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Stirling Economics Discussion Paper 2008-27

November 2008

Online at http://www.economics.stir.ac.uk

Going NUTS: The Effect of EU Structural Funds on Regional Performance*

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November 24, 2008

Abstract

The European Union (EU) provides grants to disadvantaged regions of member states to allow them to catch up with the EU average. Under the Objective 1 scheme, NUTS2 regions with a GDP per capita level below 75% of the EU average qualify for structural funds transfers from the central EU budget. This rule gives rise to a regression-discontinuity design that exploits the discrete jump in the probability of EU transfer receipt at the 75% threshold. Additional variability arises for smaller regional aggregates – so-called NUTS3 regions – which are nested in a NUTS2 mother region. Whereas some relatively rich NUTS3 regions may receive EU funds because their NUTS2 mother region qualifies, other relatively poor NUTS3 regions may not receive EU funds because their NUTS2 mother region does not qualify. We find positive growth effects of Objective 1 funds, but no employment effects. A simple cost-benefit calculation suggests that Objective 1 transfers are not only effective, but also cost-efficient.

Keywords: Structural funds; Regional growth; Regression discontinuity design; Quasi-randomized experiment

JEL Classification: C21; O40; H54; R11

**Acknowledgements:* We thank seminar participants at the IIPF 2008, EEA 2008, the 7th Workshop on Spatial Econometrics and Statistics in Paris, the Universities of Osnabrück and Stirling, the Center for Economic Studies, and at the Ifo Institute for Economic Research for valuable comments.

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1 Introduction

Most federations – national or supra-national in scope – rely on a system of fiscal federalism which allows for transfers across jurisdictions. Examples of such national federations are the United States of America or the German States (Länder). An example of a supra-national federation is the European Union (EU). The most important aim of the aforementioned transfers is to establish equalization – at least partially – of fiscal capacity and per-capita income among the participating jurisdictions (see Ma 1997).

In comparison to other federations, the magnitude of equalization transfers is particularly large within the EU. Before briefly summarizing the EU system of transfers, it is useful to introduce the administrative regional units in the EU. EUROSTAT, the statistical office of the European Commission, distinguishes between three subnational regional aggregates: NUTS1 (large regions with a population of 3-7 million inhabitants); NUTS2 (groups of counties and unitary authorities with a population of 0.8-3 million inhabitants); and NUTS3 regions (counties of 150-800 thousand inhabitants).[1]

The largest part of fiscal equalization transfers at the level of the EU is spent under the auspices of the *Structural Funds Programme*. Most of the associated transfers are assigned at the NUTS2 level. Overall, the *Structural Funds Programme* currently distinguishes between transfers under three mutually exclusive schemes: Objective 1, Objective 2 and Objective 3. We confine our analysis to Objective 1 treatment for three reasons. First, Objective 1 funding has the explicit aim of fostering GDP-per-capita growth in regions that are lagging behind the EU average and of promoting aggregate growth in the EU (European Commission 2001). Second, Objective 1 expenditures form the largest part of the overall *Structural Funds Programme* budget. They account for more than two thirds of the programme's total budget: 70% in the 1988-1993 period, 68% in the 1994-1999 period and 72% in the 2000-2006 period (see EU 1997, p. 154f., and EU 2007, p. 202). Third, Objective 1 regulations have been largely unchanged over the three programming periods for which we have data.[2] A region classifies for Objective 1 transfers if its GDP per capita in

[1]NUTS is the acronym for *N*omenclature des *U*nités *T*erritoriales *S*tatistiques coined by EUROSTAT. The highest level of regional aggregation (NUTS1) corresponds to Germany's *Bundesländer*, France's *Zones d'Études et d'Aménagement du Territoire*, the United Kingdom's *Regions of England/Scotland/Wales* or Spain's *Grupos de Comunidades Autónomas*. At the other end of the NUTS classification scheme, NUTS3 regions correspond to *Landkreise* in Germany, to *Départements* in France, to *Unitary Authorities* in the UK or to *Comunidades Autónomas* in Spain.

[2]Objective 2 covers regions that face socioeconomic problems which are mainly defined by high unemployment rates. More precisely, regions must satisfy three criteria to be eligible for Objective

purchasing power parity terms (PPP) is less than 75% of the EU average. For the programming periods 1989-93, 1994-99, and 2000-06, the EU commission computed the relevant threshold of GDP per capita in PPP terms based on the figures for the last three years of data available when the Commission's regulations came out. Those were the years 1984-86, 1988-90, and 1995-97, respectively.

Transfer eligibility is thus determined in advance for a whole programming period of several years. For instance, in the 1994-99 programming period, the European Commission provided Objective 1 transfers to 64 out of 215 NUTS2 regions in the EU15 area. A graphical illustration of the regions receiving Objective 1 funds ("treated regions") across the three most recent budgetary periods is provided in Figure 1.

Figure 1 and Table 1 about here

The amounts that are paid are quite significant for the recipient regions. In the 1994-99 programming period the 64 NUTS2 regions received on average transfer in the order of 1.5 percent of their GDP (see European Commission, 1997, 2007; Table 1 provides information for the three most recent programming periods). A number of questions relating to these expenses are of obvious interest to both policy makers and economists. *To which extent do economic outcomes in the recipient regions actually respond to such re-distributional transfers?* This calls for an evaluation of the overall (causal) impact of transfers. Moreover, one could ask about the efficiency of transfers: *Does the response in economic outcome in the treated regions justify the size of the programme and, in particular, its costs to the untreated net-paying jurisdictions?* Surprisingly little is known to answer these questions.

A small number of previous studies looked into the impact of re-distributional regional policies on economic outcomes (see section 2 for a detailed discussion of the literature). Most of that research focused on the impact of the EU's *Structural Funds Programme*. Yet, essentially all existing work on that topic uses fairly aggregated regional data at the NUTS1 or NUTS2 level. This might be problematic because, by design of the programme, regions which are eligible for transfer payments under

2 transfers: first, an unemployment rate above the Community average; second, a higher percentage of jobs in the industrial sector than the Community average; and, third, a decline in industrial employment. Objective 3 deals with the promotion of human capital. The main goal is the support of the adaption and modernization of education, training and employment policies in regions. Objectives 2 and 3 were modified slightly over the programming periods considered here. In 1989-93 and 1994-99 three additional objectives of minor importance existed which were abolished in 2000-06. For the new programming period 2007-2013 the three objectives have been renamed Convergence objective, Regional Competitiveness and Employment objective and European Territorial Co-operation objective.

Objective 1 ("poor regions") differ systematically from non-eligible ones ("rich regions"). Furthermore, with regard to transfers under the auspices of the *Structural Funds Programme*, most papers use cross-sectional data. Hence, the level of aggregation and cross-sectional nature of the data employed in previous work renders identification of the causal effect of the programme difficult if not impossible.

We compile data on 1213 NUTS3 regions in Europe for three programming periods – 1989-93, 1994-99, and 2000-06 – to assess the causal effect of transfers through the EU's *Structural Funds Programme* on economic outcomes such as average annual growth of GDP per capita and employment growth of NUTS3 regions. The 75% threshold at the NUTS2 level gives rise to a regression-discontinuity design whereby regions very close to that threshold are likely to be very similar ex ante, but those below the 75% threshold qualify for Objective 1 funds, whereas those above do not.

Our identification strategy is strengthened through the use of data at the NUTS3 level. In particular, we exploit variation in GDP per capita across NUTS3 jurisdictions *within* eligible or non-eligible NUTS2 regions. For instance, some of the NUTS3 regions in eligible (and actually transfer-receiving) NUTS2 aggregates were richer than the pre-specified threshold level which determines transfer eligibility at the NUTS2 level. These regions were assigned to Objective 1 status, but would not have qualified had they been independent entities. Similarly, some of the NUTS3 regions in non-eligible (transfer non-recipient) NUTS2 regions had a per-capita GDP below the threshold determining eligibility at the higher level of aggregation, so would have been eligible for Objective 1 status as independent entities, but were assigned to the non-treatment group. Exploitation of this variation in per-capita income across NUTS3 regions within eligible and non-eligible NUTS2 regions allows for a much richer design than in previous work and permits the identification of the causal effect of the EU's fiscal transfer programme on economic outcomes. The key feature is that, within a narrow band around the 75% eligibility threshold, there are treated and untreated NUTS3 regions *on both sides of the threshold* which are otherwise very similar, even in terms of their per capita GDP. We use both cross-sectional and panel variation, the latter giving rise to a *difference-in-difference regression discontinuity design* (DID-RDD).

The analysis identifies a small positive impact of Objective 1 transfers on regional growth of GDP per capita which is robust to period choice and estimation methods applied. In the preferred specification and procedure, we estimate that Objective 1 programme participation exerts a differential impact on GDP-per-capita growth of about 1.8 percentage points within the same programming period. With respect to employment we find a significant positive effect of about 0.5 percentage points only in the last programming period. However, it is not explicitly and directly the aim of Objective 1 to stimulate employment growth in the treated regions.

Altogether, a back-of-the envelope calculation suggests that – on average – the funds spent on Objective 1 have a return which is about 1.21 times higher than their costs in terms of GDP. Hence, the programme seems effective *and* relatively efficient with regard to fostering GDP-per-capita growth in the recipient regions.

The remainder of the paper is organized as follows. The next section provides a discussion of the state of the literature on the evaluation of the *Structural Funds Programme*. Section 3 presents our data and shows descriptives on treated (i.e. Objective 1) and untreated (i.e. non-Objective 1) NUTS2 and NUTS3 regions. Section 4 shows the findings about the (causal) effects of Objective 1 treatment on the growth of GDP per capita and employment when using our quasi-experimental design. Section 5 provides sensitivity checks and a back-of-the-envelope calculation of the efficiency of the European Union's *Objective 1 Programme*. The last section concludes with a summary of the most important findings.

2 Effects of the Structural Funds Programme: state of the debate

The interest in effects of the EU's structural policy roots in empirical work on regional growth and convergence. In particular, Sala-i-Martin (1996) started the debate by diagnosing from cross-sectional regressions that the regional growth and convergence pattern in the EU was not different from the one in other federations which lack such an extensive cohesion programme. Obviously, such a conclusion requires comparability of federations and their regions in all other respects, which is not necessarily the case. However, Boldrin and Canova (2001) came to similar conclusions when focusing on regional growth within the EU and comparing recipient and non-recipient regions. Yet, both papers did not specifically focus on Objective 1, which primarily aims at closing the gap in per-capita income, but at the combined *Structural Funds Programme*. Furthermore, they used fairly aggregated NUTS2 and NUTS1 data, since data at the NUTS3 level was not available at the time.

The latter evidence is in contrast to the findings of Midelfart-Knarvik and Overman (2002) who identify a positive impact of the *Structural Funds Programme* on industry location and agglomeration at the national level.[3] Similarly, Beugelsdijk and Eijffinger (2005) and Ederveen, de Groot and Nahuis (2006) took a national perspective and found a positive relationship between *Structural Funds Programme* spending and GDP-per-capita growth (at least, in countries with favorable institutions). At the sub-national (NUTS1 or NUTS2) level, Cappelen, Castellacci,

[3]However, they find that the funds seem to stimulate economic activity counter to the comparative advantage of the recipient countries.

Fagerberg and Verspagen (2003) as well as Ederveen, Gorter, de Mooij and Nahuis (2002) detect a significant positive impact of structural funds on regional growth while Dall'erba and Le Gallo (2008) do not support this conclusion.

However, as argued in the introduction, one potential problem of previous work was the lack of information about sufficiently disaggregated data. The latter is a corner stone of our analysis. It does not only enable a more efficient identification of the programme's impact from larger number of observations[4] but – even more importantly – enables randomization in a quasi-experiment and facilitates identification of the causal impact of the programme on economic outcomes.[5]

3 Data and descriptive statistics

For the empirical analysis, we link data from several sources. Information on GDP at purchasing power parity (PPP), total and sectoral employment,[6] population, and investment at the level of NUTS2 and NUTS3 regions stems from Cambridge Econometrics' Regional Database. Data on treatment under Objective 1 (and other objectives) in the *Structural Funds Programme* at various levels of regional aggregation was collected from the European Commission documents concerning structural funds.[7] In part of our analysis, we use data on the size and geographical loca-

[4]In many of the previous studies, the number of observations and, hence, the number of treated and untreated regions, is fairly small. This almost precludes the use of modern techniques for program evaluation, such as our regression-discontinuity design.

[5]A related approach of identifying causal effects of regional policy is conducted in Criscuolo, Martin, Overman and van Reenen (2007). They use micro level data on firms in the United Kingdom (UK) to construct a quasi-experimental framework to identify the causal effects of the UK's *Regional Selective Assistance* programme on firm performance. They generate an instrument for recipient status of state aid by exploiting changes in the area-specific eligibility criteria. The eligibility criteria in the UK are determined by the European Commission's guidelines for regional development policies which also underly the *Structural Funds Programme*. The revision of regional eligibility for structural funds before each programming period also determines the provision of *Regional Selective Assistance* to firms in the UK and may therefore be used as an exogenous instrument. The authors find a significant positive effect of state aid on investment as well as on employment.

[6]Sectoral employment is used to compute sector shares of industry and services to establish comparability of recipient and non-recipient regions.

[7]For each programming period, eligibility was determined by the European Commission one year before the start of the programming period on the basis of the figures for the last three years available at the time. Concerning the first programming period 1989-1993, see Council Regulation number 2052/88, and Official Journal L 114, 07/05/1991 regarding the New German Länder. The NUTS2 regions covered by Objective 1 in 1994-1999 are listed in Council Regulation 2081/93, and in the Official Journal L 001, 01/01/1995 regarding the new member states Austria, Finland and Sweden. For the last programming period 2000-2006, data stems from Council Regulation

tion of NUTS3 regions from the Geographic Information System of the European Commission (GISCO) to exploit spatial characteristics.

Objective 1 transfers primarily hinge upon NUTS2 regional GDP per capita relative to the EU average and aim at fostering per-capita GDP growth in the eligible regions. As described before, from an econometric perspective further leverage for identification of causal effects is gained by using data at the NUTS3 level. The reason is that NUTS3 regions that are richer than the NUTS2 than their mother region will be receiving Objective 1 funds only because their mother region qualifies, but would not have obtained Objective 1 funds if their own GDP per capita had been considered. The mirror image of this concerns poor NUTS3 regions that on their own would have qualified for Objective 1 funds, but are unlucky to be part of a relatively rich NUTS2 mother region and thus do not obtain Objective 1 funds.

It is instructive to consider the variation in GDP per capita across both NUTS2 and NUTS3 jurisdictions within the EU. This is done in Table 2 for either level of regional disaggregation and the year 1999 (i.e., the year prior to the last available programming period, 2000-06).

Table 2 about here

The number of countries considered in the table is 25. Between 1986 and 1995, the EU consisted of 12 economies as included in the programming period 1989-93. Countries that joined the EU in 1995 (Austria, Finland, and Sweden) were included in the EU regulations for the programming period 1994-99. Similarly, the *Eastern Enlargement* of the European Union (in 2004) by 10 economies[8] was incorporated in the programming period 2000-06. Table 2 sheds light on the variation of GDP per capita across NUTS2 and NUTS3 regions within a country, the EU12, the EU15, and the EU25 in 1999.

We may summarize insights from that exercise as follows. According to the formal eligibility rule, *all* NUTS2 regions in a country are eligible for Objective 1 transfers if the maximum GDP per capita across all regions is smaller than 75% of the EU25 average (see fifth data column in Panel A of Table 2). For instance, this

502/1999, and from the Official Journal L 236, 23/09/2003 for the new members in 2004. All the Regulations are available on EUR-Lex the database for European Law. In one of the sensitivity checks, we exploit information about the actual amount of funds paid rather than a binary treatment indicator alone, using information kindly provided by ESPON (European Spatial Planning Observation Network). However, data on funds paid are not as abundant as the ones about binary treatment status. Complete coverage of NUTS3 regions is only obtained for the 1994-1999 programming period.

[8]Cyprus, Malta, and 8 Central and Eastern European countries: Czech Republic, Estonia, Hungary, Lithuania, Latvia, Poland, Slovenia, Slovak Republic.

is the case for the Baltic countries (Estonia, Latvia, and Lithuania) in 1999.[9] On the other hand, none of the NUTS2 regions in a country is eligible for Objective 1 transfers if the minimum GDP per capita in a region is higher than 75% of the EU25 average. This is the case for Luxembourg, Cyprus, and Malta (all of them cases of small countries consisting of only one NUTS2 region) as well as for Belgium, Denmark, Finland, France, Ireland, the Netherlands, and Sweden.

For the NUTS3 regions in Panel B of the table, the picture is similar to the one for the NUTS2 regions in Panel A. However, there is more variation at the NUTS3 level, as can be seen from the fact that the maximum GDP per capita is higher and the minimum GDP per capita is lower for NUTS3 regions than for their NUTS2 counterparts in most countries. Note that the maximum GDP per capita in a country is often reached in the capital city (or the metropolitan area around it). The corresponding NUTS2 areas are often not sub-divided into several NUTS3 regions there, but NUTS2 and a NUTS3 region are then one and the same. Therefore, the entries in columns 2 and 5 (country maxima) are sometimes identical for Panels A and B but those in columns 3 and 6 are not (country minima).

Table 3 about here

Table 3 points to the advantage of using regionally more disaggregated NUTS3 data, namely (partial) randomization, as will become clear immediately. Again, Panel A is dedicated to regional characteristics at the NUTS2 level whereas Panel B considers the same characteristics for NUTS3 regions. Yet, rather than only looking at moments of characteristics across regions as in Table 2, we now focus on the difference between Objective 1 transfer recipient and non-recipient regions. Column 3 shows the difference in averages of important variables, and column 4 displays the corresponding standard errors. It can be seen that there is more variation in GDP per capita between Objective 1 treated and untreated regions at the NUTS3 level. We discussed above that partial randomization of Objective 1 status at the NUTS3 level is established by the fact that eligibility is defined at the NUTS2 level but NUTS3 regions within a NUTS2 mother region are heterogenous in their GDP per capita. The associated randomization is not perfect, however: the probability of being treated under Objective 1 is still higher for NUTS3 regions with a GDP per capita below the EU's 75% threshold than for regions above the threshold.[10]

[9]Of course, Objective 1 transfer eligibility of the Baltic countries became only relevant after their EU membership in 2004.

[10]In other words, a NUTS3 region with a GDP per capita below the 75% threshold is more likely to be part of a NUTS2 region with per-capita income below the 75% threshold than to be part of a NUTS2 region with per-capita income above the 75% threshold.

Since we wish to infer causal effects of Objective 1 treatment on EU regions across different periods, we report summary statistics for the EU12, EU15 and EU25 in the three programming periods 1989-93, 1994-99, and 2000-06.

The most prominent source of differences between the average Objective 1 recipient and non-recipient region is their GDP per capita. The reduction of this gap is the prime target of Objective 1 transfers. Not surprisingly, the average difference in per-capita GDP between Objective 1 and non-Objective 1 regions in column 3 increases as further countries join the EU over the course of the three programming periods. In 1988, for the EU12, the average NUTS2 recipient region had a per-capita GDP that was 64 percent of the average non-recipient region. In 1999, for the EU25, the average recipient region had a per-capita GDP that was 53 percent of the average non-recipient region. But GDP per capita is not the only difference between treated and untreated regions. Similar trends arise for other characteristics. Regions differ systematically also in their employment shares, their population densities, and their sector distributions. These differences occur at both the NUTS2 and the NUTS3 level.

An unconditional comparison of the economic performance of some of the poorest (Objective 1) and least developed regions to that of the richest (non-Objective 1) regions thus seems like comparing apples to oranges. Also multivariate regressions in the sense of conditional mean comparisons do not necessarily achieve a better comparability. Angrist (1998) argues that one may achieve comparability and, hence, reproduce a (quasi-)natural experiment by estimating a fully saturated model which includes exclusively indicator variables on the right-hand side of the model. With continuous regressors as in Panel A of Table 3, this would require interacting each level a regressor may take with those of all other regressors. Obviously, the fully saturated model cannot be estimated with continuous explanatory variables. Comparability between funded and non-funded regions may, however, be achieved when restricting the analysis to regions within a small interval around the 75% per-capita GDP threshold.

4 Regression analysis

We seek to estimate the causal effect of EU structural funds recipience on regional economic performance. Ideally, in an experimental setting, we would randomly assign regions to a treatment and control group, i.e., give structural funds to some randomly selected regions and compare their economic outcomes to those of randomly selected control regions. While such an ideal experiment is not possible, the EU criteria for assigning Objective 1 status have quasi-experimental features.

The regression-discontinuity design (RDD) The discontinuous jump at the 75% cutoff gives rise to a regression discontinuity design (RDD). Think of a NUTS2 region A with a GDP per capita of 74.99% and a NUTS2 region B with a GDP per capita of 75.01%, one eligible, one not. These two regions are likely to be more comparable than regions far away from the threshold. Ideally, with many observations very close to the threshold, and with full compliance with the EU's threshold rule, a *sharp* regression discontinuity design arises: on average, regions to the left and the right of the threshold do not systematically differ in their characteristics except that those to the left of the 75% threshold receive EU structural funds and those to the right do not. In a neighborhood of the threshold for selection, a *sharp* RDD presents some features of a pure experiment (see Trochim 1984 as well as Angrist and Pischke 2009 for a general discussion of the methodology). The comparison of mean outcomes for participants and non-participants *at the margin* allows to control for confounding factors and identifies the mean impact of the intervention *locally* at the threshold for selection.

The *sharp* RDD features two main limitations: first, assignment to treatment must depend *only* on observable pre-intervention variables. Second, identification of the mean treatment effect is possible only at the threshold for selection. The second limitation represents a natural trade-off. The benefit of reliable causal estimates comes at the cost of being valid only in a limited value range. The first condition is unlikely to be met in the context of assignment to Objective 1 status. The reason is EU power politics.

Column (1) of Table 4 shows that several NUTS2 regions that are ineligible according to the 75% rule nevertheless obtain Objective 1 status. These exceptions are the result of bargaining between delegates of the respective EU member countries and representatives of the European Commission. Conversely, as can be seen from column (2), (nearly) all NUTS2 regions below the 75% threshold – except for two British NUTS2 regions[11] – *do* receive Objective 1 status.

An alternative representation of this information is given in Figure 2. Note that the solid lines in Figure 2 mark the fraction of NUTS2 regions that obtain Objective 1 funds.[12] To the left of the 75% GDP per capita threshold this fraction is approximately one. Thus, no national government voluntarily foregoes the possibility to collect EU structural funds for regions which are formally eligible. The existence of Objective 1 treated NUTS2 regions which are formally ineligible and situated to the right of the threshold – as the result of bargaining – gives rise to a so-called *fuzzy* RDD. Hence, there is imperfect compliance with the assignment rule at the

[11]The reason for this exception is that Britain did not collect data at the NUTS2 level at the time. At the NUTS1 level, these two British NUTS2 regions did not qualify for Objective 1 status.

[12]This fraction is computed for 5-percentage point intervals.

threshold.

The dotted lines in Figure 2 represent the fractions of NUTS3 regions that received Objective 1 transfers for each level of GDP per capita. Since eligibility for Objective 1 status is determined at the NUTS2 level and there is some heterogeneity of NUTS3 regions within NUTS2 regions, the 75% threshold is less sharp at the NUTS3 level. To see why this is the case, think of two equally sized NUTS2 regions A and B, the first having a per-capita GDP equal to 74% of the EU average and the second having a per-capita GDP equal to 76% of the EU average. Whereas region A qualifies for Objective 1 funds, region B does not. Now, imagine that both NUTS2 regions have two equally sized NUTS3 daughter regions: NUTS2 region A hosting one NUTS3 daughter region (A1) with 72% and one (A2) with 76% and NUTS2 region B hosting one NUTS3 daughter (B1) region with 74% and one (B2) with 78% of the EU average per-capita GDP. From a NUTS3 perspective, half of the NUTS3 regions to the left of the 75% threshold receive Objective 1 transfers (A1, but not B1) and the same to the right of the 75% threshold (A2 receives money, B2 not).

This example illustrates an interesting feature: from a NUTS3 level perspective, Objective 1 status is partially decoupled from NUTS3 level GDP per capita. NUTS3 region A2 receives Objective 1 funds whereas NUTS3 region B1 does not, although region A2's per-capita GDP (76% of EU average) is larger than that of region B1 (74%). Thus, A2 receives EU funds although it would not have qualified on the basis of its own income level. Conversely, B1 does not receive Objective 1 funds, although it would have qualified on the basis of its own GDP per capita. Put differently, some rich NUTS3 regions located within poor NUTS2 regions receive EU funds, whereas some poor NUTS3 regions located within rich NUTS2 regions receive no EU funds.

Econometrically speaking, within some interval around the Objective 1 threshold, recipience of EU structural fund status is thus – to some extent – randomly assigned from the perspective of NUTS3 regions. As indicated before, random assignment is not perfect because poor NUTS2 regions have, on average, poor daughter regions. As a consequence, the dotted curve in Figure 2 is flatter (attesting to the *partial* randomness) than the thick curve but it is not horizontal either, as would be the case if Objective 1 status were perfectly randomly assigned. Columns (3) and (4) in Table 4 show the (actual) Objective 1 status of NUTS3 regions compared to their (hypothetical) eligibility if the 75% rule were applied to their own per-capita GDP.

Still, within a small band around the 75% threshold the probability of a NUTS3 region to obtain Objective 1 status is relatively close on both sides of the threshold. For instance, in the 2000-2006 programming period (third panel of Figure 2) the probability of qualifying as Objective 1 equals 0.35 for NUTS3 regions whose GDP per capita lies between 70% and 75% of the EU average and equals 0.26 for NUTS3 regions whose GDP per capita lies between 75% and 80% of the EU average.

By restricting our analysis to the 70-80% interval, we can ensure a large degree of comparability between treated and control regions. Taking a NUTS3 perspective has the additional benefits of yielding a larger estimation sample and the (partial) random assignment of Objective 1 status illustrated above. In the regression analysis, we further control for remaining differences in observable characteristics to eliminate a possible bias of the treatment effect estimates due to the omission of other determinants of economic outcome.

We estimate the following regression equation where $g_{i,t}$ is the average annual growth rate of GDP per capita or, alternatively, employment over the respective period t. The coefficient we are interested in measures the effect of a dummy variable for Objective 1 status ($Treat_{i,t}$) on outcome. Other covariates we control for in the initial period are included in vector $\mathbf{X}_{i,t}$. We pool the data for the last three programming periods which lasted 5,6, and 7 years respectively. In various specifications we include time-fixed effects as well as region-fixed effects.

$$g_{i,t} = \alpha + \beta Treat_{i,t} + \mathbf{X}_{i,t}\gamma + u_{i,t} \quad (1)$$

$$g_{i,t} = \frac{1}{p_t} ln \left(\frac{y_{i,t}}{y_{i,t-p_t}} \right) \quad (2)$$

$$\text{for} \quad t = \{1993, 1999, 2006\} \quad \text{and} \quad p_t = \left\{ \begin{array}{c} 5 \text{ if } t = 1993 \\ 6 \text{ if } t = 1999 \\ 7 \text{ if } t = 2006 \end{array} \right\}$$

where $y_{i,t}$ and $y_{i,t-p_t}$ measure per-capita GDP (at PPP) and employment in periods t and $t - p_t$, respectively.

Estimation results Tables 5 and 6 start with bivariate regressions of per-capita GDP growth on the full estimation sample, showing raw differences in growth rates between treated and control regions. While column (1) reports results from a pooled OLS regression, column (2) applies an estimator with fixed region-specific effects. Both the pooled OLS and the fixed effects estimator control for time-fixed effects. Columns (3) and (4) show results from multivariate regressions, using several control variables: the population growth rate, the beginning-of-period employment share, the service share, the industry share, the investment rate, the population density as well as EU12 and EU15 membership dummies. The latter, being time-constant indicators, drop out in the estimations that use region-fixed effects. The variation primarily exploited for identifying causal effects of Objective 1 treatment in the *difference-in-difference regression discontinuity design* (DID-RDD) is the one across regions that changed their Objective 1 status over the periods considered. Those regions are highlighted in Figure 3.

Figure 3 about here

Tables 5 and 6 about here

Either regression points to statistically significant GDP per capita growth differences between treated and control regions in Table 5. The fixed effects estimates differ starkly from their pooled OLS counterparts and a Hausman test rejects the latter against the former estimates. Columns (1) to (4) compare the GDP per capita growth of the average Objective 1 treated NUTS3 region to the average untreated one in the average programming period. We know that some of the treated as well as some of the untreated regions may be very distant from the 75% threshold in GDP per capita space relative to the respective EU average.

Columns (5) to (7) restrict the sample to a certain window around the threshold, always employing fixed NUTS3-region effects, fixed time effects, and the covariates as in column (4). As mentioned before, we would expect the quality of identification of causal effects to rise as the window size declines. Hence, we would prefer the window which includes NUTS3 regions with a GDP per capita between 70% and 80% of the respective EU average. This strategy reduces the number of observations to less than one-seventh of the original sample. However, the DID-RDD average treatment effect estimate in column (5) is fairly close to the simple difference-in-difference average treatment effect in column (4) and the same holds true for larger window sizes (65-85% and 60-90%). Hence, we conclude from this that the degree of randomization obtained from using NUTS3 regional data together with regional and time fixed effects and covariates practically eliminates the endogeneity bias of the impact of Objective 1 treatment status on outcome such as GDP per capita or employment growth.

Since part of the funds are used as employment subsidies one might also expect a positive effect of Objective 1 treatment on employment growth. However, as the first column of Table 6 shows, the simple correlation between Objective 1 treatment and employment growth is even negative. This result is probably due to an omitted variables bias. After including the control variables we find a positive effect of Objective 1 treatment on employment growth. Yet, this result is not robust. As is shown in columns (5)-(6) of Table 6 there is no significant effect in any of the time windows considered.

5 Sensitivity checks, extensions, and quantification of the effects

The average treatment effects reported in Tables 5 and 6 are our reference estimates and point to a positive GDP growth effect, but no employment growth effect of Objective 1 transfers.

In this section, we consider several sensitivity checks and extensions to probe the robustness of this finding. First, we ask whether the effect of Objective 1 transfers varies across programming periods. Second, we check whether and to which extent the estimated treatment effect is downward biased due to spillover effects of Objective 1 transfers – associated with the public goods character of infrastructure investments – across NUTS3 regional borders. The latter may lead to a downward bias of the estimated effects. Third, there may be some residual systematic difference between treated and untreated regions with regard to the observable variables considered. While the difference in per capita GDP is eliminated by the DID-RDD, this is not necessarily the case for the other observables. An instrumental variables strategy helps to remove the potentially remaining bias. Fourth, in the preceding analysis we have focused on a binary treatment indicator. The amount of Objective 1 transfers differs across recipient regions, however. *Dose-response function* estimation allows us to assess how Objective 1 regions respond to variations in the *treatment intensity*.[13]

Apart from these robustness checks, this section also provides a cost-benefit analysis of the EU Objective 1 program.

Estimates for individual programming periods In the previous analysis, the parameter estimates were obtained after pooling the data across all three programming periods. It may be the case that the treatment effect differs across periods. We shed light on this question in Tables 7 and 8, where we consider the impact of Objective 1 status in programme-period-specific regressions. Of course, a limitation of such an analysis is that we cannot include region-specific fixed effects. The results could thus be biased due to omitted relevant, time-invariant (e.g., region-specific) variables. Hence, the results from the period-specific models should be interpreted with caution.

Tables 7 and 8 about here

[13]The latter cold not be done throughout our analysis, because of the limited availability of continuous information about Objective 1 transfers.

The results in Table 7 suggest that per-capita GDP growth – the main target of Objective 1 – is quite similarly affected by Objective 1 treatment across the three periods. This is not the case for employment growth, according to Table 8. Positive employment effects which are significantly different from zero are found in the last programming period, but neither before that nor on average. Taken together with the results from the fixed-effects estimation in the previous section, we should probably be more cautious about the estimated employment effects as compared to the impact of Objective 1 treatment on GDP per capita growth.

Avoiding a downward bias of the treatment effects from cross-border spillovers One concern with the estimates in the previous tables is that Objective 1 transfers may be used to finance public infrastructure, generating not only local effects on the treated regions but also spillover effects to neighboring regions. The latter would violate the so-called *stable unit treatment value assumption* and lead to downward-biased estimates of the average Objective 1 treatment effect.

Provided that the aforementioned spillovers are of medium reach, such a bias can be avoided by the following procedure. We assume that Objective 1 transfers mainly affect regions within a radius of 200 kilometers but not farther than that. We exclude all untreated control regions that are located within a 200-kilometer-radius from any treated region.

Tables 9 and 10 about here

Tables 9 and 10 show the results from this particular estimation sample (labeled *spatial control exclusion mechanism*) for the two outcomes: per-capita GDP growth and employment growth. Columns (1) and (2) impose no restriction with respect to per-capita GDP, whereas columns (3)-(5) restrict the sample to regions close to the 75% threshold. It turns out that the point estimates of Objective 1 treatment effects are somewhat higher than those in the main Tables 5 and 6. This is consistent with moderate cross-border spillover effects of Objective 1 treatment. Ignoring cross-border spillovers leads to slightly downward biased Objective 1 treatment effect estimates because the per-capita income or employment growth in some of the control regions is positively affected. However, with respect to employment growth the treatment effects remain insignificant in all interval specifications.

Eliminating the bias from further observable differences between treated and untreated regions So far, we have tried to account for differences between treated and control regions by restricting estimation to a tight interval around the 75% per-capita GDP threshold and by allowing other observable sources of heterogeneity to enter linearly in the regressions. However, we may allow for a further non-linear impact of these observables by applying a two-stage procedure that improves the comparability of treated and untreated regions within the 70-80% interval as suggested by Van der Klaauw (2002) and Battistin and Rettore (2008).

In the first stage, we estimate the probability of Objective 1 treatment by a propensity score function:

$$E[I_i|S_i] = f(S_i) + \gamma 1[S_i \geq \bar{S}] \tag{3}$$

where $f(S_i)$ is a continuous function of S and $[S_i \geq \bar{S}]$ is a dummy variable that is set to unity, if a region's GDP per capita is below the 75% threshold. We do so for each programming period separately so that we may omit the time index in equation (3).

In the second stage, the economic outcome of interest in the same programming period is modeled as a function of treatment I_i instrumented by the first stage estimate of $E[I_i|S_i] = Prob[I_i = 1|S_i]$. Note that both the first stage probit regression as well as the second stage regression include only observations within the 70-80% GDP-per-capita interval. We pool the data in the second stage and again include region and time fixed effects. This procedure should provide the best possible comparison of treated and untreated observations around the 75% threshold.

The results for this estimation are shown in Table 11. The first three columns report the first stage probit regressions that serve to predict our instrument of Objective 1 status. The first period data set consists only of EU12 members, hence, the EU12 and EU15 dummies are removed. In the second period there are EU12 as well as EU15 members. However, the dummies are removed as well because none of the countries joining the EU in 1994 qualified for Objective 1 status.

With regard to GDP-per-capita growth, a significant positive effect of Objective 1 treatment shows up. It amounts to 2.6% which is in line with our results for the sharp regression discontinuity design. Note that the 95% confidence interval ranges from 0.66% to 4.4%. With respect to employment growth, no significant effects are found, as before.

Estimating the effect of marginal changes in Objective 1 transfers: dose-response function estimation In a final assessment, we consider continuous Objective 1 transfers and estimate their effects on outcome. Binary indicators of Objective 1 recipient status may conceal varying effects of different magnitudes of EU transfers. We consider Objective 1 funds as a fraction of GDP as the continuous treatment variable. However, information on continuous transfers at the NUTS3 level of aggregation is only available for the programming period 1994-99. So, unlike with binary Objective 1 transfer recipient status, we may not entertain the advantages of region-fixed effects estimation.

Hirano and Imbens (2004) derive an extension of the Rosenbaum and Rubin (1983) propensity-score method to estimate the average local effects of continuous treatments. We discuss this relatively recent method, known as generalized propensity score matching, in Appendix A. The estimates from generalized propensity score matching are typically reported with a so-called dose-response function. In our case, the dose-response function depicts the growth rate over a programming period as a function of EU transfers relative to GDP. Figure 4 plots the dose-response function (left panel) as well as the treatment effect function for the central programming period, 1994-99.

The dose-response function indicates that at low values of the treatment (Objective 1 transfer volumes that are small relative to a region's GDP) regions grow at around 3 percent per year, similar to regions without Objective 1 status. An increase in Objective 1 transfers leads to a more-than-proportionate increase in per capita growth until a level of transfers of 1.25% of the recipient region's GDP is reached. Beyond that value, the marginal effect of further transfers declines. That is also evidenced by the treatment effect function (the derivative of the dose-response function) where confidence bands include a zero additional growth effect for transfer-to-GDP ratios above 1.25 percent. These results point to the possibility of leakage effects if transfers are exceeding a certain value.

Assessing the effectiveness of Objective 1 treatment With the estimates at hand, we may easily infer whether the use of Objective 1 transfers is justified on average or not, when requiring effectiveness within a programming period. Let us consider the estimates about the impact of (binary) Objective 1 treatment for the 70-80% interval in Tables 5 and 6 as a benchmark. According to those tables, Objective 1 participation only generates effects only on GDP per capita growth but not employment, at least not within the same programming period as Objective 1 participation occurs.

Objective 1 treatment led to average per-capita-GDP growth effects of approximately 1.8 percentage points in recipient regions.[14] The level of GDP per capita and GDP (at PPP), in the average treated region and year amounted to $11,016$ Euro and $3,872$ million Euros, respectively.[15] The average Objective 1 region's population changed only slightly over the average period with a growth rate of -0.13 percent. Hence, Objective 1 treatment caused absolute GDP to change by about

[14]Note that the semi-logarithmic equations we estimate would actually require a slight transformation of the estimated coefficients following Van Garderen and Shah (2002). However, in our case, the associated difference is small.

[15]Taking GDP and GDP per capita at the beginning of each single programming period, i.e., in 1988, 1993, and 1999.

the same rate as per-capita GDP, namely 1.8% or 69.70 million Euros (at PPP) per year in the average treated region and programming period. Aggregating this effect up for all treated regions in the average programming period results in a treatment effect of 24.05 billion Euros (at PPP) per year within the EU as a whole.[16] The total cost of the Objective 1 programme was 19.80 billion Euro (at PPP) per year in the average programming period (see Table 1).[17] Then, we may conclude that the Objective 1 programme induces a net effect of 4.25 billion Euros (at PPP) per year or 121 percent of the expenses per year in the EU as a whole. In other words, every Euro spent on Objective 1 transfers leads to 1.21 EUR of additional GDP.

These calculations are well in line with the dose-response function estimates, where we observe a more-than-proportionate increase in per-capita GDP growth in the lower range of Objective 1 funds per GDP (up to transfers of around 1.25% of the recipient region's GDP). Since the majority of Objective 1 regions is in that range, the more-than-proportionate increase in the lower range dominates the less-than-proportionate treatment effect in the upper range of transfer-to-GDP ratios.

6 Concluding remarks

This paper considers the estimation of causal effects of the European Union's (EU) Objective 1 transfers on economic growth, the major objective in the EU's *Structural Funds Programme*, which aims at facilitating convergence and cohesion within the EU. Objective 1 funds target fairly large, sub-national regional aggregates – referred to as NUTS2 regions – to foster growth in regions, whose per-capita GDP in purchasing power parity is lower than 75% of the EU's average per-capita income.

We use panel data at a fairly disaggregated regional level – referred to as NUTS3 – to exploit variation in per-capita GDP *within* NUTS2 aggregates for which Objective 1 transfer eligibility is determined. This alone leads to a partial randomization of treatment status. We then employ a regression discontinuity design – considering only comparable regions within a fairly narrow window around the 75% threshold – to identify the causal effect of Objective 1 treatment on per-capita income growth, using NUTS3 regional data.

[16]There were 286 treated regions in the first, 309 in the second, and 417 treated regions in the third programming period. The first period lasted 5, the second 6, and the most recent one 7 years. Hence, on average 345 NUTS3 regions received Objective 1 transfers over the 18 year-period under consideration.

[17]A crucial assumption for this cost assessment is that the associated collection of taxes did not distort economic activity in net paying regions. Hence, we assume that one Euro of Objective 1 transfers is identical to one Euro of costs. However, for a violation of this assumption, one would have to blame the taxing authorities at the national level rather than the European Commission.

Our results suggest the following conclusions. First, Objective 1 transfers exert a robust positive effect on GDP per capita growth. On average, Objective 1 status raises per-capita income by about 1.8% relative to comparable regions. Second, different from the positive effects on per-capita GDP, we do not find significant employment effects during the period in which transfers are allocated. There may be various reasons for that. One reason could be that Objective 1 transfers mainly stimulate investment. Another reason could be that the creation of jobs takes longer than the duration of a programming period of five to seven years.

According to conservative benchmark estimates, every Euro spent on Objective 1 transfers leads to 1.21 EUR of additional GDP. Hence, our analysis shows that Objective 1 transfers under the EU's *Structural Funds Programme* are not only effective but also cost-efficient.

A Generalized propensity scores

Index a sample of regions with $i = 1, \ldots, N$ and consider the *unit-level dose-response function* of outcomes $Y_i(\tau)$ as a function of treatments $\tau \in \mathscr{T}$. In the binary treatment case $\mathscr{T} = \{0, 1\}$. In the continuous case, we allow $\mathscr{T}$ to be an interval $[\tau_0, \tau_1]$. We restrict $\tau_0 > 0$ to study the range of transfers (as fraction of GDP) that we used to summarize with a treatment indicator of one and in order to exclude the probability mass at zero treatment in accordance with the Hirano and Imbens approach. We are interested in the average dose-response function across all regions i, $\mu(\tau) = E[Y_i(\tau)]$. We observe the vector X_i, the treatment T_i, and the outcome corresponding to the level of treatment received, $Y_i = Y_i(T_i)$. We drop the index i for simplicity and assume that $Y(\tau)_{\tau \in \mathscr{T}}, T, X$ are defined on a common probability space, that τ is continuously distributed with respect to a Lebesgue measure on $\mathscr{T}$, and that $Y = Y(T)$ is a well defined random variable.

In this setting, the definition of unconfoundedness for binary treatments generalizes to *weak unconfoundedness* for continuous treatments

$$Y(\tau) \quad \perp \quad T|X \quad \text{for all} \quad \tau \in \mathscr{T}. \tag{4}$$

Regions differ in their characteristics x so that they are more or less likely to receive Objective 1 funds. The weak unconfoundedness assumption says that, after controlling for observable characteristics X, any remaining difference in Objective 1 transfers T across regions is independent of the potential outcomes $Y(\tau)$. Assumption (4) is called weak unconfoundedness because it does not require joint independence of all potential outcomes, $Y(\tau)_{\tau \in [\tau_0, \tau_1]}, T, X$. Instead, it requires conditional independence to hold at every treatment level.

Hirano and Imbens (2004) define the generalized propensity score as

$$R = r(T, X), \tag{5}$$

where $r(\tau, x) = f_{T|X}(\tau|x)$ is the conditional density of the treatment given the covariates. The generalized propensity score is assumed to have a *balancing property* similar to that of the conventional propensity score under binary treatment: within strata with the same value of $r(\tau, X)$, the probability that $T = \tau$ does not depend on the value of X. In other words, when looking at two regions with the same probability (conditional on observable characteristics X) of being exposed to a particular EU transfer, their treatment level is independent of X. That is, the generalized propensity score summarizes all information in the multi-dimensional vector X so that

$$X \quad \perp \quad 1\{T = \tau\}|r(\tau, X).$$

This is a mechanical property of the generalized propensity score, and does not require unconfoundedness. In combination with unconfoundedness, the balancing property implies that assignment to treatment is *weakly unconfounded given the generalized propensity score* (see Hirano and Imbens 2004 for a proof): if assignment to the treatment is weakly unconfounded given pre-treatment variables X, then

$$f_T(\tau|r(\tau,X),y(T)) = f_T(\tau|r(\tau,X)) \tag{6}$$

for every τ. This result says that we can evaluate the generalized propensity score at a given treatment level by considering the conditional density of the respective treatment level τ. In that sense we use as many propensity scores as there are treatment levels, but never more than a single score at one treatment level.

We eliminate biases associated with differences in the covariates in two steps (for a proof that the procedure removes bias, see Hirano and Imbens 2004):

1. Estimate the conditional expectation of the outcome as a function of two scalar variables, the treatment level T and the generalized propensity score R, $\beta(\tau,r) = E[y|T=\tau, R=r]$

2. Estimate the dose-response function at a particular level of the treatment by averaging this conditional expectation over the generalized propensity score at that particular level of the treatment, $\mu(\tau) = E[\beta(\tau, r(\tau,X))]$.

It is important to note that, in the second step, we do not average over the generalized propensity score $R = r(\tau,X)$; rather we average over the score evaluated at the treatment level of interest, $r(\tau,X)$. In other words, we fix τ and average over X_i and $r(\tau,X_i)$ $\forall i$.

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B Tables and Figures

Table 1: Funds spent on Objective 1 regions

	1989-1993	1994-1999	2000-2006
	EU12	EU15	EU25
NUTS2			
Total number of NUTS2 regions	193	215	285
Number of Obj. 1 NUTS2 regions	58	64	129
NUTS3			
Total number of NUTS3 regions	1015	1091	1213
Number of Obj. 1 NUTS3 regions	286	309	417
Overall yearly funds (Mio. Euro)	8763.600	15661.670	23144.020
Overall yearly funds (Mio. Euro PPP)	11343.254	17731.411	27626.010
Yearly funds as fraction of Obj. 1 region GDP	.012	.015	.015
Yearly funds per inhabitant of Obj. 1 region (Euro)	100	165	146

Notes: Data on EU Structural Funds stem from European Commission (1997 p.154-155 and 2007 p.202). To obtain average yearly funds we divide period-specific figures by the number of years the respective programming period lasted. We calculate the funds in PPP terms by weighting the funds each single country received in the respective programming period with the country's Purchasing Power Parity Index of the programming period's initial year. Funds per GDP and funds per inhabitant are calculated as the average yearly funds divided by regional GDP and regional population, respectively at the begin of the programming period. This is 1989 for the first, 1994 for the second, and 2000 for the third programming period.

Table 2: Disparities in the EU25 1999 (GDP per capita)

	Country Avg. (Euro PPP)	Country Max (Euro PPP)	Country Min (Euro PPP)	Country Avg. rel. to EU25	Country Max rel. to EU25	Country Min rel. to EU25
			Panel A: NUTS2 level			
Austria	18855.38	29546.84	13446.46	1.02	1.59	.72
Belgium	18466.26	43347.16	14331.10	.99	2.34	.77
Cyprus	15040.00	15040.00	15040.00	.81	.81	.81
Czech Republic	11411.80	23708.24	9554.07	.61	1.28	.51
Germany	19929.09	35739.29	12738.76	1.07	1.93	.69
Denmark	22634.88	27954.49	17869.64	1.22	1.51	.96
Estonia	6252.50	10644.65	4636.73	.34	.57	.25
Spain	16005.10	22823.61	11146.41	.86	1.23	.60
Finland	20302.39	28662.20	15392.66	1.09	1.54	.83
France	19790.04	32908.45	16100.37	1.07	1.77	.87
Greece	12530.61	16631.15	9377.14	.68	.90	.51
Hungary	8598.66	14861.88	6192.45	.46	.80	.33
Ireland	21651.46	24769.80	16454.23	1.17	1.33	.89
Italy	21184.88	29900.69	12915.68	1.14	1.61	.70
Lithuania	6243.72	9153.68	4171.41	.34	.49	.22
Luxembourg	41111.00	41111.00	41111.00	2.22	2.22	2.22
Latvia	5296.85	10829.71	3191.77	.29	.58	.17
Malta	14751.00	14751.00	14751.00	.79	.79	.79
Netherland	22107.05	29016.06	16808.08	1.19	1.56	.91
Poland	8382.42	13092.61	6015.52	.45	.71	.32
Portugal	13250.58	21408.19	12207.97	.71	1.15	.66
Sweden	19942.22	30431.47	18754.28	1.07	1.64	1.01
Slovenia	12438.66	19182.09	9761.78	.67	1.03	.53
Slovak Republic	8824.24	18931.21	6546.31	.48	1.02	.35
United Kingdom	19392.81	49362.68	12384.90	1.04	2.66	.67
			Panel B: NUTS3 level			
Austria	17735.97	29546.84	11558.47	.96	1.59	.62
Belgium	17466.13	43347.16	9196.50	.94	2.34	.50
Cyprus	15040.00	15040.00	15040.00	.81	.81	.81
Czech Republic	11368.54	23708.24	9505.94	.61	1.28	.51
Germany	19383.22	59233.63	9518.86	1.04	3.19	.51
Denmark	22029.58	36353.23	16356.74	1.19	1.96	.88
Estonia	6252.50	10644.65	4636.73	.34	.57	.25
Spain	16042.51	24063.16	10542.56	.86	1.30	.57
Finland	18645.21	28949.18	14581.10	1.00	1.56	.79
France	18813.59	60237.51	13404.89	1.01	3.25	.72
Greece	12158.81	27390.63	7790.99	.66	1.48	.42
Hungary	8378.10	18758.00	5239.88	.45	1.01	.28
Ireland	20338.09	30179.18	15950.16	1.10	1.63	.86
Italy	20266.30	33351.66	11364.21	1.09	1.80	.61
Lithuania	6243.72	9153.68	4171.41	.34	.49	.22
Luxembourg	41111.00	41111.00	41111.00	2.22	2.22	2.22
Latvia	5296.85	10829.71	3191.77	.29	.58	.17
Malta	14751.00	14751.00	14751.00	.79	.79	.79
Netherland	20888.92	34469.48	13887.72	1.13	1.86	.75
Poland	8093.41	24305.55	4948.30	.44	1.31	.27
Portugal	12319.29	24791.92	7108.58	.66	1.34	.38
Sweden	19653.05	30431.47	17096.12	1.06	1.64	.92
Slovenia	12438.66	19182.09	9761.78	.67	1.03	.53
Slovak Republic	8903.64	18931.21	5296.31	.48	1.02	.29
United Kingdom	19459.71	89296.20	10416.94	1.05	4.81	.56

Notes: Panel A shows average, maximum and minimum GDP per capita (PPP terms) within country for NUTS2 regions. Panel B shows average, maximum and minimum GDP per capita within country for NUTS3 regions.

Table 3: Characteristics of Obj. 1 recipient vs. non-recipient regions

	Panel A: NUTS2 level			
	Mean recipient	Mean non-recipient	Difference col.(1)-col.(2)	Std. Err. of col.(3)
	(1)	(2)	(3)	(4)
EU12				
GDP per capita 1988	8653.82	13612.51	-4958.69	478.44
Employment share 1988	.37	.44	-.06	.01
Population density 1988	.36	.44	-.08	.15
Industry share 1988	.16	.25	-.09	.01
Service share 1988	.28	.37	-.09	.01
No. of observations	52	135		
EU15				
GDP per capita 1993	10795.99	16310.49	-5514.51	541.80
Employment share 1993	.37	.44	-.07	.01
Population density 1993	.37	.42	-.04	.15
Industry share 1993	.16	.22	-.06	.01
Service share 1993	.31	.38	-.07	.01
No. of observations	58	151		
EU25				
GDP per capita 1999	11159.71	21255.49	-10095.79	557.01
Employment share 1999	.39	.46	-.07	.008
Population denisty 1999	.22	.46	-.23	.10
Industry share 1999	.23	.19	.04	.01
Service share 1999	.36	.40	-.04	.01
No. of observations	123	156		

	Panel B: NUTS3 level			
	Mean recipient	Mean non-recipient	Difference col.(1)-col.(2)	Std. Err. of col.(3)
	(1)	(2)	(3)	(4)
EU12				
GDP per capita 1988	7799.97	13593.50	-5793.53	301.91
Employment share 1988	.39	.44	-.05	.009
Population density 1988	.27	.60	-.33	.08
Industry share 1988	.26	.35	-.09	.007
Service share 1988	.56	.59	-.03	.009
No. of observations	280	729		
EU15				
GDP per capita 1993	10204.29	16129.33	-5925.04	325.83
Employment share 1993	.38	.44	-.06	.008
Population density 1993	.29	.57	-.28	.07
Industry share 1993	.26	.32	-.06	.007
Service share 1993	.60	.63	-.02	.008
No. of observations	303	782		
EU25				
GDP per capita 1999	12148.56	20591.74	-8443.19	377.93
Employment share 1999	.39	.45	-.07	.007
Population density 1999	.27	.58	-.31	.06
Industry share 1999	.28	.29	-.004	.006
Service share 1999	.58	.67	-.09	.006
No. of observations	411	796		

Notes: Panel A (Panel B) shows differences in characteristics of recipient and non-recipient regions at the NUTS2 (NUTS3) level. We miss information on the four French overseas-departéments and the two autonomous Portuguese regions Madeira and Azores for all three years. Each of them makes up a NUTS2 as well as a NUTS3 region. For the 113 East-German NUTS3 regions (11 NUTS2 regions) we use GDP per capita from 1991 instead of 1988. GDP per capita is measured in PPP terms. Employment share is calculated as the fraction of total population. Industry as well as service share are calculated as fraction of total employment.

Table 4: ELIGIBILITY AND ACTUAL TREATMENT UNDER OBJECTIVE 1 ACCORDING TO 75% GDP PER CAPITA THRESHOLD

	Recipients NUTS2	Non-recipients NUTS2	Recipients NUTS3	Non-recipients NUTS3
1989-93 EU12				
Eligible	40	2	233	84
Non Eligible	12	133	47	645
1994-99 EU15				
Eligible	43	2	257	110
Non Eligible	15	149	46	672
2000-06 EU25				
Eligible	115	7	357	132
Non Eligible	8	149	54	664

Notes: Eligible regions are characterized by a GDP per capita of less than 75% of EU average in the qualifying years of each programming period (3-year average over the years preceding the start of a new programming period). Recipient regions are those that did effectively receive Objective 1 status. We miss information on the four French overseas-departéments and the two autonomous Portuguese regions Madeira and Azores for all three years. Regarding the East-German regions we miss GDP per capita information for the qualifying year of the first period. However, we declare them eligible in the first period, too. GDP per capita is measured in PPP terms.

Table 5: Objective 1 and GDP per capita growth

	Full sample		Full sample		70-80%	65-85%	60-90%
	Pooled OLS	Fixed Effects	Pooled OLS	Fixed Effects	Fixed Effects	Fixed Effects	Fixed Effects
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Objective 1	.029	.012	.005	.013	.018	.012	.011
	(.002)***	(.003)***	(.001)***	(.003)***	(.004)***	(.004)***	(.003)***
Population growth rate			-.621	-1.308	-1.589	-1.673	-1.739
			(.123)***	(.248)***	(.295)***	(.515)***	(.446)***
Employment share			-.006	.026	.255	.094	.081
			(.004)	(.027)	(.083)***	(.069)	(.055)
Service share			.040	.116	.166	.145	.144
			(.006)***	(.024)***	(.068)**	(.048)***	(.035)***
Industry share			.012	-.033	-.017	.017	.012
			(.006)*	(.026)	(.070)	(.053)	(.040)
Investment rate			.209	.551	.556	.670	.621
			(.014)***	(.026)***	(.040)***	(.035)***	(.031)***
Population density			-.0004	.035	.054	.019	.023
			(.0004)	(.016)**	(.037)	(.044)	(.038)
EU12			-.002				
			(.001)*				
EU15			-.008				
			(.003)***				
Const.	.047	.053	-.009	-.165	-.316	-.263	-.237
	(.001)***	(.001)***	(.007)	(.026)***	(.072)***	(.039)***	(.034)***
Obs.	3301	3301	3301	3301	598	1081	1487
R^2	.159	.077	.386	.416	.555	.546	.508

Notes: All regressions include time fixed effects. We take the sample of EU12 NUTS3 regions for the first period, EU15 NUTS3 regions for the second and EU25 for the third programming period. We miss information on the four French overseas-departéments and the two autonomous Portuguese regions Madeira and Azores for all three periods. For the 113 East-German NUTS3 regions we use average yearly growth rates between 1991 and 1993 and initial values from 1991 for the controls. Hence, we end up with 1009 NUTS3 regions in the first period, 1085 in the second and 1207 in the last period. Pooling those periods gives 3301 observations. Note that there is no data on investment rates for the Baltic regions as well as the Slovenian regions. Therefore, we impute investment rates from the national level for these regions. The last three columns report the 70-80%, the 65-85% and the 60-90% interval-regressions. Whether an observation lies within the interval is determined by the NUTS2 mother-region's GDP per capita in the qualifying years.

Table 6: OBJECTIVE 1 AND EMPLOYMENT GROWTH

	Full sample		Full sample		70-80%	65-85%	60-90%
	Pooled OLS	Fixed Effects	Pooled OLS	Fixed Effects	Fixed Effects	Fixed Effects	Fixed Effects
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Objective 1	-.010 (.001)***	.002 (.002)	.005 (.002)***	.002 (.002)	.001 (.002)	-.0002 (.002)	.0005 (.002)
Population growth rate			.938 (.080)***	.954 (.167)***	1.177 (.231)***	.769 (.294)***	.837 (.252)***
Service share			.028 (.009)***	-.045 (.039)	-.275 (.084)***	-.136 (.071)*	-.072 (.055)
Industry share			.006 (.009)	-.038 (.035)	-.269 (.073)***	-.158 (.057)***	-.102 (.046)**
Investment rate			-.067 (.008)***	-.108 (.017)***	-.092 (.030)***	-.122 (.029)***	-.131 (.023)***
Population density			-.001 (.0003)***	.003 (.011)	.082 (.026)***	.065 (.023)***	.046 (.022)**
EU12			-.003 (.0008)***				
EU15			.006 (.002)***				
Const.	.003 (.0007)***	-.0003 (.0007)	-.009 (.008)	.059 (.033)*	.229 (.068)***	.129 (.052)**	.085 (.041)**
Obs.	3301	3301	3301	3301	598	1081	1487
R^2	.056	.038	.245	.165	.265	.246	.213

Notes: All regressions include time fixed effects. We take the sample of EU12 NUTS3 regions for the first period, EU15 NUTS3 regions for the second and EU25 for the third programming period. We miss information on the four French overseas-departéments and the two autonomous Portuguese regions Madeira and Azores for all three periods. For the 113 East-German NUTS3 regions we use average yearly growth rates between 1991 and 1993 and initial values from 1991 for the controls. Hence, we end up with 1009 NUTS3 regions in the first period, 1085 in the second and 1207 in the last period. Pooling those periods gives 3301 observations. Note that there is no data on investment rates for the Baltic regions as well as the Slovenian regions. Therefore, we impute investment rates from the national level for these regions. The last three columns report the 70-80%, the 65-85% and the 60-90% interval-regressions. Whether an observation lies within the interval is determined by the NUTS2 mother-region's GDP per capita in the qualifying years.

Table 7: Objective 1 and GDP per capita growth (sub-periods)

	1989-1993	1989-1993	1994-1999	1994-1999	2000-2006	2000-2006
	(1)	(2)	(3)	(4)	(5)	(6)
Objective 1	.068 (.006)***	.012 (.004)***	.012 (.001)***	.010 (.002)***	.013 (.001)***	.011 (.001)***
Population growth rate		-.942 (.233)***		-.314 (.074)***		-.136 (.098)
Employment share		-.013 (.009)		-.008 (.005)		-.005 (.005)
Investment rate		.405 (.019)***		.016 (.007)**		-.017 (.010)*
Industry share		.059 (.012)***		-.005 (.009)		-.033 (.007)***
Service share		.058 (.011)***		.020 (.008)**		-.028 (.006)***
Population density		-.001 (.0008)		-.0002 (.0005)		.001 (.0007)**
Const.	.036 (.0007)***	-.092 (.011)***	.040 (.0005)***	.031 (.007)***	.033 (.0005)***	.067 (.006)***
Obs.	1009	1009	1085	1085	1207	1207
R^2	.238	.683	.117	.179	.145	.176

Notes: We take the sample of EU12 NUTS3 regions for the first period, EU15 NUTS3 regions for the second and EU25 for the third programming period. We miss information on the four French overseas-departéments and the two autonomous Portuguese regions Madeira and Azores for all three periods. For the 113 East-German NUTS3 regions we use average yearly growth rates between 1991 and 1993 and initial values from 1991 for the controls. Hence, we end up with 1009 NUTS3 regions in the first period, 1085 in the second and 1207 in the last period. Note that there is no data on investment rates for the Baltic regions as well as the Slovenian regions. Therefore, we impute investment rates from the national level for these regions.

Table 8: Objective 1 and employment growth (sub-periods)

	1989-1993	1989-1993	1994-1999	1994-1999	2000-2006	2000-2006
	(1)	(2)	(3)	(4)	(5)	(6)
Objective 1	-.022	-.0001	-.002	.003	-.007	.005
	(.003)***	(.005)	(.002)	(.002)	(.001)***	(.001)***
Population growth rate		1.046		.795		.861
		(.173)***		(.099)***		(.086)***
Investment rate		-.107		-.005		-.047
		(.016)***		(.009)		(.011)***
Industry share		-.023		.022		.022
		(.019)		(.014)		(.008)***
Service share		.010		.050		.040
		(.022)		(.015)***		(.006)***
Population density		-.002		-.001		-.001
		(.0008)***		(.0005)**		(.0003)***
Const.	.007	.025	.007	-.032	.008	-.018
	(.0005)***	(.017)	(.0004)***	(.013)**	(.0003)***	(.006)***
Obs.	1009	1009	1085	1085	1207	1207
R^2	.107	.343	.002	.137	.044	.297

Notes: We take the sample of EU12 NUTS3 regions for the first period, EU15 NUTS3 regions for the second and EU25 for the third programming period. We miss information on the four French overseas-departéments and the two autonomous Portuguese regions Madeira and Azores for all three periods. For the 113 East-German NUTS3 regions we use average yearly growth rates between 1991 and 1993 and initial values from 1991 for the controls. Hence, we end up with 1009 NUTS3 regions in the first period, 1085 in the second and 1207 in the last period. Note that there is no data on investment rates for the Baltic regions as well as the Slovenian regions. Therefore, we impute investment rates from the national level for these regions.

Table 9: Objective 1 and GDP per capita growth (spatial control exclusion-mechanism)

	Full sample		70-80%	65-85%	60-90%
	(1)	(2)	(3)	(4)	(5)
Objective 1	.022 (.004)***	.021 (.004)***	.024 (.004)***	.023 (.005)***	.023 (.005)***
Population growth rate		-1.545 (.313)***	-1.550 (.324)***	-1.573 (.532)***	-1.734 (.477)***
Employment share		.049 (.038)	.313 (.095)***	.102 (.080)	.092 (.066)
Service share		.138 (.028)***	.147 (.076)*	.154 (.054)***	.167 (.038)***
Industry share		-.011 (.031)	-.008 (.080)	.054 (.061)	.061 (.046)
Investment rate		.563 (.027)***	.585 (.045)***	.674 (.038)***	.622 (.033)***
Population density		.050 (.020)**	.060 (.039)	.027 (.049)	.028 (.045)
Const.	.052 (.002)***	-.211 (.030)***	-.351 (.079)***	-.298 (.042)***	-.281 (.038)***
Obs.	2392	2392	480	899	1246
R^2	.091	.458	.586	.571	.539

Notes: All regressions include time and state fixed effects. We take the sample of EU12 NUTS3 regions for the first period, EU15 NUTS3 regions for the second and EU25 for the third programming period. We miss information on the four French overseas-departéments and the two autonomous Portuguese regions Madeira and Azores for all three periods. For the 113 East-German NUTS3 regions we use average yearly growth rates between 1991 and 1993 and initial values from 1991 for the controls. Note that there is no data on investment rates for the Baltic regions as well as the Slovenian regions. Therefore, we impute investment rates from the national level for these regions. Hence, we end up with 1009 NUTS3 regions in the first period, 1085 in the second and 1207 in the last period. The distance matrices are used such that only those non-Objective 1 regions are included in the control group that are more than 200 km away from the next Objective 1 region. This confines the sample in each period such that pooling those periods leaves 2392 observations. The last three columns report the 70-80%, the 65-85% and the 60-90% interval-regressions. Whether an observation lies within the interval is determined by the NUTS2 mother-region's GDP per capita in the qualifying years.

Table 10: OBJECTIVE 1 AND EMPLOYMENT GROWTH (SPATIAL CONTROL EXCLUSION-MECHANISM)

	Full sample		70-80%	65-85%	60-90%
	(1)	(2)	(3)	(4)	(5)
Objective 1	.004	.005	-.002	.0004	.003
	(.002)*	(.002)**	(.004)	(.003)	(.003)
Population growth rate		.810	1.155	.697	.800
		(.189)***	(.251)***	(.304)**	(.270)***
Service share		-.030	-.289	-.133	-.067
		(.046)	(.093)***	(.077)*	(.058)
Industry share		-.037	-.297	-.174	-.106
		(.039)	(.079)***	(.060)***	(.050)**
Investment rate		-.129	-.092	-.134	-.145
		(.019)***	(.034)***	(.033)***	(.026)***
Population density		.007	.090	.078	.060
		(.013)	(.030)***	(.027)***	(.025)**
Const.	-.004	.053	.240	.130	.082
	(.001)***	(.037)	(.074)***	(.055)**	(.043)*
Obs.	2392	2392	480	899	1246
R^2	.059	.175	.288	.262	.218

Notes: All regressions include time and state fixed effects. We take the sample of EU12 NUTS3 regions for the first period, EU15 NUTS3 regions for the second and EU25 for the third programming period. We miss information on the four French overseas-departéments and the two autonomous Portuguese regions Madeira and Azores for all three periods. For the 113 East-German NUTS3 regions we use average yearly growth rates between 1991 and 1993 and initial values from 1991 for the controls. Note that there is no data on investment rates for the Baltic regions as well as the Slovenian regions. Therefore, we impute investment rates from the national level for these regions. Hence, we end up with 1009 NUTS3 regions in the first period, 1085 in the second and 1207 in the last period. The distance matrices are used such that only those non-Objective 1 regions are included in the control group that are more than 200 km away from the next Objective 1 region. This confines the sample in each period such that pooling those periods leaves 2392 observations. The last three columns report the 70-80%, the 65-85% and the 60-90% interval-regressions. Whether an observation lies within the interval is determined by the NUTS2 mother-region's GDP per capita in the qualifying years.

Table 11: Objective 1 and regional performance: 70-80% interval (2SLS)

	1989-1993	1994-1999	2000-2006	GDP per Capita	Employment
	Probit	Probit	Probit	Fixed	Fixed
	(1)	(2)	(3)	(4)	(5)
Objective 1				.027 (.010)***	.006 (.007)
Employment share	-56.611 (17.180)***	-57.002 (20.875)***	27.057 (18.405)	.266 (.059)***	
Industry share	-18.242 (7.503)**	-4.754 (12.256)	-66.107 (25.734)**	-.007 (.082)	-.263 (.056)***
Service share	-75.416 (27.558)***	-79.266 (35.686)**	-16.761 (28.422)	.172 (.080)**	-.271 (.055)***
Population density	4.794 (1.169)***	4.471 (.897)***	5.043 (1.147)***	.058 (.045)	.083 (.031)***
Population growth rate	116.584 (48.427)**	-1.347 (52.836)	52.457 (43.127)	-1.591 (.294)***	1.184 (.197)***
Investment rate	-52.935 (45.010)	-176.977 (97.248)*	-342.838 (87.394)***	.554 (.041)***	-.092 (.028)***
Peripheral	1.252 (.511)**	.959 (.434)**	1.126 (.442)**		
Border Region	-.331 (.544)	.870 (.524)*	-1.163 (.445)***		
Area of Region (m^2)	.658 (.226)***	.414 (.208)**	.260 (.142)*		
Employment share ^{2}	58.850 (19.559)***	51.471 (26.590)*	-55.248 (25.520)**		
Industry share ^{2}	18.188 (14.360)	-15.520 (23.530)	82.494 (47.770)*		
Service share ^{2}	53.642 (20.793)***	48.271 (26.742)*	-3.533 (21.882)		
Population density ^{2}	-1.089 (.283)***	-.866 (.204)***	-.860 (.219)***		
Population growth rate ^{2}	-7525.202 (4022.118)*	1289.900 (4346.563)	-752.544 (1909.919)		
Investment rate ^{2}	182.938 (111.894)	505.793 (265.408)*	807.875 (219.730)***		
Area of Region (m^2) ^{2}	-.018 (.016)	-.014 (.017)	.005 (.006)		
EU12			2.692 (.762)***		
EU15			-9.181 (1.497)***		
Const.	49.153 (15.389)***	37.249 (16.202)**	72.445 (14.584)***	-.333 (.069)***	.222 (.046)***
Obs.	186	203	209	598	598
R^2	0.74	0.66	0.73	0.55	0.26

Notes: All regressions include time fixed effects. We take the sample of EU12 NUTS3 regions for the first period, EU15 NUTS3 regions for the second and EU25 for the third programming period. We miss information on the four French overseas-departéments and the two autonomous Portuguese regions Madeira and Azores for all three periods. For the 113 East-German NUTS3 regions we use average yearly growth rates between 1991 and 1993 and initial values from 1991 for the controls. Hence, we end up with 1009 NUTS3 regions in the first period, 1085 in the second and 1207 in the last period. Pooling those periods gives 3301 observations. Note that there is no data on investment rates for the Baltic regions as well as the Slovenian regions. Therefore, we impute investment rates from the national level for these regions. The first three columns report the first stage probit regression. Predicted values from these regressions are used as instruments for actual treatment status in the second stage IV estimations reported in the last two columns. The first stage as well as the second stage is calculated within the 70-80% interval. Whether an observation lies within the interval is determined by the NUTS2 mother-region's GDP per capita in the qualifying years.

Figure 1: Objective 1 regions

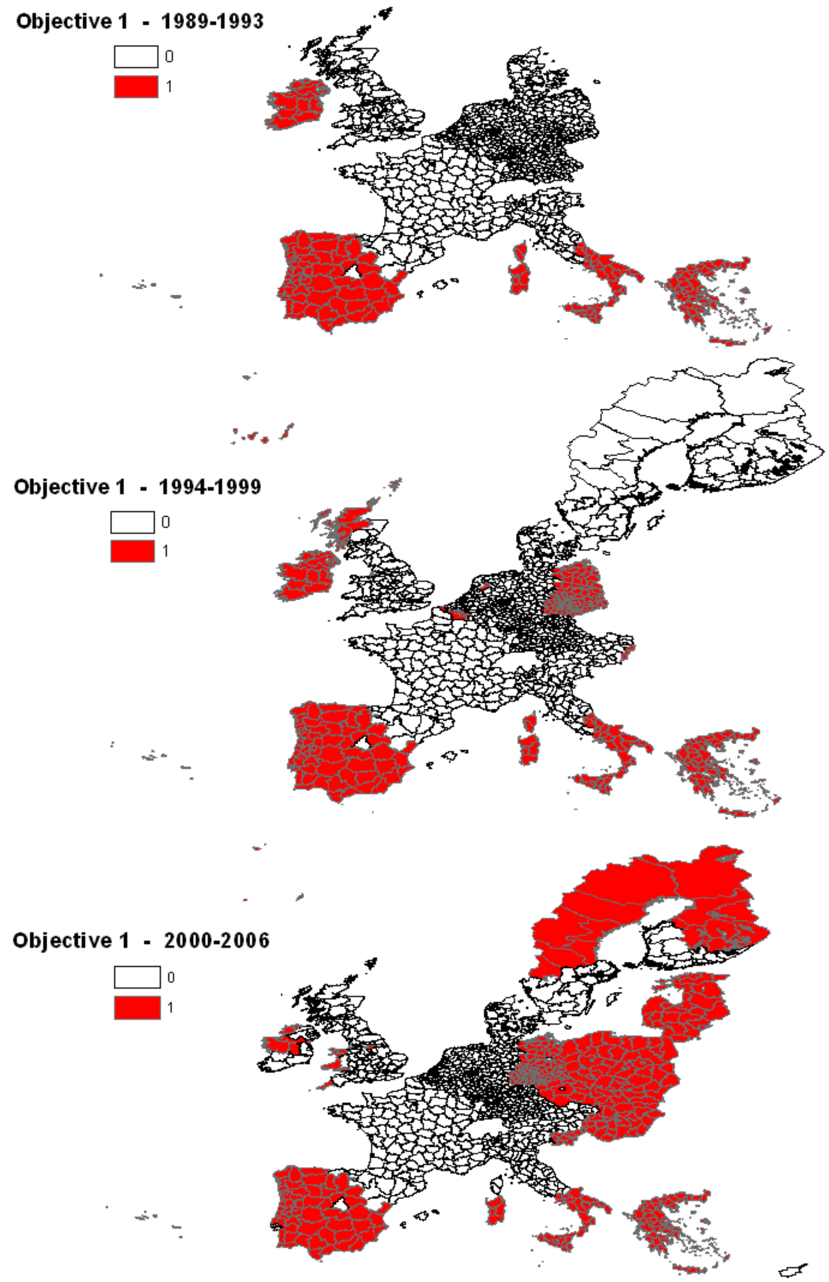


Figure 2: Objective 1 status and the 75% GDP threshold

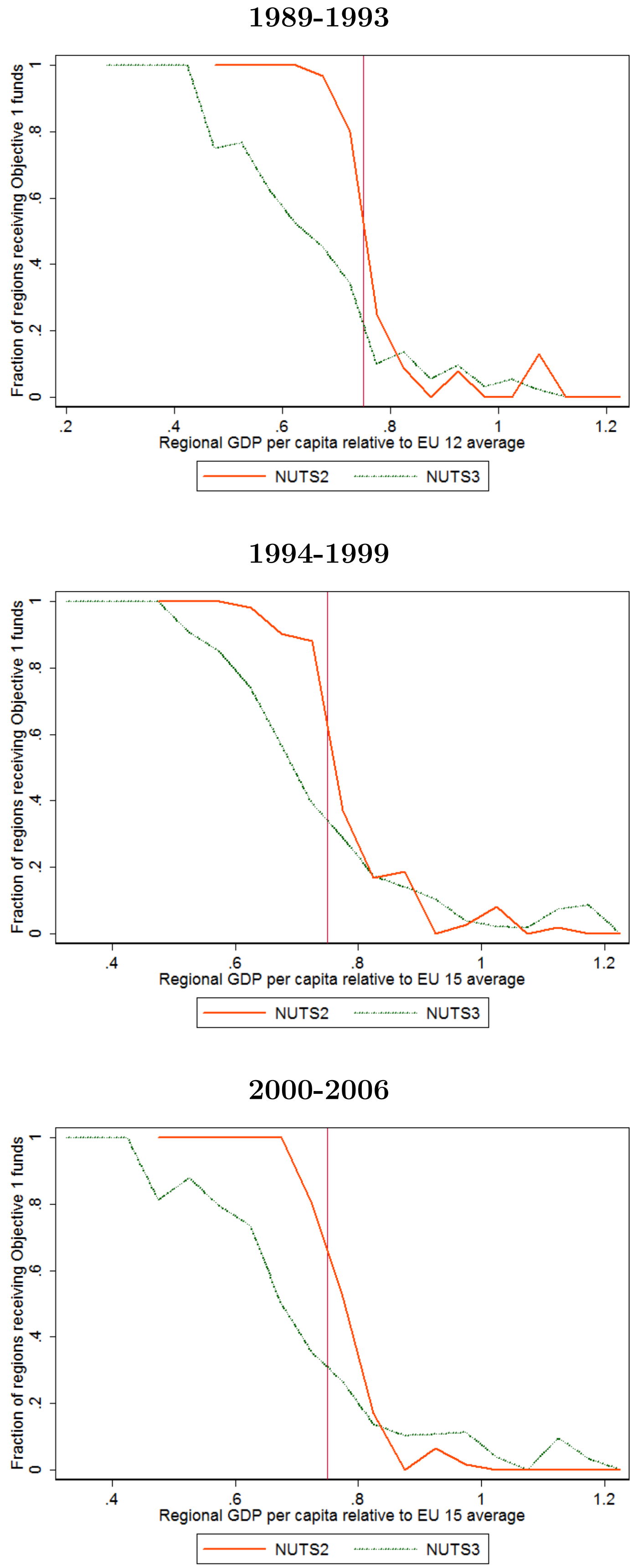


Figure 3: Regions changing Objective 1 status

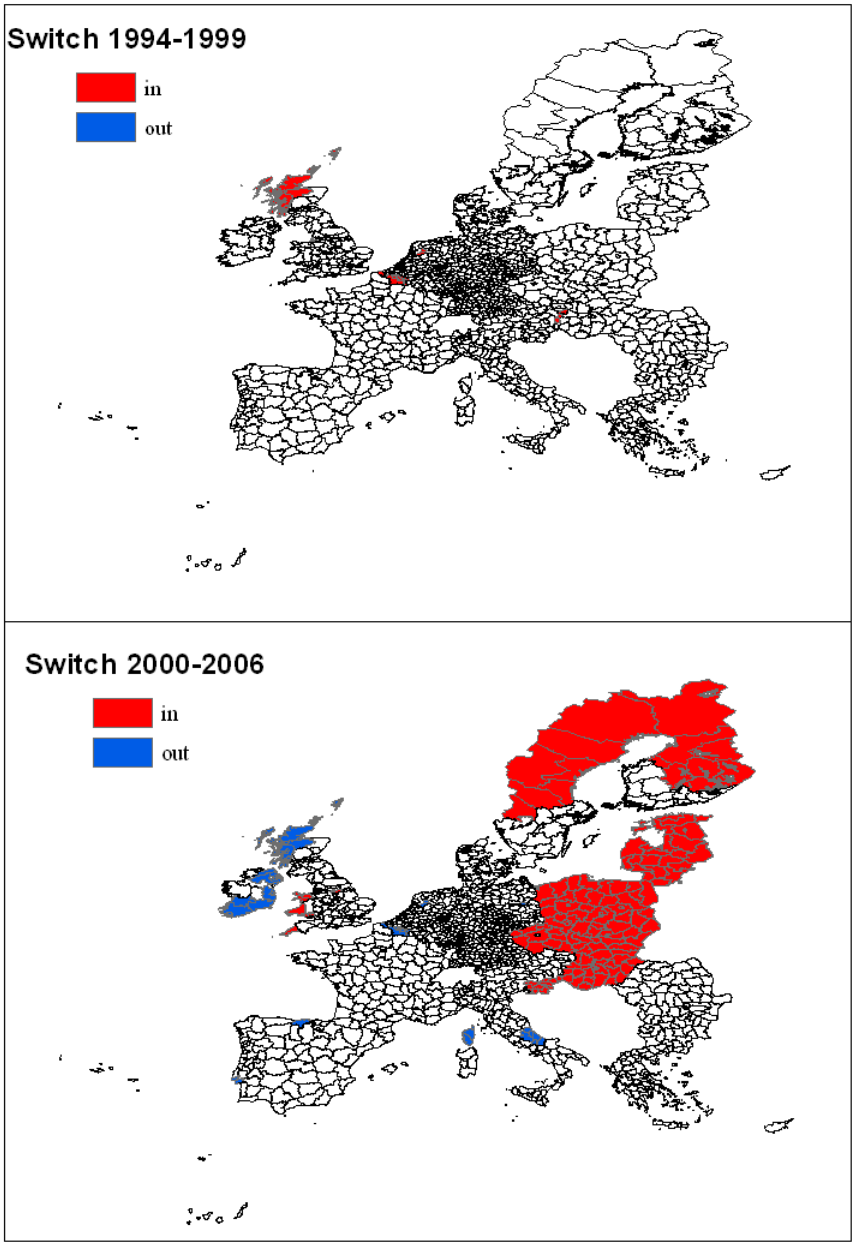
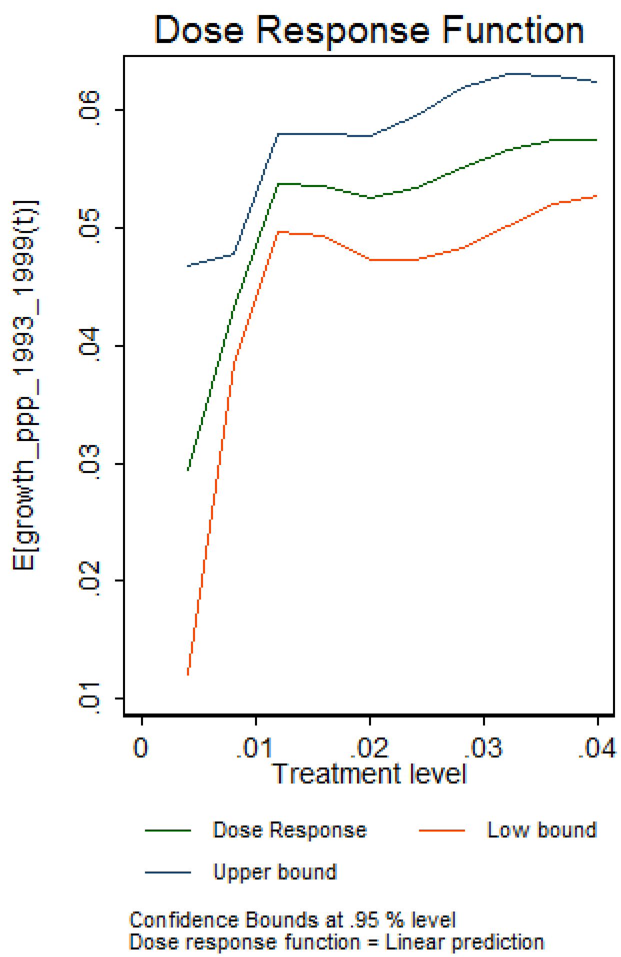
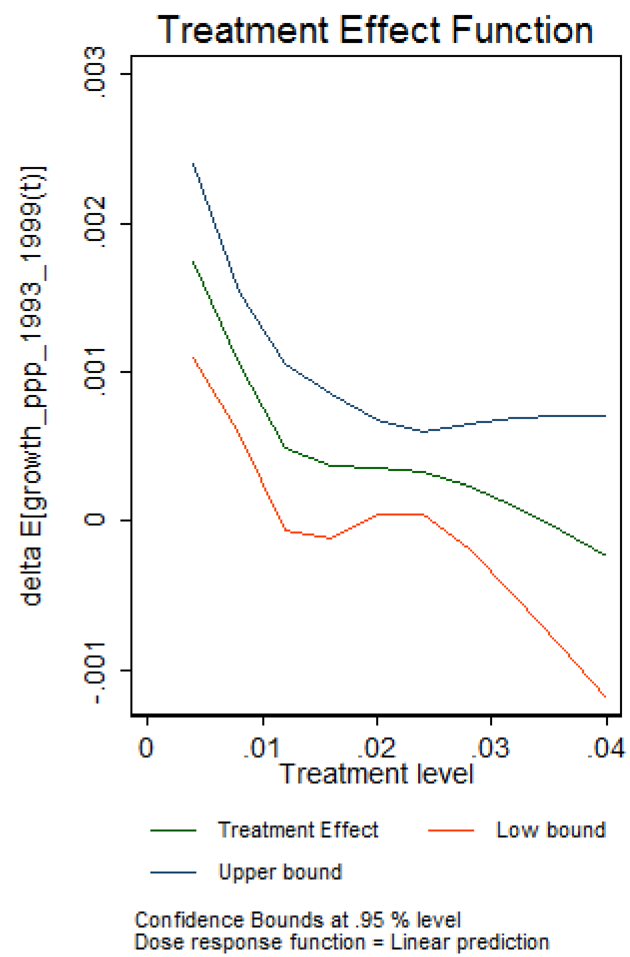


Figure 4: Dose-response estimates of Objective 1 transfers





Note: Objective 1 transfers are computed as a fraction of beginning of period GDP.