)	(0.000804)	(0.000802)
Ln Objective 1 (t-3)				0.000768	0.00165	0.00174
				(0.000478)	(0.00113)	(0.00108)
Ln Objective 1 (t-4)					-0.00189	-0.00130
					(0.00145)	(0.00164)
Ln Objective 1 (t-5)						-0.00116
						(0.000730)
Obj. joint signif. (sum)			0.00116	0.00126	0.000525	5.09e-05
Obj. joint signif. (p-value)			0.0800	0.0829	0.326	0.919
Obj. long-term elasticity		0.0554	0.0511	0.0675	0.0134	0.00128
Obj. long-term elasticity (p-value)		0.231	0.249	0.361	0.0396	0.0747
AR(1) (p-value)	3.81e-09	3.19e-09	4.28e-09	9.95e-09	1.39e-07	2.15e-07
AR(2) (p-value)	0.0897	0.134	0.118	0.298	0.0751	0.0233
Hansen (p-value)	0.00883	0.196	0.226	0.205	0.102	0.0460
Number of instruments	88	122	123	120	110	97
Observations	1062	1062	943	826	705	584
Number of regions	124	124	124	124	124	124

Notes: Standard errors are corrected using the approach by Windmeijer (2005) and are listed in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%; constant and time dummies are not shown. Endogenous variables are real GDP p.c., investment and Obj. 1, while all other variables are assumed to be exogenous. We instrument the endogenous variables with both its lags and its differenced lags restricting the laglimit to seven in order to prevent that the number of instruments exceeds the number of regions. Calculations are done with *xtabond2* by Roodman (2006).

Table 11: Objective 2: LSDV Estimator

	(1)	(2)	(3)	(4)	(5)
Ln real GDP p.c. (t-1)	-0.176***	-0.227***	-0.275***	-0.371***	-0.581***
	(0.0304)	(0.0377)	(0.0508)	(0.0704)	(0.0595)
Ln investment (t-1)	0.00261	0.00449	0.0130**	0.0216	0.0403**
	(0.00375)	(0.00428)	(0.00521)	(0.0136)	(0.0181)
Ln pop. growth + 0.05 (t-1)	-0.0127	-0.0176	-0.0249**	-0.0293**	-0.0346**
	(0.0107)	(0.0117)	(0.0123)	(0.0129)	(0.0147)
Ln innovation (t-1)	0.00124	0.00136	6.90e-05	0.00220	0.00121
	(0.00205)	(0.00232)	(0.00281)	(0.00310)	(0.00350)
Ln Objective 2 (t-1)	-0.000379	-0.000294	-0.000357	-0.000356	-0.000311
	(0.000234)	(0.000271)	(0.000288)	(0.000317)	(0.000350)
Ln Objective 2 (t-2)		0.000285	0.000393	0.000421	0.000600
		(0.000255)	(0.000285)	(0.000356)	(0.000415)
Ln Objective 2 (t-3)			-0.00142***	-0.00127***	-0.00149**
			(0.000296)	(0.000399)	(0.000742)
Ln Objective 2 (t-4)				-0.000697**	-0.00139**
				(0.000350)	(0.000549)
Ln Objective 2 (t-5)					-0.00125**
					(0.000500)
Obj. joint significance (sum)		-8.67e-06	-0.00138	-0.00190	-0.00384
Obj. joint significance (p-value)		0.981	0.0106	0.0151	0.00277
Obj. long-term elasticity	-0.00216	-3.82e-05	-0.00502	-0.00513	-0.00661
Obj. long-term elasticity (p-value)	9.88e-09	3.13e-09	8.74e-08	1.95e-07	0
Wald test time dummies (p-value)	0	0	0	0	0
Wooldridge test AR(1) (p-value)	0	0	0	0	0
Observations	1062	943	826	705	584
Number of regions	124	124	124	124	124
R-squared	0.363	0.404	0.440	0.474	0.563
Adj. R-squared	0.354	0.395	0.430	0.464	0.552

Notes: White-Huber heteroskedasticity robust standard errors in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%; constant and time dummies are not shown.

Table 12: Objective 2: Newey and West (1987)

	(1)	(2)	(3)	(4)	(5)
Ln real GDP p.c. (t-1)	-0.176***	-0.227***	-0.275***	-0.371***	-0.581***
	(0.0316)	(0.0394)	(0.0509)	(0.0573)	(0.0605)
Ln investment (t-1)	0.00261	0.00449	0.0130**	0.0216*	0.0403**
	(0.00398)	(0.00444)	(0.00525)	(0.0123)	(0.0187)
Ln pop. growth + 0.05 (t-1)	-0.0127	-0.0176	-0.0249*	-0.0293**	-0.0346**
	(0.0118)	(0.0129)	(0.0134)	(0.0130)	(0.0164)
Ln innovation (t-1)	0.00124	0.00136	6.90e-05	0.00220	0.00121
	(0.00205)	(0.00234)	(0.00277)	(0.00302)	(0.00333)
Ln Objective 2 (t-1)	-0.000379	-0.000294	-0.000357	-0.000356	-0.000311
	(0.000234)	(0.000269)	(0.000291)	(0.000314)	(0.000356)
Ln Objective 2 (t-2)		0.000285	0.000393	0.000421	0.000600
		(0.000252)	(0.000273)	(0.000332)	(0.000389)
Ln Objective 2 (t-3)			-0.00142***	-0.00127***	-0.00149**
			(0.000274)	(0.000370)	(0.000665)
Ln Objective 2 (t-4)				-0.000697**	-0.00139**
				(0.000350)	(0.000556)
Ln Objective 2 (t-5)					-0.00125**
					(0.000490)
Obj. joint significance (sum)		-8.67e-06	-0.00138	-0.00190	-0.00384
Obj. joint significance (p-value)		0.982	0.00852	0.00976	0.00203
Obj. long-term elasticity	-0.00216	-3.82e-05	-0.00502	-0.00513	-0.00661
Obj. long-term elasticity (p-value)	3.51e-08	1.34e-08	8.87e-08	2.08e-10	0
Wald test time dummies (p-value)	0	0	0	0	0
Observations	1062	943	826	705	584
Number of regions	124	124	124	124	124
R-squared	0.363	0.404	0.44	0.474	0.563

Notes: Serially-adjusted standard errors according to Newey and West (1987) are reported in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%; constant, region and time dummies are not shown.

Table 13: Objective 2: Prais-Winsten

	(1)	(2)	(3)	(4)	(5)
Ln real GDP p.c. (t-1)	-0.170***	-0.214***	-0.248***	-0.338***	-0.620***
	(0.0300)	(0.0370)	(0.0488)	(0.0632)	(0.0565)
Ln investment (t-1)	0.00239	0.00445	0.0138**	0.0228*	0.0416**
	(0.00372)	(0.00425)	(0.00538)	(0.0134)	(0.0175)
Ln pop. Growth (t-1)	-0.0137	-0.0198*	-0.0286**	-0.0345***	-0.0331**
	(0.0107)	(0.0117)	(0.0121)	(0.0129)	(0.0139)
Ln innovation (t-1)	0.00120	0.00128	-0.000131	0.00196	0.00183
	(0.00205)	(0.00231)	(0.00278)	(0.00325)	(0.00347)
Ln Objective 2 (t-1)	-0.000355	-0.000252	-0.000290	-0.000229	-0.000344
	(0.000234)	(0.000271)	(0.000292)	(0.000319)	(0.000348)
Ln Objective 2 (t-2)		0.000245	0.000379	0.000365	0.000606
		(0.000256)	(0.000282)	(0.000353)	(0.000422)
Ln Objective 2 (t-3)			-0.00147***	-0.00135***	-0.00144**
			(0.000297)	(0.000418)	(0.000724)
Ln Objective 2 (t-4)				-0.000747**	-0.00147***
				(0.000356)	(0.000546)
Ln Objective 2 (t-5)					-0.00128***
					(0.000480)
Obj. joint significance (sum)		-6.95e-06	-0.00138	-0.00196	-0.00394
Obj. joint significance (p-value)		0.985	0.00801	0.00794	0.00241
Obj. long-term elasticity	-0.00209	-3.25e-05	-0.00557	-0.00580	-0.00635
Obj. long-term elasticity (p-value)	2.01e-08	1.22e-08	5.01e-07	1.34e-07	0
Wald test time dummies (p-value)	0	0	0	0	0
Wald test region dummies (p-value)	0	0	0	0	0
Observations	1062	943	826	705	584
Number of regions	124	124	124	124	124
R-squared	0.478	0.519	0.564	0.613	0.661
Adj. R-squared	0.401	0.438	0.477	0.519	0.556

Notes: Serially adjusted standard errors according to the Prais-Winsten method are reported in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%; constant, region and time dummies are not shown.

Table 14: Objective 2: Driscoll and Kraay (1998)

	(1)	(2)	(3)	(4)	(5)
Ln real GDP p.c. (t-1)	-0.176**	-0.227**	-0.275**	-0.371***	-0.581***
	(0.0761)	(0.0901)	(0.120)	(0.133)	(0.113)
Ln investment (t-1)	0.00261	0.00449	0.0130*	0.0216**	0.0403**
	(0.00633)	(0.00711)	(0.00734)	(0.0108)	(0.0172)
Ln pop. growth + 0.05 (t-1)	-0.0127	-0.0176	-0.0249	-0.0293**	-0.0346**
	(0.0234)	(0.0215)	(0.0186)	(0.0116)	(0.0139)
Ln innovation (t-1)	0.00124	0.00136	6.90e-05	0.00220	0.00121
	(0.000880)	(0.00118)	(0.00157)	(0.00162)	(0.00205)
Ln Objective 2 (t-1)	-0.000379	-0.000294	-0.000357	-0.000356	-0.000311
	(0.000281)	(0.000313)	(0.000367)	(0.000427)	(0.000419)
Ln Objective 2 (t-2)		0.000285	0.000393	0.000421	0.000600
		(0.000392)	(0.000411)	(0.000490)	(0.000499)
Ln Objective 2 (t-3)			-0.00142***	-0.00127***	-0.00149***
			(0.000300)	(0.000290)	(0.000427)
Ln Objective 2 (t-4)				-0.000697	-0.00139*
				(0.000447)	(0.000716)
Ln Objective 2 (t-5)					-0.00125***
					(0.000407)
Obj. joint significance (sum)		-8.67e-06	-0.00138	-0.00190	-0.00384
Obj. joint significance (p-value)		0.986	0.0636	0.0305	1.08e-05
Obj. long-term elasticity	-0.00216	-3.82e-05	-0.00502	-0.00513	-0.00661
Obj. long-term elasticity (p-value)	0.0225	0.0134	0.0233	0.00617	1.03e-06
Wald test time dummies (p-value)	0	0	0	0	0
Observations	1062	943	826	705	584
Number of regions	124	124	124	124	124

Notes: Standard errors are adjusted according to Driscoll and Kraay (1998) and are reported parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%; constant and time dummies are not shown.

Table 15: Objective 2: Two-step system GMM

	(1)	(2)	(3)	(4)	(5)
Ln real GDP p.c. (t-1)	-0.0341**	-0.0346**	-0.0351**	-0.0276*	-0.0259
	(0.0142)	(0.0141)	(0.0142)	(0.0145)	(0.0175)
Ln investment (t-1)	-0.00724*	-0.00626	-0.00185	-0.00264	-0.00363
	(0.00388)	(0.00404)	(0.00505)	(0.0155)	(0.0190)
Ln pop. growth + 0.05 (t-1)	0.0220**	0.0211**	0.0178*	0.0154	0.0130
	(0.00894)	(0.00870)	(0.00915)	(0.00965)	(0.0110)
Ln innovation (t-1)	0.00296*	0.00278	0.00384*	0.00335	0.00308
	(0.00175)	(0.00180)	(0.00202)	(0.00219)	(0.00269)
Ln Objective 2 (t-1)	-0.000457	-0.000975**	-0.000535	-0.000683	-0.000541
	(0.000405)	(0.000417)	(0.000459)	(0.000508)	(0.000540)
Ln Objective 2 (t-2)		0.000705**	0.000791***	0.000642*	0.000712*
		(0.000315)	(0.000303)	(0.000336)	(0.000384)
Ln Objective 2 (t-3)			-0.000679***	-0.000764***	-0.000778**
			(0.000239)	(0.000230)	(0.000385)
Ln Objective 2 (t-4)				0.000283	8.09e-05
				(0.000378)	(0.000552)
Ln Objective 2 (t-5)					3.45e-05
					(0.000515)
Obj. joint significance (sum)		-0.000270	-0.000423	-0.000523	-0.000492
Obj. joint significance (p-value)		0.535	0.369	0.267	0.351
Obj. long-term elasticity	-0.0134	-0.00780	-0.0121	-0.0189	-0.0190
Obj. long-term elasticity (p-value)	0.0161	0.0144	0.0136	0.0578	0.139
AR(1) (p-value)	4.86e-09	3.09e-08	9.17e-08	1.59e-06	5.76e-07
AR(2) (p-value)	0.135	0.138	0.398	0.197	0.0782
Hansen (p-value)	0.184	0.187	0.156	0.0827	0.0260
Number of instruments	122	123	120	110	97
Observations	1062	943	826	705	584
Number of regions	124	124	124	124	124

Notes: Standard errors are corrected using the approach by Windmeijer (2005) and are listed in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%; constant and time dummies are not shown. Endogenous variables are real GDP p.c., investment and Obj. 2, while all other variables are assumed to be exogenous. We instrument the endogenous variables with both its lags and its differenced lags restricting the laglimit to seven in order to prevent that the number of instruments exceeds the number of regions. Calculations are done with *xtabond2* by Roodman (2006).

Table 16: Objective 3: LSDV Estimator

	(1)	(2)	(3)	(4)	(5)
Ln real GDP PPS p.c. (t-1)	-0.170***	-0.218***	-0.273***	-0.356***	-0.559***
	(0.0302)	(0.0379)	(0.0512)	(0.0706)	(0.0590)
Ln investment (t-1)	0.00204	0.00359	0.0100**	0.0174	0.0316*
	(0.00369)	(0.00417)	(0.00504)	(0.0134)	(0.0182)
Ln pop. growth + 0.05 (t-1)	-0.0186*	-0.0251**	-0.0346**	-0.0380**	-0.0469***
	(0.0109)	(0.0122)	(0.0138)	(0.0152)	(0.0178)
Ln innovation (t-1)	0.000649	0.000800	-0.000420	0.00179	0.00192
	(0.00208)	(0.00233)	(0.00278)	(0.00305)	(0.00332)
Ln Objective 3 (t-1)	-0.000561***	-0.000518***	-0.000544***	-0.000518**	-0.000732***
	(0.000142)	(0.000168)	(0.000186)	(0.000215)	(0.000225)
Ln Objective 3 (t-2)		-2.90e-05	0.000393*	0.000370*	0.000283
		(0.000173)	(0.000201)	(0.000219)	(0.000234)
Ln Objective 3 (t-3)			-0.00105***	-0.000933***	-0.00134***
			(0.000210)	(0.000256)	(0.000281)
Ln Objective 3 (t-4)				0.000179	0.000447
				(0.000285)	(0.000325)
Ln Objective 3 (t-5)					-0.00175***
					(0.000437)
Obj. joint significance (sum)		-0.000547	-0.00120	-0.000902	-0.00309
Obj. joint significance (p-value)		0.00484	8.21e-07	0.00280	5.17e-07
Obj. long-term elasticity	-0.00331	-0.00251	-0.00441	-0.00253	-0.00553
Obj. long-term elasticity (p-value)	2.72e-08	1.38e-08	1.37e-07	6.17e-07	0
Wald test time dummies (p-value)	0	0	0	0	1.75e-08
Wooldridge test (p-value)	0	0	0	0	0
Observations	1062	943	826	705	584
Number of regions	124	124	124	124	124
R-squared	0.370	0.409	0.448	0.478	0.588
Adj. R-squared	0.361	0.400	0.438	0.467	0.578

Notes: White-Huber heteroskedasticity robust standard errors in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%; constant and time dummies are not shown.

Table 17: Objective 3: Newey and West (1987)

	(1)	(2)	(3)	(4)	(5)
Ln real GDP PPS p.c. (t-1)	-0.170***	-0.218***	-0.273***	-0.356***	-0.559***
	(0.0312)	(0.0392)	(0.0508)	(0.0571)	(0.0594)
Ln investment (t-1)	0.00204	0.00359	0.0100**	0.0174	0.0316*
	(0.00388)	(0.00431)	(0.00509)	(0.0124)	(0.0188)
Ln pop. growth + 0.05 (t-1)	-0.0186	-0.0251*	-0.0346**	-0.0380**	-0.0469**
	(0.0119)	(0.0133)	(0.0148)	(0.0158)	(0.0204)
Ln innovation (t-1)	0.000649	0.000800	-0.000420	0.00179	0.00192
	(0.00209)	(0.00236)	(0.00279)	(0.00296)	(0.00314)
Ln Objective 3 (t-1)	-0.000561***	-0.000518***	-0.000544***	-0.000518***	-0.000732***
	(0.000139)	(0.000165)	(0.000178)	(0.000193)	(0.000211)
Ln Objective 3 (t-2)		-2.90e-05	0.000393**	0.000370*	0.000283
		(0.000171)	(0.000198)	(0.000209)	(0.000226)
Ln Objective 3 (t-3)			-0.00105***	-0.000933***	-0.00134***
			(0.000205)	(0.000242)	(0.000270)
Ln Objective 3 (t-4)				0.000179	0.000447
				(0.000259)	(0.000303)
Ln Objective 3 (t-5)					-0.00175***
					(0.000442)
Obj. joint significance (sum)		-0.000547	-0.00120	-0.000902	-0.00309
Obj. joint significance (p-value)		0.00449	5.84e-07	0.00197	5.83e-07
Obj. long-term elasticity	-0.00331	-0.00251	-0.00441	-0.00253	-0.00553
Obj. long-term elasticity (p-value)	7.22e-08	3.90e-08	1.09e-07	8.54e-10	0
Wald test time dummies (p-value)	0	0	0	0	3.07e-10
Wald test region dummies (p-value)	0	0	0	0	0
Observations	1062	943	826	705	584
Number of regions	124	124	124	124	124

Notes: Serially-adjusted standard errors according to Newey and West (1987) are reported in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%; constant, region and time dummies are not shown.

Table 18: Objective 3: Prais-Winsten

	(1)	(2)	(3)	(4)	(5)
Ln real GDP PPS p.c. (t-1)	-0.163***	-0.202***	-0.246***	-0.326***	-0.579***
	(0.0298)	(0.0371)	(0.0493)	(0.0641)	(0.0573)
Ln investment (t-1)	0.00178	0.00334	0.0107**	0.0185	0.0322*
	(0.00365)	(0.00412)	(0.00522)	(0.0134)	(0.0179)
Ln pop. growth + 0.05 (t-1)	-0.0195*	-0.0272**	-0.0374***	-0.0423***	-0.0455**
	(0.0109)	(0.0122)	(0.0137)	(0.0152)	(0.0176)
Ln innovation (t-1)	0.000597	0.000649	-0.000679	0.00153	0.00229
	(0.00207)	(0.00232)	(0.00277)	(0.00316)	(0.00332)
Ln Objective 3 (t-1)	-0.000550***	-0.000474***	-0.000505***	-0.000456**	-0.000721***
	(0.000141)	(0.000168)	(0.000188)	(0.000217)	(0.000222)
Ln Objective 3 (t-2)		-9.25e-05	0.000354*	0.000288	0.000284
		(0.000174)	(0.000207)	(0.000232)	(0.000233)
Ln Objective 3 (t-3)			-0.00103***	-0.000895***	-0.00132***
			(0.000207)	(0.000268)	(0.000280)
Ln Objective 3 (t-4)				0.000109	0.000419
				(0.000306)	(0.000316)
Ln Objective 3 (t-5)					-0.00166***
					(0.000434)
Obj. joint significance (sum)		-0.000566	-0.00119	-0.000953	-0.00300
Obj. joint significance (p-value)		0.00261	2.18e-07	0.00120	1.04e-06
Obj. long-term elasticity	-0.00338	-0.00280	-0.00482	-0.00292	-0.00517
Obj. long-term elasticity (p-value)	5.87e-08	6.57e-08	7.57e-07	4.94e-07	0
Wald test time dummies (p-value)	0	0	0	0	6.80e-09
Wald test region dummies (p-value)	0	0	0	0	0
Observations	1062	943	826	705	584
Number of regions	124	124	124	124	124
R-squared	0.484	0.527	0.567	0.609	0.676
Adj. R-squared	0.408	0.446	0.481	0.515	0.577

Notes: Serially adjusted standard errors according to the Prais-Winsten method are reported in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%; constant, region and time dummies are not shown.

Table 19: Objective 3: Driscoll and Kraay (1998)

	(1)	(2)	(3)	(4)	(5)
Ln real GDP PPS p.c. (t-1)	-0.170**	-0.218**	-0.273**	-0.356***	-0.559***
	(0.0739)	(0.0887)	(0.116)	(0.132)	(0.110)
Ln investment (t-1)	0.00204	0.00359	0.0100	0.0174*	0.0316
	(0.00629)	(0.00699)	(0.00609)	(0.0104)	(0.0194)
Ln pop. growth + 0.05 (t-1)	-0.0186	-0.0251	-0.0346*	-0.0380**	-0.0469***
	(0.0235)	(0.0235)	(0.0193)	(0.0158)	(0.0160)
Ln innovation (t-1)	0.000649	0.000800	-0.000420	0.00179	0.00192
	(0.000740)	(0.000996)	(0.00143)	(0.00136)	(0.00197)
Ln Objective 3 (t-1)	-0.000561***	-0.000518**	-0.000544***	-0.000518**	-0.000732**
	(0.000176)	(0.000225)	(0.000185)	(0.000219)	(0.000327)
Ln Objective 3 (t-2)		-2.90e-05	0.000393	0.000370	0.000283
		(0.000307)	(0.000298)	(0.000295)	(0.000368)
Ln Objective 3 (t-3)			-0.00105***	-0.000933***	-0.00134***
			(0.000204)	(0.000304)	(0.000125)
Ln Objective 3 (t-4)				0.000179	0.000447
				(0.000496)	(0.000347)
Ln Objective 3 (t-5)					-0.00175***
					(0.000559)
Obj. joint significance (sum)		-0.000547	-0.00120	-0.000902	-0.00309
Obj. joint significance (p-value)		0.0302	0.000296	0.0189	3.72e-05
Obj. long-term elasticity	-0.00331	-0.00251	-0.00441	-0.00253	-0.00553
Obj. long-term elasticity (p-value)	0.0235	0.0156	0.0206	0.00775	1.32e-06
Wald test time dummies (p-value)	0	0	0	0	0
Number of regions	124	124	124	124	124
Observations	1062	943	826	705	584

Notes: Standard errors are adjusted according to Driscoll and Kraay (1998) and are reported parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%; constant and time dummies are not shown.

Table 20: Objective 3: Two-step system GMM

	(1)	(2)	(3)	(4)	(5)
Ln real GDP p.c. (t-1)	-0.0250**	-0.0253**	-0.0179	-0.0204	-0.0159
	(0.0119)	(0.0113)	(0.0119)	(0.0129)	(0.0182)
Ln investment (t-1)	-0.00328	-0.00297	0.00259	-0.00358	0.00164
	(0.00379)	(0.00386)	(0.00474)	(0.0122)	(0.0157)
Ln pop. growth + 0.05 (t-1)	0.0176**	0.0176**	0.0126	0.0133	0.00575
	(0.00755)	(0.00742)	(0.00846)	(0.0102)	(0.0125)
Ln innovation (t-1)	0.00296**	0.00325**	0.00395***	0.00433**	0.00668**
	(0.00130)	(0.00137)	(0.00145)	(0.00189)	(0.00263)
Ln Objective 3 (t-1)	-0.00114***	-0.00104***	-0.000814***	-0.000947***	-0.00149***
	(0.000212)	(0.000231)	(0.000233)	(0.000272)	(0.000326)
Ln Objective 3 (t-2)		-0.000136	9.04e-05	-2.83e-05	-0.000109
		(0.000244)	(0.000255)	(0.000277)	(0.000295)
Ln Objective 3 (t-3)			-0.000919***	-0.00110***	-0.00133***
			(0.000199)	(0.000238)	(0.000271)
Ln Objective 3 (t-4)				0.000383*	0.000944***
				(0.000211)	(0.000258)
Ln Objective 3 (t-5)					-0.00117***
					(0.000335)
Obj. joint significance (sum)		-0.00118	-0.00164	-0.00169	-0.00316
Obj. joint significance (p-value)		4.88e-07	4.05e-09	1.70e-06	3.61e-09
Obj. long-term elasticity	-0.0455	-0.0464	-0.0916	-0.0829	-0.198
Obj. long-term elasticity (p-value)	0.0350	0.0254	0.132	0.114	0.380
AR(1) (p-value)	1.29e-08	2.86e-08	2.05e-07	4.65e-06	5.63e-07
AR(2) (p-value)	0.338	0.153	0.687	0.292	0.273
Hansen (p-value)	0.180	0.194	0.143	0.0670	0.0887
Number of instruments	122	123	120	110	97
Observations	1062	943	826	705	584
Number of regions	124	124	124	124	124

Notes: Standard errors are corrected using the approach by Windmeijer (2005) and are listed in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%; constant and time dummies are not shown. Endogenous variables are real GDP p.c., investment and Obj. 3, while all other variables are assumed to be exogenous. We instrument the endogenous variables with both its lags and its differenced lags restricting the laglimit to seven in order to prevent that the number of instruments exceeds the number of regions. Calculations are done with *xtabond2* by Roodman (2006).

Table 21: Objectives 1+2+3: LSDV Estimator

	(1)	(2)	(3)	(4)	(5)
Ln real GDP p.c. (t-1)	-0.177***	-0.237***	-0.281***	-0.370***	-0.574***
	(0.0306)	(0.0372)	(0.0516)	(0.0705)	(0.0583)
Ln investment (t-1)	0.00356	0.00619	0.0140**	0.0257*	0.0439**
	(0.00376)	(0.00434)	(0.00548)	(0.0141)	(0.0186)
Ln pop. growth + 0.05 (t-1)	-0.0123	-0.0133	-0.0226*	-0.0276**	-0.0340**
	(0.0108)	(0.0115)	(0.0129)	(0.0132)	(0.0158)
Ln innovation (t-1)	0.00153	0.00161	0.000646	0.00283	0.00254
	(0.00204)	(0.00228)	(0.00283)	(0.00297)	(0.00343)
Ln Objectives 1+2+3 (t-1)	0.000263	0.000308	7.11e-05	0.000212	0.000435
	(0.000264)	(0.000287)	(0.000279)	(0.000300)	(0.000330)
Ln Objectives 1+2+3 (t-2)		0.000772**	0.000848**	0.000708*	0.00126***
		(0.000306)	(0.000381)	(0.000416)	(0.000446)
Ln Objectives 1+2+3 (t-3)			-0.000460	7.99e-06	-0.000605
			(0.000434)	(0.000707)	(0.000742)
Ln Objective2 1+2+3 (t-4)				-0.000242	-0.000778*
				(0.000477)	(0.000471)
Ln Objectives 1+2+3 (t-5)					-0.000770*
					(0.000455)
Obj. joint significance (sum)		0.00108	0.000459	0.000686	-0.000463
Obj. joint significance (p-value)		0.0167	0.495	0.506	0.695
Obj. long-term elasticity	0.00149	0.00456	0.00164	0.00185	-0.000806
Obj. long-term elasticity (p-value)	9.95e-09	3.18e-10	7.44e-08	2.19e-07	0
Wald test time dummies (p-value)	0	0	0	0	0
Wooldridge test AR(1) (p-value)	0	0	0	0	0
Observations	1062	943	826	705	584
Number of regions	124	124	124	124	124
R-squared	0.362	0.410	0.430	0.465	0.557
Adj. R-squared	0.353	0.401	0.420	0.454	0.546

Notes: White-Huber heteroskedasticity robust standard errors in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%; constant and time dummies are not shown.

Table 22: Objectives 1+2+3: Newey and West (1987)

	(1)	(2)	(3)	(4)	(5)
Ln real GDP p.c. (t-1)	-0.177***	-0.237***	-0.281***	-0.370***	-0.574***
	(0.0315)	(0.0376)	(0.0504)	(0.0577)	(0.0593)
Ln investment (t-1)	0.00356	0.00619	0.0140**	0.0257**	0.0439**
	(0.00399)	(0.00453)	(0.00558)	(0.0128)	(0.0193)
Ln pop. growth + 0.05 (t-1)	-0.0123	-0.0133	-0.0226	-0.0276**	-0.0340*
	(0.0118)	(0.0123)	(0.0137)	(0.0139)	(0.0178)
Ln innovation (t-1)	0.00153	0.00161	0.000646	0.00283	0.00254
	(0.00204)	(0.00231)	(0.00280)	(0.00287)	(0.00329)
Ln Objectives 1+2+3 (t-1)	0.000263	0.000308	7.11e-05	0.000212	0.000435
	(0.000278)	(0.000277)	(0.000278)	(0.000291)	(0.000327)
Ln Objectives 1+2+3 (t-2)		0.000772**	0.000848**	0.000708*	0.00126***
		(0.000301)	(0.000345)	(0.000406)	(0.000450)
Ln Objectives 1+2+3 (t-3)			-0.000460	7.99e-06	-0.000605
			(0.000499)	(0.000733)	(0.000655)
Ln Objectives 1+2+3 (t-4)				-0.000242	-0.000778*
				(0.000411)	(0.000471)
Ln Objectives 1+2+3 (t-5)					-0.000770*
					(0.000463)
Obj. joint significance (sum)		0.00108	0.000459	0.000686	-0.000463
Obj. joint significance (p-value)		0.0186	0.516	0.492	0.687
Obj. long-term elasticity	0.00149	0.00456	0.00164	0.00185	-0.000806
Obj. long-term elasticity (p-value)	2.68e-08	4.82e-10	3.63e-08	3.10e-10	0
Wald test time dummies (p-value)	0	0	0	0	0
Wald test region dummies (p-value)	0	0	0	0	0
Observations	1062	943	826	705	584
Number of regions	124	124	124	124	124

Notes: Serially-adjusted standard errors according to Newey and West (1987) are reported in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%; constant, region and time dummies are not shown.

Table 23: Objectives 1+2+3: Prais-Winsten

	(1)	(2)	(3)	(4)	(5)
Ln real GDP p.c. (t-1)	-0.167***	-0.222***	-0.252***	-0.334***	-0.603***
	(0.0299)	(0.0364)	(0.0498)	(0.0633)	(0.0571)
Ln investment (t-1)	0.00327	0.00618	0.0150***	0.0268*	0.0450**
	(0.00371)	(0.00430)	(0.00568)	(0.0139)	(0.0182)
Ln pop. growth + 0.05 (t-1)	-0.0137	-0.0155	-0.0262**	-0.0332**	-0.0327**
	(0.0108)	(0.0115)	(0.0128)	(0.0132)	(0.0153)
Ln innovation (t-1)	0.00149	0.00153	0.000464	0.00259	0.00293
	(0.00204)	(0.00228)	(0.00279)	(0.00312)	(0.00342)
Ln Objectives 1+2+3 (t-1)	0.000317	0.000333	0.000125	0.000384	0.000395
	(0.000266)	(0.000283)	(0.000285)	(0.000300)	(0.000328)
Ln Objectives 1+2+3 (t-2)		0.000740**	0.000814**	0.000639	0.00127***
		(0.000307)	(0.000376)	(0.000422)	(0.000448)
Ln Objectives 1+2+3 (t-3)			-0.000533	-0.000235	-0.000549
			(0.000440)	(0.000686)	(0.000727)
Ln Objective2 1+2+3 (t-4)				-0.000311	-0.000805*
				(0.000439)	(0.000479)
Ln Objectives 1+2+3 (t-5)					-0.000751*
					(0.000449)
Obj. joint significance (sum)		0.00107	0.000406	0.000478	-0.000436
Obj. joint significance (p-value)		0.0154	0.525	0.615	0.715
Obj. long-term elasticity	0.00190	0.00483	0.00161	0.00143	-0.000723
Obj. long-term elasticity (p-value)	2.78e-08	1.59e-09	5.44e-07	1.87e-07	0
Wald test time dummies (p-value)	0	0	0	0	0
Wald test region dummies (p-value)	0	0	0	0	0
Observations	1062	943	826	705	584
Number of regions	124	124	124	124	124
R-squared	0.482	0.526	0.556	0.606	0.654
Adj. R-squared	0.405	0.446	0.467	0.511	0.547

Notes: Serially adjusted standard errors according to the Prais-Winsten method are reported in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%; constant, region and time dummies are not shown.

Table 24: Objectives 1+2+3: Driscoll and Kraay (1998)

	(1)	(2)	(3)	(4)	(5)
Ln real GDP p.c. (t-1)	-0.177**	-0.237***	-0.281**	-0.370***	-0.574***
	(0.0784)	(0.0901)	(0.123)	(0.133)	(0.100)
Ln investment (t-1)	0.00356	0.00619	0.0140*	0.0257**	0.0439**
	(0.00659)	(0.00708)	(0.00771)	(0.0119)	(0.0195)
Ln pop. growth + 0.05 (t-1)	-0.0123	-0.0133	-0.0226	-0.0276**	-0.0340**
	(0.0251)	(0.0211)	(0.0189)	(0.0125)	(0.0148)
Ln innovation (t-1)	0.00153*	0.00161	0.000646	0.00283**	0.00254
	(0.000918)	(0.00126)	(0.00152)	(0.00131)	(0.00230)
Ln Objectives 1+2+3 (t-1)	0.000263	0.000308	7.11e-05	0.000212	0.000435
	(0.000331)	(0.000386)	(0.000448)	(0.000535)	(0.000565)
Ln Objectives 1+2+3 (t-2)		0.000772*	0.000848*	0.000708	0.00126**
		(0.000439)	(0.000486)	(0.000671)	(0.000590)
Ln Objectives 1+2+3 (t-3)			-0.000460	7.99e-06	-0.000605*
			(0.000422)	(0.000396)	(0.000336)
Ln Objective2 1+2+3 (t-4)				-0.000242	-0.000778
				(0.000278)	(0.000502)
Ln Objectives 1+2+3 (t-5)					-0.000770
					(0.000505)
Obj. joint significance (sum)		0.00108	0.000459	0.000686	-0.000463
Obj. joint significance (p-value)		0.0807	0.645	0.473	0.369
Obj. long-term elasticity	0.00149	0.00456	0.00164	0.00185	-0.000806
Obj. long-term elasticity (p-value)	0.0259	0.00972	0.0241	0.00641	6.83e-08
Wald test time dummies (p-value)	0	0	0	0	0
Observations	1062	943	826	705	584
Number of regions	124	124	124	124	124

Notes: Standard errors are adjusted according to Driscoll and Kraay (1998) and are reported parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%; constant and time dummies are not shown.

Table 25: Objectives 1+2+3: Two-step system GMM

	(1)	(2)	(3)	(4)	(5)
Ln real GDP PPS p.c. (t-1)	-0.0180	-0.0108	-0.0191	-0.0269*	-0.0251
	(0.0127)	(0.0132)	(0.0166)	(0.0159)	(0.0209)
Ln investment (t-1)	-0.00521	-0.00521	0.00157	0.00484	0.0122
	(0.00403)	(0.00430)	(0.00570)	(0.0159)	(0.0180)
Ln pop. growth + 0.05 (t-1)	0.0127	0.0101	0.00661	0.00512	-0.00304
	(0.00838)	(0.00799)	(0.00913)	(0.0101)	(0.0126)
Ln innovation (t-1)	0.000595	3.09e-05	0.000655	0.00121	0.00110
	(0.00144)	(0.00173)	(0.00170)	(0.00227)	(0.00274)
Ln Objectives 1+2+3 (t-1)	0.000233	-0.000163	8.57e-05	0.000262	0.000180
	(0.000631)	(0.000570)	(0.000581)	(0.000649)	(0.000710)
Ln Objectives 1+2+3 (t-2)		0.000579**	0.000379	0.000272	0.000472
		(0.000295)	(0.000343)	(0.000449)	(0.000500)
Ln Objectives 1+2+3 (t-3)			-0.000970***	-0.000901**	-0.000853
			(0.000337)	(0.000416)	(0.000552)
Ln Objectives 1+2+3 (t-4)				-0.000528	-0.000806
				(0.000456)	(0.000631)
Ln Objectives 1+2+3 (t-5)					-0.000225
					(0.000579)
Obj. joint significance (sum)		0.000417	-0.000506	-0.000895	-0.00123
Obj. joint significance (p-value)		0.495	0.531	0.232	0.210
Obj. long-term elasticity	0.0129	0.0386	-0.0265	-0.0332	-0.0491
Obj. long-term elasticity (p-value)	0.156	0.414	0.250	0.0906	0.230
AR(1) (p-value)	3.52e-09	2.07e-08	7.45e-08	6.85e-07	4.27e-07
AR(2) (p-value)	0.0817	0.0827	0.259	0.114	0.0557
Hansen (p-value)	0.188	0.228	0.188	0.102	0.0398
Number of instruments	122	123	120	110	97
Observations	1062	943	826	705	584
Number of regions	124	124	124	124	124

Notes: Standard errors are corrected using the approach by Windmeijer (2005) and are listed in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%; constant and time dummies are not shown. Endogenous variables are real GDP p.c., investment and Obj. 1+2+3, while all other variables are assumed to be exogenous. We instrument the endogenous variables with both its lags and its differenced lags restricting the laglimit to seven in order to prevent that the number of instruments exceeds the number of regions. Calculations are done with *xtabond2* by Roodman (2006).

Table 26: Centroids of NUTS regions

NUTS code	latitude	longitude	NUTS code	latitude	longitude
be1	50° 50' 9.60"	4° 22' 13.78"	fr63	45° 46' 26.40"	1° 42' 50.76"
be2	51° 2' 16.80"	4° 14' 20.04"	fr71	45° 25' 55.20"	5° 20' 4.56"
be3	50° 18' 54.00"	5° 0' 30.96"	fr72	45° 39' 21.60"	3° 10' 37.20"
dk	55° 57' 36.00"	10° 2' 24.00"	fr81	43° 35' 38.40"	3° 13' 32.16"
de1	48° 32' 45.60"	9° 2' 48.12"	fr82	43° 57' 32.40"	6° 3' 37.80"
de2	48° 57' 3.60"	11° 25' 8.40"	fr83	42° 9' 7.20"	9° 6' 21.96"
de3	52° 30' 7.20"	13° 24' 0.00"	ie	53° 10' 30.00"	-8° 9' 12.24"
de4	52° 28' 22.80"	13° 23' 52.80"	itc1	45° 3' 25.20"	7° 55' 10.92"
de5	53° 11' 49.20"	8° 44' 45.24"	itc2	45° 43' 51.60"	7° 23' 9.96"
de6	53° 32' 42.00"	10° 1' 26.40"	itc3	44° 15' 57.60"	8° 42' 16.92"
de7	50° 36' 10.80"	9° 1' 52.68"	itc4	45° 37' 1.20"	9° 46' 9.84"
de8	53° 45' 7.20"	12° 32' 2.40"	itd1	46° 41' 49.20"	11° 24' 57.60"
de9	52° 46' 4.80"	9° 9' 40.68"	itd2	46° 8' 6.00"	11° 7' 15.60"
dea	51° 28' 48.00"	7° 33' 44.64"	itd3	45° 39' 7.20"	11° 52' 8.40"
deb	49° 54' 50.40"	7° 26' 55.68"	itd4	46° 9' 3.60"	13° 3' 21.60"
ded	51° 3' 7.20"	13° 20' 52.80"	itd5	44° 32' 9.60"	11° 1' 12.00"
dee	52° 0' 46.80"	11° 42' 3.60"	ite1	43° 27' 3.60"	11° 7' 33.60"
def	54° 10' 58.80"	9° 48' 57.60"	ite2	42° 57' 57.60"	12° 29' 24"
deg	50° 54' 14.40"	11° 1' 33.60"	ite3	43° 21' 54.00"	13° 6' 28.80"
gr11	41° 9' 46.80"	25° 8' 20.40"	ite4	41° 58' 30.00"	12° 46' 30"
gr12	40° 44' 34.80"	22° 57' 25.20"	itf1	42° 13' 40.80"	13° 51' 18"
gr13	40° 21' 43.20"	21° 29' 2.40"	itf2	41° 41' 2.40"	14° 35' 42"
gr14	39° 31' 58.80"	22° 12' 57.60"	itf3	40° 51' 36.00"	14° 50' 24.00"
gr21	39° 36' 3.60"	20° 47' 2.40"	itf4	40° 59' 2.40"	16.° 37' 12.00"
gr23	38° 16' 55.20"	21° 34' 26.40"	itf5	40° 30' 0.00"	16° 4' 51.60"
gr24	38° 39' 18.00"	22° 50' 9.60"	itf6	39° 4' 4.80"	16° 20' 49.20"
gr25	37° 20' 34.80"	22° 27' 28.80"	itg1	37° 35' 20.40"	14° 8' 45.60"
gr31	37° 50' 27.60"	23° 36' 3.60"	itg2	40° 5' 16.80"	9° 1' 51.24"
gr42	36° 44' 45.60"	26° 18' 21.60"	nl1	53° 3' 46.80"	6° 20' 7.08"
gr43	35° 13' 44.40"	24° 50' 45.60"	nl2	52° 15' 46.80"	6° 3' 25.56"
es11	42° 45' 21.60"	-7° 54' 36.72"	nl3	52° 4' 22.80"	4° 35' 33.72"
es12	43° 17' 31.20"	-5° 59' 37.32"	nl4	51° 27' 14.40"	5° 24' 51.48"
es13	43° 11' 52.80"	-4° 1' 49.08"	at1	48° 8' 60.00"	15° 53' 31.20"
es21	43° 2' 38.40"	-2° 36' 59.76"	at2	47° 5' 16.80"	14° 36' 46.80"
es22	42° 40' 1.20"	-1° 38' 45.96"	at3	47° 34' 15.60"	12° 34' 51.60"
es23	42° 16' 30.00"	-2° 31' 2.28"	pt11	41° 27' 25.20"	-7° 40' 43.68"
es24	41° 31' 12"	0.00° 39' 35.39"	pt15	37° 14' 38.40"	-8° 7' 54.48"
es30	40° 29' 42.00"	-3° 43' 1.92"	pt16	40° 7' 19.20"	-8° 0' 23.04"
es41	41° 45' 14.40"	-4° 46' 54.84"	pt17	38° 42' 36.00"	-9° 0' 37.08"
es42	39° 34' 51.60"	-3° 0' 16.20"	pt18	38° 29' 27.60"	-8° 0' 57.24"
es43	39° 11' 27.60"	-6° 9' 2.88"	fi1	64° 31' 19.20"	26° 12' 18.00"
es51	41° 47' 56.40"	-1° 31' 43.68"	fi2	60° 12' 50.40"	20° 6' 57.60"
es52	39° 24' 7.20"	0° 33' 17.68"	se11	59° 28' 37.20"	18° 10' 58.80"
es53	39° 34' 30.00"	2° 54' 51.479"	se12	59° 14' 31.20"	16° 8' 52.80"
es61	37° 27' 46.80"	-4° 34' 32.16"	se21	57° 13' 12.00"	15° 23' 13.20"
es62	38° 0' 7.20"	-1° 29' 8.52"	se22	56° 1' 15.60"	13° 56' 9.60"
fr10	48° 42' 32.40"	2° 30' 9.36"	se23	58° 1' 33.60"	12° 46' 19.20"
fr21	48° 44' 9.60"	4° 32' 28.32"	se31	60° 48' 14.40"	14° 34' 37.20"
fr22	49° 38' 34.80"	2° 48' 30.24"	se32	63° 12' 36.00"	15° 11' 24.00"
fr23	49° 23' 31.20"	1° 0' 43.92"	se33	66° 14' 34.80"	19° 19' 8.40"
fr24	47° 29' 6.00"	1° 41' 3.12"	ukc	55° 1' 12.00"	-1.° 54' 21.24"
fr25	48° 55' 44.40"	0° 31' 17.83"	ukd	54° 3' 25.20"	-2° 43' 23.16"
fr26	47° 14' 52.80"	4° 8' 57.48"	uke	53° 57' 54.00"	-1° 13' 44.76"
fr30	50° 28' 19.20"	2° 42' 54.36"	ukf	52° 55' 37.20"	0° 48' 24.77"
fr41	48° 45' 43.20"	6° 8' 31.92"	ukg	52° 28' 48.00"	-2° 16' 14.88"
fr42	48° 19' 48.00"	7° 26' 7.08"	ukh	52° 15' 3.60"	0° 32' 23.35"
fr43	47° 12' 28.80"	6° 5' 16.80"	uki	51° 30' 3.60"	0° 6' 42.73"
fr51	47° 28' 40.80"	0° 48' 55.98"	ukj	51° 16' 51.60"	0° 32' 4.81"
fr52	48° 10' 40.80"	-2° 50' 27.24"	ukk	51° 0' 3.60"	-3° 7' 49.80"
fr53	46° 9' 46.80"	0° 4' 52.11"	ukl	52° 20' 9.60"	-3° 45' 46.44"
fr61	44° 21' 18.00"	0° 13' 34.00"	ukm	56° 51' 0.00"	-4° 10' 42.24"
fr62	43° 46' 8.40"	1° 29' 15.00"	ukn	54° 36' 36.00"	-6° 42' 6.84"

Notes: The abbreviations of the NUTS code follow the official codes used by the European Commission (2007). The centroids of the NUTS regions expressed in decimal degrees are calculated using the Matlab toolbox "Arc_Mat" (LeSage and Pace, 2004). Subsequently, they are converted to lattitude and longitude coordinates. Note that negative longitude values imply that the centroid of the region is located West of the Meridian (Greenwich) Line.

Table 27: Objective 1: Spatial panel lag model

	(1)	(2)	(3)	(4)	(5)	(6)
Ln real GDP p.c. (t-1)	-0.1337***	-0.1364***	-0.1708***	-0.2014***	-0.2599***	-0.3630***
	(0.01408)	(0.01407)	(0.01567)	(0.018)	(0.02124)	(0.0257)
Ln investment (t-1)	0.0038	0.0037	0.0056*	0.0104***	0.0126**	0.0254***
	(0.00264)	(0.00263)	(0.00296)	(0.00358)	(0.00592)	(0.00695)
Ln pop. growth + 0.05 (t-1)	-0.0067	-0.0039	-0.0093	-0.0145	-0.0143	-0.0243**
	(0.00877)	(0.00883)	(0.00922)	(0.00964)	(0.01025)	(0.01071)
Ln innovation (t-1)	-0.0001	-0.0001	-0.0001	-0.0002	-0.0001	-0.0001
	(0.00024)	(0.00024)	(0.00024)	(0.00024)	(0.00024)	(0.00024)
Ln Objective 1 (t-1)		0.0006	0.0000	-0.0004	-0.0001	-0.0001
		(0.00346)	(0.00029)	(0.00032)	(0.00034)	(0.00036)
Ln Objective 1 (t-2)			0.0006**	0.0002	0.0000	0.0003
			(0.00029)	(0.00031)	(0.00034)	(0.00034)
Ln Objective 1 (t-3)				0.0011***	0.0009***	0.0006
				(0.00032)	(0.00033)	(0.00036)
Ln Objective 1 (t-4)					0.0002	-0.0001
					(0.00036)	(0.00036)
Ln Objective 1 (t-5)						-0.0002
						(0.00038)
ρ	0.6400***	0.6380***	0.6400***	0.6400***	0.6410***	0.6230***
	(0.0318)	(0.03187)	(0.03236)	(0.03351)	(0.03433)	(0.03554)
LR-test joint sign. spatial effects	345.44	347.19	389.56	386.23	421.52	528.58
LR-test joint sign. spatial effects (p-value)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Obj. joint significance (sum)			0.0006	0.0009	0.0009	0.0004
Obj. joint significance (Wald stat.)			4.6911	7.2584	4.0900	0.5653
Obj. long-term elasticity		0.004305	0.003604	0.004673	0.003428	0.001102
Obj. long-term elasticity (p-value)		0.0001	0.0004	0.0005	0.0004	0.0001
Observations	1230	1230	1107	984	861	738
R-squared	0.5697	0.5717	0.6054	0.6157	0.6410	0.6819
Adj. R-squared	0.3024	0.3049	0.3322	0.3390	0.3454	0.3730

Notes: Standard errors in parentheses; constant, country and time dummies are not shown. Calculations are done with the Matlab routine *sar_panel* by Elhorst (2009).

Table 28: Objective 2: Spatial panel lag model

	(1)	(2)	(3)	(4)	(5)
Ln real GDP p.c. (t-1)	-0.1351***	-0.1671***	-0.1903***	-0.2569***	-0.3855***
	(0.01404)	(0.01561)	(0.01784)	(0.02115)	(0.02519)
Ln investment (t-1)	0.0035	0.0054*	0.0097***	0.0120**	0.0265***
	(0.00263)	(0.00296)	(0.00359)	(0.0059)	(0.00684)
Ln pop. growth + 0.05 (t-1)	-0.0062	-0.0083	-0.0150	-0.0148	-0.0190*
	(0.00874)	(0.00909)	(0.00955)	(0.01011)	(0.01046)
Ln innovation (t-1)	-0.0001	-0.0001	-0.0002	-0.0001	-0.0001
	(0.00024)	(0.00024)	(0.00024)	(0.00024)	(0.00024)
Ln Objective 1 (t-1)	-0.0005	-0.0004*	-0.0004*	-0.0003	-0.0004*
	(-0.00471)	(0.00019)	(0.00022)	(0.00023)	(0.00023)
Ln Objective 2 (t-2)		-0.0001	0.0000	-0.0001	-0.0001
			(0.00021)	(0.00023)	(0.00023)
Ln Objective 2 (t-3)			-0.0006***	-0.0002	0.0000
			(0.0002)	(0.00023)	(0.00025)
Ln Objective 2 (t-4)				-0.0005*	-0.0008**
				(0.00026)	(0.00032)
Ln Objective 2 (t-5)					-0.0011***
					(0.00027)
ρ	0.6370***	0.6490***	0.6360***	0.6400***	0.6070***
	(0.03187)	(0.0318)	(0.03383)	(0.03444)	(0.03605)
LR-test joint sign. spatial effects	337.42	378.10	369.91	412.09	540.71
LR-test joint sign. spatial effects (p-value)	0.0000	0.0000	0.0000	0.0000	0.0000
Obj. joint significance (sum)		-0.0004	-0.0010	-0.0012	-0.0024
Obj. joint significance (Wald stat.)		3.4251	9.9022	7.6471	18.9590
Obj. long-term elasticity	-0.0037	-0.0026	-0.0052	-0.0045	-0.0063
Obj. long-term elasticity (p-value)	0.0001	0.0002	0.0004	0.0004	0.0006
Observations	1230	1107	984	861	738
R-squared	0.5723	0.6056	0.6146	0.6409	0.6903
Adj. R-squared	0.3087	0.3288	0.3429	0.3531	0.4168

Notes: Standard errors in parentheses; constant, country and time dummies are not shown. Calculations are done with the Matlab routine *sar_panel* by Elhorst (2009).

Table 29: Objective 3: Spatial panel lag model

	(1)	(2)	(3)	(4)	(5)
Ln real GDP p.c. (t-1)	-0.1320***	-0.1649***	-0.1895***	-0.2496***	-0.3580***
	(0.01411)	(0.01573)	(0.01799)	(0.02118)	(0.02524)
Ln investment (t-1)	0.0040	0.0057*	0.0100***	0.0116*	0.0232***
	(0.00264)	(0.00297)	(0.00361)	(0.00597)	(0.00692)
Ln pop. growth + 0.05 (t-1)	-0.0080	-0.0097	-0.0159	-0.0147	-0.0227**
	(0.00879)	(0.00918)	(0.00965)	(0.0102)	(0.01053)
Ln innovation (t-1)	-0.0001	-0.0002	-0.0002	-0.0001	-0.0001
	(0.00024)	(0.00024)	(0.00024)	(0.00024)	(0.00024)
Ln Objective 1 (t-1)	-0.0002	-0.0002	-0.0002	-0.0002	-0.0004**
	(-0.00114)	(0.00014)	(0.00015)	(0.00016)	(0.00018)
Ln Objective 3 (t-2)		0.0000	0.0002	0.0001	0.0000
		(0.00014)	(0.00016)	(0.00016)	(0.00016)
Ln Objective 3 (t-3)			-0.0002	0.0000	-0.0002
			(0.00015)	(0.00017)	(0.00016)
Ln Objective 3 (t-4)				0.0001	0.0004**
				(0.00017)	(0.00019)
Ln Objective 3 (t-5)					-0.0005***
					(0.00019)
ρ	0.6290***	0.6370***	0.6310***	0.6360***	0.6020***
	(0.03232)	(0.03257)	(0.03426)	(0.03479)	(0.03594)
LR-test joint sign. spatial effects	323.23	364.84	351.04	401.14	528.58
LR-test joint sign. spatial effects (p-value)	0.0000	0.0000	0.0000	0.0000	0.0000
Obj. joint significance (sum)		-0.0002	-0.0003	-0.0001	-0.0006
Obj. joint significance (Wald stat.)		1.5348	3.1605	0.2888	5.5046
Obj. long-term elasticity	-0.0018	-0.0011	-0.0016	-0.0001	-0.0018
Obj. long-term elasticity (p-value)	0.0001	0.0001	0.0001	0.0000	0.0001
Observations	1230	1107	984	861	738
R-squared	0.5701	0.6038	0.6112	0.6381	0.6849
Adj. R-squared	0.3100	0.3336	0.3476	0.3466	0.3990

Notes: Standard errors in parentheses; constant, country and time dummies are not shown. Calculations are done with the Matlab routine *sar_panel_FE* by Elhorst (2009).

Table 30: Objectives 1+2+3: Spatial panel lag model

	(1)	(2)	(3)	(4)	(5)
Ln real GDP p.c. (t-1)	-0.1339***	-0.1686***	-0.1937***	-0.2609***	-0.3735***
	(0.0141)	(0.01566)	(0.01815)	(0.02109)	(0.02475)
Ln investment (t-1)	0.0037	0.0057*	0.0099***	0.0117**	0.0252***
	(0.00265)	(0.00297)	(0.00361)	(0.00592)	(0.00684)
Ln pop. growth + 0.05 (t-1)	-0.0069	-0.0076	-0.0120	-0.0110	-0.0168
	(0.00879)	(0.00913)	(0.00964)	(0.01014)	(0.01046)
Ln innovation (t-1)	-0.0001	-0.0001	-0.0002	-0.0001	0.0000
	(0.00024)	(0.00024)	(0.00024)	(0.00024)	(0.00024)
Ln Objective 1 (t-1)	0.0000	0.0000	-0.0002	-0.0001	-0.0001
	(-0.00018)	(0.0002)	(0.00023)	(0.00023)	(0.00023)
Ln Objectives 1+2+3 (t-2)		0.0003	0.0003	0.0000	0.0003
		(0.00018)	(0.00021)	(0.00024)	(0.00023)
Ln Objectives 1+2+3 (t-3)			0.0000	0.0004*	0.0005**
			(0.0002)	(0.00023)	(0.00026)
Ln Objectives 1+2+3 (t-4)				-0.0005*	-0.0009***
				(0.00025)	(0.00033)
Ln Objectives 1+2+3 (t-5)					-0.0008***
					(0.00025)
ρ	0.6290***	0.6430***	0.6450***	0.6470***	0.6250***
	(0.0325)	(0.03228)	(0.03356)	(0.03466)	(0.03662)
LR-test joint sign. spatial effects	344.75	385.56	366.19	420.14	534.42
LR-test joint sign. spatial effects (p-value)	0.0000	0.0000	0.0000	0.0000	0.0000
Obj. joint significance (sum)		0.0003	0.0000	-0.0001	-0.0010
Obj. joint significance (Wald stat.)		1.1457	0.0088	0.0569	2.7933
Obj. long-term elasticity	-0.0003	0.001582	0.000166	-0.000411	-0.002558
Obj. long-term elasticity (p-value)	0.0000	0.0001	0.0000	0.0000	0.0002
Observations	1230	1107	984	861	738
R-squared	0.5687	0.6045	0.6111	0.6410	0.6906
Adj. R-squared	0.3051	0.3323	0.3372	0.3538	0.4154

Notes: Standard errors in parentheses; constant, country and time dummies are not shown. Calculations are done with the Matlab routine *sar_panel_FE* by Elhorst (2009).

Table 31: Results of the LSDV approach using 2-years averaged dataset I

	No funds	Objective 1				Objectives 2			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Ln real GDP p.c. (t-1)	-0.206***	-0.216***	-0.348***	-0.612***	-0.458***	-0.205***	-0.346***	-0.615***	-0.397***
	(0.0592)	(0.0564)	(0.0728)	(0.0949)	(0.0635)	(0.0591)	(0.0835)	(0.0834)	(0.0699)
Ln investment (t-1)	0.00812	0.00969	0.0194***	0.0466**	-0.0150	0.00743	0.0167**	0.0416**	-0.0256
	(0.00592)	(0.00599)	(0.00674)	(0.0215)	(0.0188)	(0.00591)	(0.00660)	(0.0203)	(0.0179)
Ln pop. growth + 0.05 (t-1)	-0.0581**	-0.0403*	-0.0783***	-0.109***	-0.0541	-0.0584**	-0.0783***	-0.103***	-0.0881**
	(0.0244)	(0.0239)	(0.0256)	(0.0295)	(0.0443)	(0.0244)	(0.0276)	(0.0270)	(0.0438)
Ln innovation (t-1)	-6.82e-05	0.000746	0.000870	0.00371	-0.0102*	-0.000533	-0.00140	0.00120	-0.0115**
	(0.00472)	(0.00469)	(0.00654)	(0.00950)	(0.00544)	(0.00466)	(0.00603)	(0.00931)	(0.00525)
Ln Objective (t-1)		0.00216*	0.000164	0.000184	0.00196	-0.000766*	-0.000350	-0.000328	-0.000380
		(0.00113)	(0.000911)	(0.000853)	(0.00160)	(0.000429)	(0.000613)	(0.000802)	(0.000435)
Ln Objective (t-2)			0.00338**	0.00149	0.00179***		-0.00192***	-0.00279**	-0.00194**
			(0.00164)	(0.000990)	(0.000551)		(0.000507)	(0.00111)	(0.000862)
Ln Objective (t-3)				0.00269	0.00142			-0.00199***	0.00262***
				(0.00232)	(0.00152)			(0.000704)	(0.000910)
Ln Objective (t-4)					0.00282**				-4.96e-05
					(0.00137)				(0.000550)
Obj. joint significance (sum)			0.00354	0.00436	0.00798		-0.00227	-0.00510	0.000246
Obj. joint significance (p-value)			0.0426	0.112	0.000117		0.00402	0.000960	0.872
Obj. long-term elasticity		0.0100	0.0102	0.00713	0.0174	-0.00373	-0.00656	-0.00829	0.000621
Obj. long-term elasticity (p-value)		0.000148	2.59e-06	6.87e-10	9.70e-11	0.000561	4.33e-05	0	1.31e-07
Wald test time dummies (p-value)	0	0	1.15e-10	7.92e-05	0.0249	0	0	3.15e-05	0.0727
Wooldridge test AR(1) (p-value)	0.102	0.112	0.111	0.783	0.815	0.869	0.0673	0.481	0.500
Observations	597	597	478	357	236	597	478	357	236
Number of regions	124	124	124	124	124	124	124	124	124
R-squared	0.479	0.491	0.600	0.673	0.506	0.482	0.596	0.692	0.510
Adj. R-squared	0.472	0.484	0.592	0.664	0.486	0.474	0.589	0.684	0.491

Notes: White-Huber heteroskedasticity robust standard errors in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%; constant and time dummies are not shown.

Table 32: Results of the LSDV approach using 2-years averaged dataset II

	Objective 3				Objectives 1+2+3			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Ln real GDP p.c. (t-1)	-0.197***	-0.330***	-0.626***	-0.448***	-0.209***	-0.345***	-0.594***	-0.426***
	(0.0587)	(0.0847)	(0.0776)	(0.0742)	(0.0587)	(0.0827)	(0.0878)	(0.0653)
Ln investment (t-1)	0.00732	0.0143**	0.0399**	-0.0141	0.00896	0.0180***	0.0461**	-0.0277
	(0.00585)	(0.00657)	(0.0188)	(0.0185)	(0.00599)	(0.00684)	(0.0214)	(0.0171)
Ln pop. growth + 0.05 (t-1)	-0.0658***	-0.0923***	-0.113***	-0.0495	-0.0548**	-0.0755***	-0.104***	-0.0742*
	(0.0249)	(0.0302)	(0.0261)	(0.0487)	(0.0240)	(0.0266)	(0.0284)	(0.0386)
Ln innovation (t-1)	-0.00267	-0.00302	0.000649	-0.0113**	0.000488	6.06e-05	0.00296	-0.00889*
	(0.00483)	(0.00640)	(0.00894)	(0.00516)	(0.00475)	(0.00623)	(0.00930)	(0.00522)
Ln Objective (t-1)	-0.000807***	-0.000509	-0.00102***	-0.00134**	0.000556	0.00102	0.00111	-1.34e-05
	(0.000257)	(0.000342)	(0.000316)	(0.000667)	(0.000603)	(0.000743)	(0.000805)	(0.000510)
Ln Objective (t-2)		-0.000782**	-0.000503	5.01e-05		-0.000776	-0.00113	-0.000863
		(0.000316)	(0.000346)	(0.000303)		(0.000765)	(0.00101)	(0.00104)
Ln Objective (t-3)			-0.00406***	-0.00114			-0.00172***	0.00343**
			(0.000729)	(0.000968)			(0.000606)	(0.00138)
Ln Objective (t-4)				-0.00106				0.000222
				(0.000707)				(0.000495)
Obj. joint significance (sum)		-0.00129	-0.00559	-0.00349		0.000244	-0.00174	0.00278
Obj. joint significance (p-value)		0.000816	8.41e-09	0.0574		0.842	0.261	0.0933
Obj. long-term elasticity	-0.00409	-0.00391	-0.00893	-0.00778	0.00266	0.000709	-0.00292	0.00652
Obj. long-term elasticity (p-value)	0.000836	0.000118	0	2.44e-08	0.000406	3.90e-05	1.16e-10	2.59e-09
Wald test time dummies (p-value)	0	1.00e-08	0.000453	0.0979	0	0	4.27e-06	0.0647
Wooldridge test AR(1) (p-value)	0.0962	0.0399	0.335	0.338	0.102	0.0975	0.492	0.565
Observations	597	478	357	236	597	478	357	236
Number of regions	124	124	124	124	124	124	124	124
R-squared	0.488	0.594	0.732	0.484	0.481	0.588	0.685	0.506
Adj. R-squared	0.481	0.586	0.725	0.463	0.473	0.580	0.677	0.487

Notes: White-Huber heteroskedasticity robust standard errors in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%; constant and time dummies are not shown.

Table 33: Results of the LSDV approach using 3-years averaged dataset

	No funds	Objective 1		Objective 2		Objective 3		Objectives 1+2+3	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Ln real GDP p.c. (t-1)	-0.381***	-0.406***	-0.829***	-0.385***	-0.812***	-0.365***	-0.799***	-0.393***	-0.794***
	(0.109)	(0.0969)	(0.109)	(0.109)	(0.105)	(0.107)	(0.0895)	(0.0991)	(0.119)
Ln investment (t-1)	0.0108	0.0121	0.0427*	0.00943	0.0381*	0.00943	0.0355**	0.0188	0.0449*
	(0.0116)	(0.0116)	(0.0218)	(0.0120)	(0.0205)	(0.0115)	(0.0171)	(0.0122)	(0.0228)
Ln pop. growth + 0.05 (t-1)	-0.0960*	-0.0572	-0.0842*	-0.0958*	-0.119***	-0.108**	-0.118***	-0.0671	-0.101**
	(0.0519)	(0.0438)	(0.0453)	(0.0519)	(0.0446)	(0.0523)	(0.0368)	(0.0454)	(0.0495)
Ln innovation (t-1)	-0.000128	0.000526	-0.00955	-0.000741	-0.00385	-0.00506	-0.0126	0.00240	-0.00407
	(0.00920)	(0.00922)	(0.0124)	(0.00921)	(0.0126)	(0.00932)	(0.0128)	(0.00953)	(0.0123)
Ln Objective (t-1)		0.00319	0.000999	-0.000580	0.000779	-0.00109**	-0.00171***	0.00272	0.00321
		(0.00204)	(0.000778)	(0.000964)	(0.00166)	(0.000476)	(0.000427)	(0.00185)	(0.00199)
Ln Objective (t-2)			0.00290		-0.00291**		-0.00760***		-0.00150
			(0.00253)		(0.00123)		(0.00150)		(0.00128)
Obj. joint significance (sum)			0.00390		-0.00213		-0.00930		0.00171
Obj. joint significance (p-value)			0.174		0.348		3.21e-07		0.507
Obj. long-term elasticity		0.00785	0.00470	-0.00151	-0.00262	-0.00298	-0.0116	0.00692	0.00215
Obj. long-term elasticity (p-value)		4.01e-05	0	0.000496	0	0.000812	0	9.64e-05	9.22e-10
Wald test time dummies (p-value)	0	0	0.983	0	0.723	0	0.162	0	0.985
Wooldridge test AR(1) (p-value)	0.170	0.159	0.116	0.170	0.205	0.168	0.230	0.167	0.160
Observations	364	364	244	364	244	364	244	364	244
Number of regions	123	123	123	123	123	123	123	123	123
R-squared	0.611	0.627	0.815	0.612	0.824	0.619	0.863	0.624	0.824
Adj. R-squared	0.604	0.619	0.810	0.604	0.819	0.612	0.858	0.617	0.819

Notes: White-Huber heteroskedasticity robust standard errors in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%; constant and time dummies are not shown.

Table 34: Results of the LSDV approach using 4-years averaged dataset

	No funds	Objective 1	Objective 2	Objective 3	Objectives 1+2+3
	(1)	(2)	(3)	(4)	(5)
Ln real GDP p.c. (t-1)	-0.277*	-0.322***	-0.311**	-0.292**	-0.252*
	(0.147)	(0.113)	(0.138)	(0.131)	(0.145)
Ln investment (t-1)	0.00579	0.00978	0.00511	0.0147	0.00286
	(0.0121)	(0.00985)	(0.0123)	(0.0110)	(0.0116)
Ln pop. growth + 0.05 (t-1)	-0.243**	-0.182**	-0.231**	-0.209**	-0.274***
	(0.104)	(0.0722)	(0.104)	(0.0976)	(0.0996)
Ln innovation (t-1)	-0.00508	-0.00601	-0.00919	-0.0198*	-0.00688
	(0.0116)	(0.0116)	(0.0115)	(0.0115)	(0.0114)
Ln Objective 1 (t-1)		0.00409	-0.00487***	-0.00366***	-0.00291
		(0.00351)	(0.00119)	(0.000751)	(0.00227)
Obj. long-term elasticity		0.0127	-0.0156	-0.0125	-0.0115
Obj. long-term elasticity (p-value)		0.00504	0.0256	0.0274	0.0854
Adj. R-squared	0.685	0.695	0.717	0.722	0.695
Wald test time dummies (p-value)	0.0745	0.0612	0.295	0.655	0.155
Observations	244	244	244	244	244
Number of regions	123	123	123	123	123
R-squared	0.692	0.702	0.724	0.728	0.702

Notes: White-Huber heteroskedasticity robust standard errors in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%; constant and time dummies are not shown.

Table 35: Summary of the main results: Sign of the long-term elasticities by Objectives

	Sign	Significant at at least 10% level for lags ...
$\hat{\beta}_{Obj1}$	positive	1–5
$\hat{\beta}_{Obj2}$	negative	1, 1–2, 1–3, 1–4
$\hat{\beta}_{Obj3}$	negative	1, 1–2
$\hat{\beta}_{Obj123}$	positive in most cases	1–5

Notes: This table summarises the main results of the previous regressions referring to the annual dataset.
Reading example: The regressions results show positive coefficients for the Objective 1 coefficient in all specifications. Furthermore, the up to 5 years lagged structural funds variables, i.e. $\sum_{j=1}^{5} ln(Obj.1_{i,t-j})$, is always statistically significant independently of which estimation approach is used. As motivated in section 3, we use a LSDV estimator, adjust for serial correlation according to Newey and West (1987) or Prais-Winsten and for spatial correlation following Driscoll and Kraay (1998). In addition, we control for endogeneity with a two-step system GMM estimator (Blundell and Bond, 1998) and we use a spatial panel estimator as proposed by Elhorst (2009)).

References

Anselin, L., R. Florax, and S. Rey (2004): *Advances in spatial econometrics.* Springer, Berlin, Heidelberg, New York.

Antunes, M., and E. Soukiazis (2005): "Two speed of regional convergence in Portugal and the importance of structural funds on growth," *Paper presented at the 4th Annual Meeting of the EEFS*, 19 - 22 May, Coimbra.

Bähr, C. (2008): "How does sub-national autonomy affect the effectiveness of structural funds," *Kyklos*, 61(1), 3–18.

Barro, R., and J.-W. Lee (2001): "International comparisons of educational attainment," *Journal of Monetary Economics*, 32(3), 363–394.

Barro, R., and X. Sala-I-Martin (1995): *Economic growth theory.* McGraw-Hill, Boston.

——— (2004): *Economic growth.* The MIT Press, Cambridge, Massachusetts.

Beugelsdijk, M., and S. Eijffinger (2005): "The effectiveness of structural policy in the European Union: An empirical analysis for the EU-15 in 1995-2001," *Journal of Common Market Studies*, 40, 37–51.

Blundell, R., and S. Bond (1998): "Initial conditions and moment restrictions in dynamic panel data models," *Journal of Econometrics*, 87, 115–143.

Bouvet, F. (2005): "European Union regional policy: Allocation determinants and effects on regional economic growth," *mimeo.*

Bowsher, C. (2002): "On testing overidentifying restrictions in dynamic panel data models," *Economic Letters*, 77, 211–220.

Bussoletti, S., and R. Esposti (2004): "Regional convergence, structural funds and the role of agriculture in the EU. A panel-data approach," *Universitá Politecnica delle Marche, Dipatimento die Economia, Working Paper*, 220(October 2004).

Cappelen, A., F. Castellacci, J. Fagerberg, and B. Verspagen (2003): "The impact of EU regional support on growth and convergence in the European Union," *Journal of Common Market Studies*, 41(4), 621–644.

Cohen, D., and M. Soto (2007): "Growth and human capital: good data, good results," *Journal of Economic Growth*, 12, 51–76.

Dall'erba, S., and J. Le Gallo (2008): "Regional convergence and the impact of European structural funds 1989-1999: A spatial econometric analysis," *Papers in Regional Science*, 82(2), 219–244.

de Freitag, M., F. Pereira, and F. Torres (2003): "Quality of national institutions and Objective 1 status," *Intereconomics*, September/October(2003), 270–275.

De La Fuente, A., and R. Doménech (2006): "Human capital in growth regressions: How much difference does data quality make?," *Journal of the European Economic Association*, 4(1), 1–36.

Driscoll, J., and A. Kraay (1998): "Consistent covariance matrix estimation with spatially dependent panel data," *The Review of Economics and Statistics*, 80(4), 549–560.

Ederveen, S., H. de Groot, and R. Nahuis (2006): "Fertile soil for structural funds? A panel data analysis of the conditional effectiveness of European cohesion policy," *Kyklos*, 59, 17–42.

Ederveen, S., J. Gorter, R. de Mooij, and R. Nahuis (2002): *Funds and games. The economics of European cohesion policy*. The Hague.

Eggert, W., M. von Ehrlich, R. Fenge, and G. König (2007): "Konvergenz- und Wachstumseffekte der europäischen Regionalpolitik in Deutschland," *Perspektiven der Wirtschaftspolitik*, 8(2), 130–146.

Elhorst, P. J. (2004): "Specification and estimation of spatial panel data models," *International Regional Science Review*, 26, 244–268.

——— (2009): "Spatial panel data models," in *Handbook of applied spatial analysis*, ed. by M. Fischer, and A. Getis. Springer, Berlin, forthcoming.

Ertur, C., and W. Koch (2006): "Regional disparities in the European Union and the enlargement process: an exploratory spatial data analysis, 1995-2000," *Journal of Regional Science*, 40, 723–765.

Esposti, R., and S. Bussoletti (2008): "Impact of Objective 1 funds on regional growth convergence in the European Union: A panel-data approach," *Regional Studies*, 42(2), 159–173.

European Commission (1995): *The implementation of the reform of the structural funds 1993: Fifth annual report*. Brussels.

——— (1996a): *Seventh annual report on the structural funds 1995*. Brussels.

——— (1996b): *Sixth annual report on the structural funds 1994*. Brussels.

——— (1997): *Eighth annual report on the structural funds 1996*. Brussels.

——— (1998): *Ninth annual report on the structural funds 1997*. Brussels.

——— (1999): *Tenth annual report on the structural funds 1998*. Brussels.

——— (2000): *Report from the Commission. 11th annual report on the structural funds 1999*. Brussels.

——— (2007): "Commission Regulation (EC) No 105/2007," *Official Journal of the European Union*, L 39.

Eurostat (2007): *Geographic information system of the European Commission (GISCO): NUTS 2003*. Luxembourg.

García-Milá, T., and T. McGuire (2001): "Do interregional transfers improve the economic performance of poor regions? The case of Spain," *International Tax and Public Finance*, 8, 281–295.

Hoechle, D. (2007): "Robust standard errors for panel regressions with cross-sectional dependence," *The Stata Journal*, 7(3), 281–312.

Islam, N. (1995): "Growth empirics: A panel data approach," *Quarterly Journal of Economics*, 110, 1127–1170.

Le Gallo, J., and C. Ertur (2003): "Exploratory spatial data analysis of the distribution of regional per capita in Europe, 1980-1995," *Papers in Regional Science*, 82, 175–201.

LeSage, J. P., and K. R. Pace (2004): *Arc_Mat, a toolbox for using ArcView shape files for spatial econometrics and statistics*, vol. 3234/2004 of *Lecture Notes in Computer Science*. Springer, Berlin, Heidelberg.

Mankiw, N., P. Romer, and D. Weill (1992): "A contribution to the empirics of economic growth," *Quarterly Journal of Economics*, 107, 407–437.

Newey, W., and K. West (1987): "A simple, positive semi-definite, heteroskedasticity and autocorrelation consistent covariance matrix," *Econometrica*, 55(3), 703–708.

Pace, K. R. (2003): "Spatial Statistics Toolbox 2.0," *mimeo*.

Percoco, M. (2005): "The impact of structural funds on the Italian Mezzogiorno, 1994-1999," *Région et Developpement*, 21, 141–152.

Puigcerver-Peñalver, M. (2004): "The impact of structural funds policy on European regions growth. A theoretical and empirical approach," *mimeo*, Version of 14 April 2004.

Rodriguez-Pose, A., and U. Fratesi (2004): "Between development and social policies: The impact of European structural funds in Objective 1 regions," *Regional Studies*, 38(1), 97–113.

Roodman, D. (2006): "How to do xtabond2: An introduction to "difference" and "system" GMM in Stata," *Center for Global Development Working Paper*, 103.

——— (2007): "A short note on the theme of too many instruments," *Center for Global Development Working Paper*, 125.

Solow, R. (1956): "A contribution to the theory of economic growth," *Quarterly Journal of Economics*, 70(1), 65–94.

Swan, T. (1956): "Economic growth and capital accumulation," *Economic Record*, 32(334-361).

Windmeijer, F. (2005): "A finite sample correction for the variance of linear efficient two-step GMM estimators," *Journal of Econometrics*, 126(1), 25–51.

Wooldridge, J. M. (2002): *Econometric analysis of cross section and panel data*. The MIT Press, Cambridge, MA.