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Pushing for growth

Quasi-experimental evidence on the effect of regional transfers in the EU

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Abstract

This thesis investigates the effect of Objective-1 regional transfers on the per-capita income growth performance of EU NUTS-3 regions during the budgetary period 2000-2006. To be able to distinguish a causal effect and account for possible endogeneity a quasi-experimental regression-discontinuity design is employed. This strategy relies on the arbitrary set 75%-rule for Objective-1 fund eligibility. The findings generally suggest a positive effect of the funds to promote growth in low-income regions. However, the country affiliation of recipient regions seems to be of great importance to the effectiveness of the funds in promoting growth. Moreover, evidence point to the transfers affecting different regions in different ways. Regions just below the threshold and some regions in older member states seem better at utilizing received funds. This thesis suggests that a regions absorptive capacity is closely linked to the institutional environment.

Keywords: Structural Funds, Regional growth, Regional Convergence, European Union, Regression-discontinuity design, Quasi-experimental methods.

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1. Introduction

The differences in regional per-capita incomes in Europe are vast. For example, in 2006 the richest region in the European Union, West Inner-City London, had a per-capita gross regional product (GRP) of €140,400 measured in purchasing power standard, that is about 23 times higher than the poorest region in the union at the time, the Latvian region of Latgale. Indeed, the eastward expansion of the EU in 2004, and the subsequent entry of ten new member states, increased regional income differences within the union dramatically, as the average per-capita GRP of the new entry countries amounted to about 50% to that of the old member states.

To alleviate regional inequalities the EU had as far back as 1988, in connection with the Single Market Act and the entry of then relatively low-income, southern-European, countries into the union[1], set up the so called Structural Funds Program. The objective of these funds is to promote regional cohesion in the EU. As this is a stated goal in the EU treaty and seeing as the Structural Funds amounted to about one third of the entire EU budget in the 2000-2006 budgetary period (see e.g. Monfort 2008; Mohl and Hagen 2010), regional cohesion can certainly be said to be of utmost importance to the union. In the budgetary period of 2000-2006 Structural Fund transfers where separated into three groupings; Objective 1, Objective 2 and Objective 3. The Objective-1 transfers are aimed at increasing investment and growth rates in the poorest regions of the union and will be the focus of this thesis. The poor regions, eligible for Objective-1 funding, are defined as those regions with per-capita GRP below 75 % of the EU average (EC 1999).

Puga (2001) summarizes the early evidence on regional income inequality in the EU, observing that up to the mid-eighties income inequalities between member states amounted to about half of the total income inequality in the EU. However, Puga notes that since then inequalities among member states diminished at the same time as inequalities within states increased. Consequently, the majority of income inequalities in Europe today are explained by inequalities within member states, contrary to between-country inequality. According to Puga, Europe is experiencing a process of convergence among countries at the same time as a process of divergence among regions. Thus, there seem to exist a place for policies targeted at reducing regional income disparities.

[1] Greece joined 1981, and Portugal and Spain in 1986

From an empirical perspective a few prior studies have looked at the impact of the Structural Funds on regional growth outcomes. The evidence ranges from the Structural Funds having a positive impact (e.g. Dall'erba 2005; Ramajo et al. 2008; Becker et al. 2010) to a non-existent (e.g. Dall'erba and Le Gallo 2008; Sala-i-Martin 1996; and, Boldrin and Canova 2001).

The aim of this thesis is to evaluate the effect of the Structural Funds on the per-capita gross regional product (GRP) growth performance of EU regions during the period 2000 to 2006. Specifically, the focus will be on the effects of Objective-1 funds to promote growth in this period among NUTS3-regions[2]. Drawing from previous literature (see e.g. Becker et al. 2010), it is reasonable to assume Objective-1 investments having mostly long-term effects. Hence, this thesis will also considers the growth performance of regions in the period 2000-2006 that received transfer in the preceding budgetary period, 1994-1999. To be able to estimate a treatment effect and to account for possible endogeneity, this evaluation will be done employing a quasi-experimental framework, explicitly a regression discontinuity design (see e.g. Angrist and Pischke 2009; Lemieux and Imbens 2008; and, Lee and Imbens 2009), utilizing the arbitrarily set 75%-rule for Objective 1-fund eligibility. The analysis is similar to that carried out by Becker et al. (2010), but focuses more on the most disaggregated level of regional data in the EU, adds novel approaches of spatial econometric estimation techniques to the study and explicitly looks at the long-term effects of transfers.

Different theoretical approaches give different predictions on how economic integration and regional transfers can be expected to affect regional convergence in incomes. For example, in the neoclassical Solow-Swan growth framework (Solow 1956; Swan 1956) regional transfers help poor, capital-scarce, regions to accumulate capital and stimulate faster growth rates. In the long run regional transfers help the poor regions to catch-up, to converge, to the richer regions. This convergence comes from the assumption of diminishing returns to capital.

As a contrast, new growth theory, or endogenous growth theory, considers returns to capital to have increasing returns (see e.g. Romer 1986, 1990). In this view, investments in innovation and human capital may work against the diminishing returns to capital through the

[2] Following Eurostat (2007), the NUTS-system (Nomenclature of Territorial Units of Statistics) is a hierarchal regional classification system with four regional levels; NUTS-0, -1, -2 and -3 (NUTS 0 corresponding to country level and NUTS 3 being the most disaggregated level). The system was established by Eurostat to provide a comparable regional breakdown of the EU member states. The NUTS regional system is set up after three principles. First, it is set within a specific population threshold (minimum 150 000 and maximum 800 000 inhabitants for the NUTS 3 classification). Second, for practical reasons the NUTS regulations also tries to follow the member states' national administrative units to as large extent as possible. Lastly, the NUTS regulation follows suitable natural geographical units. The three distinctions are made to keep the regional units within as functional economic units as possible, while still retaining as much of the national administrative divisions of each member state.

externalities associated with such investments, fostering increasing technological growth rates and, thus, income growth (Aghion and Howitt 2004). Hence, if regional policies promote investment in education, R&D and other innovation-inducing policies they can affect the growth rates of regions, albeit not necessarily convergence (Mohl and Hagen 2010).

Moreover, new economic geography (NEG) (Krugman 1991; Krugman and Venables 1995; Fujita et al. 1999) shows how economic integration can give rise to a core-periphery pattern and, thus, possibly divergence between regions due to the existence of agglomeration economies. In this view regional policy, for example in the form of investments in public infrastructure, may actually be harmful to convergence as it reduces transport costs and thus increases agglomeration economies, since it is now cheaper to produce in one location (Mohl and Hagen 2010). Besides, by this perspective it is also doubtful if regional aid to the periphery is warranted. Instead, higher aggregate growth can be achieved by supporting core regions, as these generate innovation and drives income growth in the entire economy (Baldwin and Martin 2004). Moreover, NEG models point to the importance of spatial growth spillovers between regions.

The findings in this thesis point towards a general positive effect of Objective-1 transfers on regional growth outcomes in the budgetary period of 2000-2006. However, if spatial spillovers and country-fixed effects are accounted for this positive effect all but disappears. This would indicate that country belonging is of great importance in explaining the effect of regional transfers on the growth outcomes of regions. Moreover, evidence point towards Objective-1 transfers having a stronger effect for relatively richer recipient regions. Lastly, the findings on the long-term effect of Objective-1 transfers suggest that regions within a group of old member states have benefited more than others.

The above reported results can be indicative of the importance of the absorptive capacity of the region, essentially the regions ability to get a “bang for the buck” when it comes to utilizing the regional funds. Regional absorptive capacity is closely linked to the skills, knowledge and institutions present in a region and has been pointed out as a key determinant in generating economic growth (see e.g. Caragliu and Nijkamp 2008; Rodriguez-Pose and Crecenzi 2008). If this interpretation is to be believed simple capital transfers are not enough to lift lagging regions from poverty. Instead, training, education or institutional reforms are equally important and will allow regions to benefit from transfers. This line of research, on which regions that benefit from regional transfer, should be pursued in the future. However, it should be noted that the period studied in this essay is fairly short and that the results probably would benefit from data from more budgetary periods.

The remainder of the thesis is structured as follows. Chapter 2 deals with a range of different theoretical approaches on regional convergence and how regional transfers can be expected to affect convergence in light of these theories. In chapter 3 a short critical review off previous empirical findings is carried out. Chapter 4 discusses the empirical methodology and specification employed in the thesis. After this, in chapter 5, the empirical estimations are carried out and presented. Lastly, in chapter 6 the results are summarized and implications are discussed.

2. Theoretical views on regional convergence and transfers

2.1. Neoclassic growth theory and regional transfers

In the neoclassical growth view, e.g. as in Solow (1956) and Swan (1956), increased economic integration, as in the EU, will lead to increased convergence in incomes between poor and rich regions. As economic barriers are lowered, the factors of production will flow, by migration or trade, between economies until the rate of return on each is equalized.

Following Aghion and Howitt (2004), in the basic Solow-Swan type model the production function can be described, in Cobb-Douglas form, as:

$$Y = AK^{\alpha}L^{1-\alpha}\ , \qquad (1)$$

where Y is the output, A represents the productivity, K and L are stocks of capital and labor in the economy, respectively. To assure convergence the production function must have the following properties:

$\frac{\partial Y}{\partial K} > 0$, $\frac{\partial^2 Y}{\partial K^2} < 0$ and $0 < \alpha \leq 1$.

That is to say, in equation (1) the marginal productivity of capital must be positive but diminishing with respects to capital inputs and the function must exhibit constant returns to scale.[3]

By dividing (1) with L we get the per-capita relationship:

$$y = Ak^{\alpha}. \qquad (2)$$

[3] With the additional assumptions of $\lim_{k\to\infty} \frac{\partial Y}{\partial K} = 0$ and $\lim_{k\to 0} \frac{\partial Y}{\partial K} = \infty$. This is usually referred to as the *Inada* condition and is necessary to able to reach a closed solution.

The prediction of the Solow-Swan model suggests that given the same production technology regions starting out with a lower capital-labor ratio, *k*, will grow faster compared to regions starting out with a higher capital-labor ratios. This comes from the assumptions of diminishing returns to capital. As the only difference between the regions is the level of capital, the initial capital-scarce regions will eventually catch up with the initial capital-rich regions.

Following this a negative relationship between initial per-capita incomes and average growth rates can be expected. This relationship (in log-linearized form) can for a region *i* be stated as:

$$g_i = \frac{1}{T}\log\left(\frac{y_{i,T}}{y_{i,t}}\right) = \alpha + \beta y_{i,t} + u_{i,t}, \qquad (3)$$

where *t* indicates the beginning of a period and T its end, α and β are constant terms, with $\beta = (1 - b)$ and $0<\beta<1$, and u_i is a disturbance term meant to reflect temporary shocks to the economy. The implied condition of $b>0$ ensures an inverse relationship between the average growth rate, g_i, and the initial per-capita income level, $y_{i,t}$. In equation (3) β represents the speeds at which regional incomes converge to a long-term equilibrium, if the only thing that differs between regions are their capital-labor ratio this interpretation of convergence is often referred to as *absolute* convergence.

On the other hand, if production technology differs between regions it can be expected that regions do not converge to the same level and that other region-specific effects besides the initial per-capita income level determines the growth rate and outcome, so called *conditional* convergence (see e.g. Islam 1995). Following Durlauf (2003) and re-defining equation (3) as:

$$g_{i,t} = \alpha + \beta y_{i,t} + \gamma X_{i,t} + u_{i,t}, \qquad (4)$$

Where, if $\gamma > 0$, $X_{i,t}$ represent such region-specific effects. In the Solow-Swan model such differences can, in addition to regional dissimilarities in capital-labor ratios and technology, be differences in regional savings rate or population growth rate (Aghion and Howitt 2004). In this case the interpretation of β is that it represent the speed of convergence to each region's (or group of regions') long-term equilibrium, which is based on its region-specific characteristics.

In the neoclassical view regional transfers fosters growth by financing a higher degree of capital in poor regions, thus both increasing the rate of per-capita incomes growth and the convergence rate (Dall'erba and Le Gallo 2007). Note that all effects of regional transfers on growth rate outcomes in the neoclassical growth setting are transitional. Transfers only increase growth rates temporarily, as they can only speed up the convergence process to each region's equilibrium (in the absolute or conditional sense). However, if technology is not publicly available, regions might have different growth trajectories and regional transfers can also have a long-term role if they spread new production technology to regions.

2.2. Endogenous growth theory and regional transfers

The private-good quality of production technologies, contrary to the more public good approach implicitly assumed in the neoclassic setting, is also the starting point of the endogenous growth theory. This theoretical approach, initially developed by Romer (1986, 1990), Lucas (1988) and Mankiw et al. (1992), questions the assumption of decreasing returns to capital and instead considers increasing returns to the factors of production. Following Aghion and Howitt (2004), in the endogenous growth view, innovation and technological change are at the center of economic growth. In this setting it is possible to affect the growth rate of technology by investing in R&D and human capital and thus spurring the rate of innovation in the economy and giving rise to increasing returns to capital. Such investments are thought to generate positive externalities, knowledge spillovers, which work against the diminishing returns, making the same amount of capital more productive.

Consequently, the assumption of increasing returns to capital allow the rich, capital abundant, regions to invest in innovation-inducing activities to a higher degree than poor region. Thus, capital-abundant regions can keep up a higher growth rate indefinitely. As a consequence, regional income divergence, instead of convergence, is a very possible outcome.

Drawing from the endogenous growth literature an additional variable needs to be added to specification (4) to represent regional knowledge spillovers. Continuing to follow Durlauf (2003) equation (4) is extended as:

$$g_{i,t} = \alpha + \beta y_{i,\tau} + \gamma X_{i,t} + \delta H_{i,t} + u_i, \qquad (5)$$

Where, if $\delta > 0$, $H_{i,t}$ represents such knowledge spillover-inducing activities, for example investments in human capital and R&D.

Traditionally, in the endogenous setting, regional transfers will only affect the convergence process if they affect the innovation capabilities of a region. However, for example, Barro (1990) shows that government spending also can have, at least initially, a positive impact on the growth rate of the economy. By investing in public infrastructure the government can increase the productivity of the production factors. In this way, regional transfers, that increase the productivity of factors by investing in physical capital, can also have a positive impact on the growth rates of regions. However, as in the neoclassic setting, all such effects are transitional and do not increase the growth rate of the economy indefinitely.

2.3. Agglomeration economies and growth

The theoretical models considered so far have not taken space, and the propensity of economic activity to cluster in it, to agglomerate, into consideration. However, both in the neoclassic and endogenous growth approaches this has been shown to be of importance to the growth outcomes of regions. That geography matter to economic activity is often attributed to existence of spatially-bounded externalities. In the neoclassical or endogenous view such externalities are of often of an external, Marshallian, nature (Marshall 1920) and are mainly concerned with labor market pooling of related industries and labor flows between firms as an explanation of agglomerations (see e.g. Glaeser et al. 1992). However, there are other complementary views, for example New Economic Geography (NEG) considers other pecuniary externalities, which help explain why firms and people tend to cluster in space.

Developed by Krugman (1991), Krugman and Venables (1995), Puga and Venables (1996) and Fujita et al. (1999), the NEG-models describes how interactions of scale economies, externalities and transportation costs explain how economic integration can lead to a agglomeration of economic activities and an uneven distribution of incomes. Firms will tend to cluster in nearby regions, the core regions, raising incomes there, and leaving more backwards regions, the periphery, behind with lower income.

Following Ottaviano and Thisse (2004), in these core-periphery models it is often assumed that the economy consists of two sectors: one modern, characterized with increasing returns, perhaps services or high-tech industries; and one traditional sector, characterized by constant returns, say agriculture. These industries use two factors of production, often labor and capital. It is regularly assumed that one factor is mobile and one immobile (at least partially), often capital is considered the mobile factor. Furthermore, the economy is divided into two regions. As the two regions integrate and transaction costs are lowered, capital concentrates to the region with initially larger endowment of the increasing-returns industry where firms can realize larger scale economies. Eventually all firms in the increasing-return industry locates to one region, the core, pushing up local incomes, leaving the other region, the periphery, specialized in the constant-return industry, with relatively lower incomes. The mobility of the other factor of production, labor, further intensifies this process, to the point where it also is completely mobile and all economic activity concentrates to the core region.

There are several examples how endogenous growth dynamics have been added to the NEG-framework to explain the link between agglomeration and growth (for an overview see e.g. Baldwin and Martin 2004). Following Martin and Ottaviano (1996), a possible tradeoff between, on the one hand, aggregate growth and, on the other, regional convergence emerges.

Integration leads to more agglomeration through a higher degree of factor mobility along the lines of the core-periphery model. In turn, agglomeration economies increase the innovation rate because it lowers the costs of investment and innovation in the core. This is because both capital investments and innovation require an array of intermediate goods which, on account of lower transaction costs and scale economies, are less costly when produced in the core. A pattern of high aggregate growth allowed by a more efficient resource usage can therefore accompany increased regional income inequality. As a result there is a tradeoff between regional equality and aggregate growth. This tradeoff comes from the assumed localized-geographical character of the knowledge spillovers in these models, as knowledge spillovers become more global the importance of the location of the firm in innovating diminishes and regional inequality lessen (Baldwin and Martin 2004). However, for example, Jaffe et al. (1993) and Anselin et al. (1997) have empirically showed that knowledge spillovers are strongly localized.

Thusly, there are from several theoretical views reason to believe that spatial externalities are of outmost importance to the growth outcome of a region. In terms of model (5) this implies that not only the human capital and technology in the region *i* matter but also the growth rate in neighboring regions, j. Thus, to account for this (5) must be extended as:

$$g_{i,t} = \alpha + \beta y_{i,t} + \gamma X_{i,t} + \delta A_{i,t} + \rho W_{ij} g_j + u_i, \qquad (6)$$

where $\rho W_{ij} g_j$ is the spatially-weighted average of neighboring regions' growth rates, with ρ as the spatial autoregressive coefficient that measures the extent of spatial externalities in the growth process.[4] Thus, the regional growth rates are not only affected by its own initial incomes, but also by growth spillovers from neighboring regions (cf. López-Bazo et al. 2004; Egger and Pfaffermayr 2006; Le Gallo and Dall'erba 2006; Ertur and Koch 2007).

2.4 Regional transfers in a model with geography and endogenous growth

How can we expect regional transfer to affect the regional economy in a setting similar to that described above? Martin (1999) shows how regional transfers can enter in a model with endogenous growth, geography and localized knowledge spillovers. In this setting the type of

[4] See appendix I for a discussion of the construction of the weighting matrix, W.

regional transfers have an impact on the outcome of the growth-equity tradeoff. First, if the core region simply transfers capital to the peripheral region, e.g. a direct monetary transfer, this makes the poor region more attractive to firms, as the capital stock and thus the market demand increases. This, in turn, will decrease income differentials between the regions, as more firms locate to poor regions, raising real incomes, but also making the geography less conductive for innovation and growth, as agglomeration economies lessen in total due to fewer firms in the core.

Similarly, if the regional policy takes the form of investments in the infrastructure[5] *within* the peripheral region, Martin shows that again agglomeration economies lessen due to more firms locating in the poor region, on account of decreased transaction costs within the region. Thus, yet again, both regional income differentials and the aggregate growth rate fall.

Lastly, there is the case of investments in infrastructure *between* regions. In this case Martin shows that more economic activity is concentrated to the core region, since transaction costs fall and it is made cheaper to trade directly with the periphery, as opposed to produce there. Thus, more firms concentrate to the core, the cost of innovating falls and the aggregate growth rate increases. Simultaneously, the geography of production and income is made more uneven.

What then, in the setting of Martin, is a desirable regional policy? Martin suggests policies that reduce the cost of innovating. Such policies are shown to both increase the growth rate and decrease income differentials. First, directly, a lower cost of innovating increases the aggregate income growth in the economy simply because more innovations are created. Second, indirectly, a lower cost of innovating also increases the number of firms that can enter the market, thus pushing down monopoly profits for capital owners, and since the initially rich region has a larger share of capital owners, income differentials between the regions, as well as between workers and capital owners, lessen. This will in turn induce more firms to locate to the initially poor region, further decreasing income inequality. Thus, as Martin (1999, p.101) puts it:

> *"If subsidies to R&D, increased competition on goods markets and labour markets, improved education, infrastructure, etc., can decrease the cost of innovation for firms, then, this kind of policy may yield more desirable outcomes than traditional transfers or regional policies."*

[5] Infrastructure in Martin (1999) is assumed to take the form of a decrease in transaction costs.

Taking into account that the rich region also needs to finance the regional transfers do not change the qualitative results of the model in any of the covered cases. However, if the cost of financing the decreased cost of innovation is higher than the expected increase in growth, the policy is of course not desirable.

2.5 Hypothesis

Thus, drawing from the discussions above there are reasons to both believe that regional transfers will have a positive and a negative effect on regional convergence. If neoclassical theory has any explanatory power it would be expected that the capital transfers from Objective-1 transfers would speed on the convergence process and recipient regions would grow faster than comparable non-recipient regions. This view features in much of the regional policies in the EU (see e.g. Monfort 2008).

However, it is also possible that the endogenous growth dynamics are stronger in relatively richer regions, allowing them to grow faster and thus counteracting convergence. Moreover, as pointed out in NEG, if agglomeration economies are sufficiently strong and knowledge spillovers are geographically localized, this will also allow relatively richer core regions to grow faster than the relatively poorer peripheral regions. This thesis will implicitly test these theoretical statements by comparing the growth outcomes of recipient regions with non-recipient regions. As the welfare effects of transfers are ambiguous in the presence of endogenous growth dynamics and agglomeration economies doing such an evaluation is of utmost policy importance.

3. Prior studies on the effect of regional transfers in the EU

The empirical evidences on the effect of regional transfers on regional incomes and growth in Europe are varied. Puga (2001) sums up the literature on regional income convergence up until the 2000s. According to Puga until the mid-1980s there seems to have been convergence among EU-regions in incomes. However, after this period most studies seem to point to regional income divergence, coinciding with the enlargement of the EU, regardless of the contemporary increase in regional transfers. Puga interprets this as a failure of the Structural Funds to induce convergence among Europe's regions.

Looking at the Structural Funds as a whole Sala-i-Martin (1996) and Boldrin and Canova (2001) all find equally pessimistic results on the effectiveness of the funds. However, Middelfart-Knarvik and Overman (2002) find positive effects of Structural Fund transfers on agglomeration and industry location at the national level. Similar positive evidence of transfers on per-capita GDP growth on the national level is found by Beugelsdijk and Eijffinger (2005).

To a large extent much of the early literature is lacking when it comes to causal interpretations, often due to weak or non-existent identification strategies that only allow for a correlative interpretation of the results. Thus, it is difficult to establish what the counter-factual situation is, i.e. if the situation would have been even worse without regional transfers. In an excellent literature review Mohl and Hagen (2010) lists four problems affecting most prior studies to a varying degree: (1) biased estimates due to imprecise data or measurement errors; (2) biased estimates due to causal endogeneity; (3) biased estimates due to failure to account for the spatial dependence in the data; and, (4) biased estimates due to omitted variables. However, as methods evolve, more recent studies have employed a wide variety of methods to overcome these shortcomings.

The results from studies trying to account for all or some of Mohl and Hagen's (2010) list of problems are equally varied, Table 1 list some these findings. For example, Garcia-Milá and McGuire (2001) employs a panel with a difference-in-difference approach and investigates the effect of national and EU transfers to stimulate private investment and growth among 17 Spanish NUTS-2 regions in the periods 1977-1981 and 1989-1992, finding that transfers are not effective in stimulating the economy in these regions. Similar evidence for the entire EU is found by Rodrigues-Pose and Fratesi (2004), who employs a fixed-effects panel on 152 NUTS-2 regions over the period 1989-1999. These authors find that Structural Funds do not seem to have a positive impact on growth; however they also find that the effects are positive for funding aimed at education and human capital. Dall'erba and Le Gallo (2008) find that the Structural Funds have a positive but non-significant impact on regional convergence, looking at 145 NUTS2-regions also during the period 1989-1999, employing a cross-sectional spatial lag model with instrumental variables. Also, Mohl and Hagen (2008) find a non-significant impact of Structural Funds on regional growth for the period 1995-2005 employing a propensity score estimator.

Table 1. Some previous studies on the effectiveness of regional transfers in the EU

Authors	Results on effectiveness of regional transfers	Time period	Units	Method
Garcia-Milá and McGuire (2001)	Not effective at stimulating overall investments or growth	1977-1981, 1989-1992	Dummy for total transfers (national+EU funds), 17 NUTS-2 regions (Spain)	Differnce-in-difference, Panel
Rodriquez-Pose and Fratesi (2004)	Not effective at stimulating regional growth. Positive effect from investments in human capital and education.	1989-1999	Obj.-1 payments (% GDP), 152 NUTS-2 regions	Cross-section OLS and FE panel
Dall'erba and Le Gallo (2008)	No impact on convergence	1989-1999	Structural Fund payments (% GDP), 145 NUTS-2 regions (EU12)	IV, Spatial lag cross-section
Mohl and Hagen (2008)	Positive but insignificant	1995-2005	Obj.-1, -2 and -3 payments and remaining funds from 1994-1999 (% of GDP), 122 NUTS-1 and -2 regions (EU15)	Generalized propensity score estimator, Panel
Ramajo et al. (2008)	Faster convergence for regions in cohesion countries	1981-1996	Separate models for regions belonging to cohesion vs non-cohesion countries, 163 NUTS-2 regions	OLS and Spatial lag model, cross-section
Becker et al. (2010)	Positive growth effect	1989-2006	Dummy for Obj-1 recipient regions, total 693 NUTS-2 regions and 3301 NUTS-3 regions	Regression discountiuity design, panel

Mohl and Hagen (2010)	Positive growth effect	1994-2006	Obj.-1, -2 and -3 payments, 126 NUTS-1 and -2 regions	OLS panel, IV by system-GMM panel and spatial lag model
Becker et al. (2012)	Positive growth effect	1994-2006	Total EU transfers, total 2078 NUTS-3 regions	Generalized propensity score estimator, Panel

More positive results on the effect of the Structural Funds on growth are found by, for example, Ramajo et al. (2008), who find faster convergence rates among Objective-1 regions than for non-Objective-1 regions for the period 1981-1996 employing a cross-sectional spatial lag model. Additionally, Becker et al. (2010) find a positive and significant effect of Structural Funds for the period 1989-2006 for both NUTS2- and -3 regions, employing a similar regression discontinuity approach as this thesis. Likewise, Mohl and Hagen (2010) find that Objective-1 payments have a positive effect on regional growth rates during the period 2000-2006 using various panel and spatial panel approaches. More recently Becker et al. (2012), employing a propensity score estimator, find that Structural Fund payments increased the growth among NUTS3 regions for the period 1994-2006.

Looking at the result from previous studies some general observations can be learned. Firstly, the effect of Structural Funds to promote growth appears to be very dependent on the period studied. Generally, the evidence point to the Structural Funds having little to no effect during the 1990s, but that this seem to have changed the further into the 2000s the studies look. Secondly, the effect also seem dependent on the length of the period studied. The studies that find a positive effect of Structural Funds on growth or convergence generally look at longer time periods. This speaks for the possibility of positive long-term effects of the Structural Funds in promoting growth.

Furthermore, not all studies take spatial effects into account, even though Abreu et al (2004) shows that ignoring this can lead to unreliable results in the context of European regions. Indeed, both Dall'erba (2005) and Dall'erba and Le Gallo (2008) show that spatial growth spillovers are present in regional European data. Thus, there seems to be a risk of ignoring possible biases in not taking these into account.

In terms of Mohl and Hagens (2010) problems this thesis will, by employing a quasi-experimental method and explicitly modelling spatial growth spillover, mainly try to account for the problems (2), (3) and (4). Problem (1) is more difficult handle and is related to data quality and coverage of European data at the regional level. This is something that hopefully will improve over time. An additional problem associated with (1) is that only data on Objective 1-fund commitment is available in this thesis, as opposed to the real usage of funds. It would of course be of great help to the analysis to have readily available data on how much and on what each Objective-1 region really spend of their allotted funds.

4. Empirical specification

4.1 The nuts and bolts of regression-discontinuity design (RDD)

The problem often faced in non-experimental settings is endogeneity. The consequence of this is that the explanatory variables can be correlated with the residuals and thus any estimates run the risk of being biased. As discussed above, and pointed out by Mohl and Hagen (2010), endogeneity is a problem affecting much of the previous literature on the effect of regional transfers on growth.

Furthermore, as pointed out in the theoretical section of this thesis, it can be expected that the poorest regions will have a higher average growth rate than richer regions due to diminishing returns, but these are also the regions that get transfers aimed at increasing growth rates. Thus, simple regressions on regional growth mix up this causal effect of capital accumulation and the causal effect of transfers on growth. This problem of simultaneity also causes endogeneity and biased estimates. Also, as seen in e.g. equation (6) above, there are theoretical reasons to believe that several variables affect the growth process of regions. Not accounting for all these in an empirical specification can also yield biased estimates due to endogeneity based on omitted variables. This thesis employs RDD to be able to find a casual effect of Objective 1 transfer on regional growth rates, in an attempt to solve these two endogeneity problems.

In an experimental setting it would be possible to have a treatment and control group of regions, where the two groups would be comparable and the only difference would be that the treatment group is given a transfer. This setting is of course a golden standard, which is not possible to reach in reality. However, it is possible to mimic this setup in a quasi-experimental setting, such as RDD. In the RDD-setting (see e.g. Angrist and Pischke 2009, chapter 6; Imbens and Lemieux 2007; Lee and Lemieux 2009; and, in the context of regional transfers, Becker et al. 2010) this is archived by exploiting arbitrary set rules or thresholds. The above mentioned 75%-rule for Objective 1 fund eligibility can be thought of such a threshold.

Intuitively, think of two regions, one with a GRP per capita of 74% of the EU-average and one with a GRP per capita of 76% of the average, the RDD relies on that these two regions are not *too* dissimilar, so that in a comparison the only thing that are significantly different between the regions is that one is treated with regional transfers while the other is not. This way it is possible to work around the problems of endogeneity. However, note the trade-off: as the window around the threshold is widened, the number of observations increases and so does the efficiency of the estimates, but, at the same time the comparability of the regions decreases, and thus the risk of biased estimates increases.

It is also important to note that the estimate in an RDD-setting is the local average treatment effect (LATE) (Lee and Lemieux 2007, p.23). Thus, in the case considered in this thesis we can only say something about the average effect of the Objective-1 funds on regions *within* the window. This means that results have a low external but high internal validity. Thus, it is only possible to discuss the results in the context of the included regions during the 2000-2006 period.

4.2 RDD-specification

Following Becker et al (2010) the aim is to estimate the effect of Objective-1 treatment on regional growth rates in the 2000-2006 budgetary period, called period *t*. Drawing from equation (6) above, this could be stated as a linear regression of the following form (Angrist and Pischke 2009):

$$OUTCOME_{i,t} = \alpha + \beta_1 TREAT_{i,t-p} + \beta_2 f\left(FORCE_{i,t}\right) + \lambda_i + \beta_3 EMP_{i,t} + \beta_4 AGR_{i,t} + \beta_5 W_{ij} g_j + u_{i,t}, \qquad (7)$$

where, $OUTCOME_{i,t}$ is the average annual growth rate of region *i* in period *t*; α is a constant intercept term; $TREAT_{i,t-p}$ is the Objective-1 treatment in period t if $p=0$ or in the prior period if $p=1$; $f\left(FORCE_{i,t}\right)$ is the forcing variable representing per-capita GRP of regions around the 75% threshold prior to period t, it is captured by a *P*th-order polynomial (*P*=1 implies a linear trend) and its intercept and trend can be allowed to differ at either side of the threshold; λ_i is country-specific effects; $EMP_{i,t}$ and $AGR_{i,t}$ are the initial employment rate and initial share of agricultural industry in each region prior to period t, respectively; $W_{ij}g_j$ is the spatially-weighted lag term of regions *i*'s neighbor *j*'s growth rate in period *t*, meant to capture spatial growth spillovers; $u_{i,t}$ is an error term[6]; and, β_1 to β_5 are parameters to be estimated. In RDD, if the variable $TREAT_{i,t-p}$ is positive and significant this suggests that regions, around the threshold, that receive the treatment of Objective-1 transfers in the 2000-2006 period grew faster on average than comparable regions that did not.

However, arguable, the effects of Objective-1 transfers are long-term in nature. Thus, both the short-term effects on the average growth rate in 2000-2006 of regions that received transfers in period 2000-2006 and the long-term effects on average growth rates in 2000-2006 of regions that received transfers in the prior period of 1994-1999 are investigated.

From neoclassical theory, as discussed in chapter 2, it is expected that the initial per-capita GRP is negatively related to the average growth rate in period *t*. Additionally, the variables λ_i, $EMP_{i,t}$, $AGR_{i,t}$ and $W_{ij}g_{j,t}$ are included to capture regional differences discussed chapter 2. From theories on knowledge spillovers it is expected that the employment rate and growth spillovers from neighboring regions have a positive effect on a region's average growth rate and a large share of agricultural employment is associated with a lagging growth rate (think of the peripheral region specialized in a constant returns industry in the core-periphery model). The country-fixed effects are meant to capture differences in e.g. technology, education or human capital as discussed in chapter 2. Possibly, such variables are not perfectly evenly distributed within each country. However, policies affecting them are usually set at the national level and arguably it is much easier for regions within the same country to share human capital and technology.

Table 2. Eligible and non-eligible NUTS-3 regions over and under the 75-% threshold rule for Objective-1 funding.

	Treated	Non-treated	Total
Eligible	316	65	381
Non-eligible	102	734	836
Total	418	799	1217

This thesis employs NUTS-3 level regions as the main object of analysis. However, Objective-1 eligibility is set at the NUTS-2 level. Consequently, there is heterogeneity in per-

[6] Note that it is not possible to include both the spatial-lag term and region-specific effects since the distance between regions are fixed over time. Instead country-specific effects, λ_i, are introduced. That way there is still some variation in distances at the sub-national level.

capita GRP between NUTS-3 regions within the same NUTS-2 region. Indeed, as can be seen in Table 2, the 75% threshold for Objective-1 transfer is not followed in all cases. This means that some NUTS-3 regions receive transfers even though they are not eligible and some do not receive transfers even though they are eligible. As pointed out by Becker et al (2008) there is to some degree a random distribution of Objective-1 funds at the NUTS-3 level around the 75%-threshold. However, this is not perfect since the likelihood of poor NUTS-2 regions containing poor NUTS-3 is fairly high. Moreover, the eastward expansion of the EU in 2004 meant that the average per-capita GRP in the union was lowered. As a consequence many regions that previously were eligible for support then opted for a special “phasing-out” transfers under the Objetive-1 funds (EC 1999). Thus, in terminology of RDD, there is partial non-compliance to the rule (Angrist and Pischke 2009; Imbens and Lemieux 2008; and, Lee and Lemieux 2009). This calls for so called *fuzzy* RDD.

Figure 1. Probability of Objective-1 treatment and the 75%-threshold

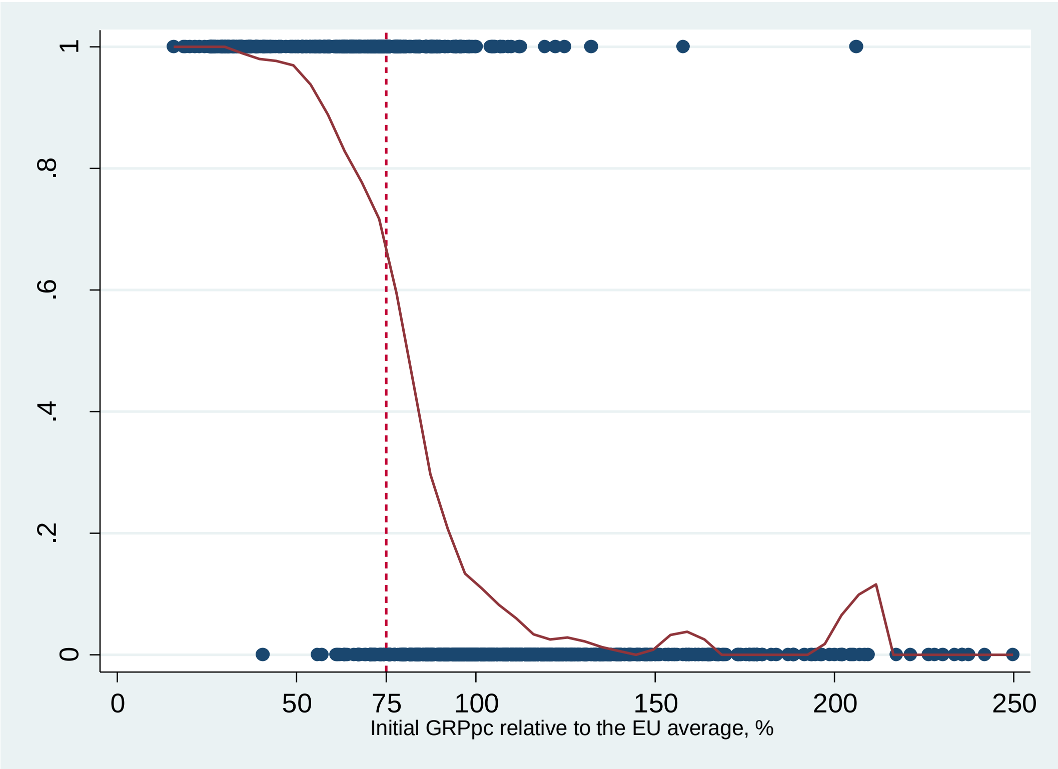

Figure 1 illustrates the probability of receiving Objective-1 transfer given the initial per-capita GRP of NUTS-3 regions relative the EU average in 1999. Fuzzy RDD relies on the probability of treatment being less than unity. However, the probability of receiving treatment should increase the further down from the 75%-rule a region moves. In fuzzy RDD a two-stage instrumental variable approach is needed as OLS estimations of (7) would yield biased estimates. Instead (7) may be instrumented with the following nonlinear first-stage regression:

$$P(TREAT_{i,t-p} = 1) = f(\vartheta + \gamma_1 RULE_{i,t-p} + \gamma_2 f(FORCE_{i,}) + \xi_i + \gamma_3 EMP_{i,t} + \gamma_4 AGR_{i,t} + \gamma_5 W_{ij} g_{j,t} + \upsilon_{it}), \quad (8)$$

where ϑ, ξ_i, γ_1 to γ_5 are parameters to be estimated, and υ_{it} denotes a disturbance term. Hence, (8) estimates the probability of being treated with Objective-1 transfers, $P(TREAT_{i,t-p} = 1)$, given the 75% rule, $RULE_{i,t-p}$. In this thesis a nonlinear probit estimator is employed. However, as Becker et al (2010) notes, the first-stage is just identified irrespective of whether a nonlinear or a linear probability model is used. However, even though a nonlinear model puts strong distributional assumptions on υ_{it}, it tends to produce more efficient estimates as it uses more of the sample variation (see the nonlinear trend in Figure 1). In addition, linear probability models tend to suffer from heteroskedastic error terms (ibid).

5. Results

5.1 Data and descriptive statistics

The sample consist of 1217 NUTS-3 regions in total. For the period entire 2000-2006 1 074 regions from the EU15 are included. Additionally, for the period of 2004-2006, 143 regions from the new member states are included.[7] The sample consists of 418 regions that received Objective-1 transfers in the 2000-2006 period and 277 regions that also received transfers during the 1994-1999 budgetary period. Objective-1 eligibility is set by the European Commission one year before each programming period. For the 1994-1999 period information on eligibility is listed in Council regulation 2081/93 and – for the 1995 members Austria, Sweden and Finland – in Official Journal L 001, 01/01/1995. For the period 2000-2006 eligible regions are listed in Council Regulation 502/1999 and – for the new 2004 members – in the Official Journal L 236, 23/09/2003. Data on per-capita GRP, employment share and agricultural share are collected from EUROSTAT's regional database and – for Austria, Italy and some German regions – from the OECD.Stat's regional database. Overseas regions are dropped from the dataset.[8]

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[7] Cyprus, Estonia, Latvia, Lithuania, Malta, Poland, Slovakia, Slovenia, the Czech Republic and Hungary joined the EU in 2004.

[8] The dropped regions are: the Spanish regions of El Hiero, Fuerteventura, Gran Canaria, La Gomera, La Palma, Lanzarote, Tenerife, Ceuta, and Melilla; the French overseas regions of Guadeloupe, Martinique, Guyana and Réunion; and, the Portuguese island regions Acores and Madeira.

During the 2000-2006 period the Objective-1 funds amounted to 70% of EU's Structural Fund Program, i.e. 137€ billion (European Commission 2007, p.202). The Structural Fund program amounted to about one third of the total EU budget, or 195€ billion, for the 2000-2006 period (ibid).

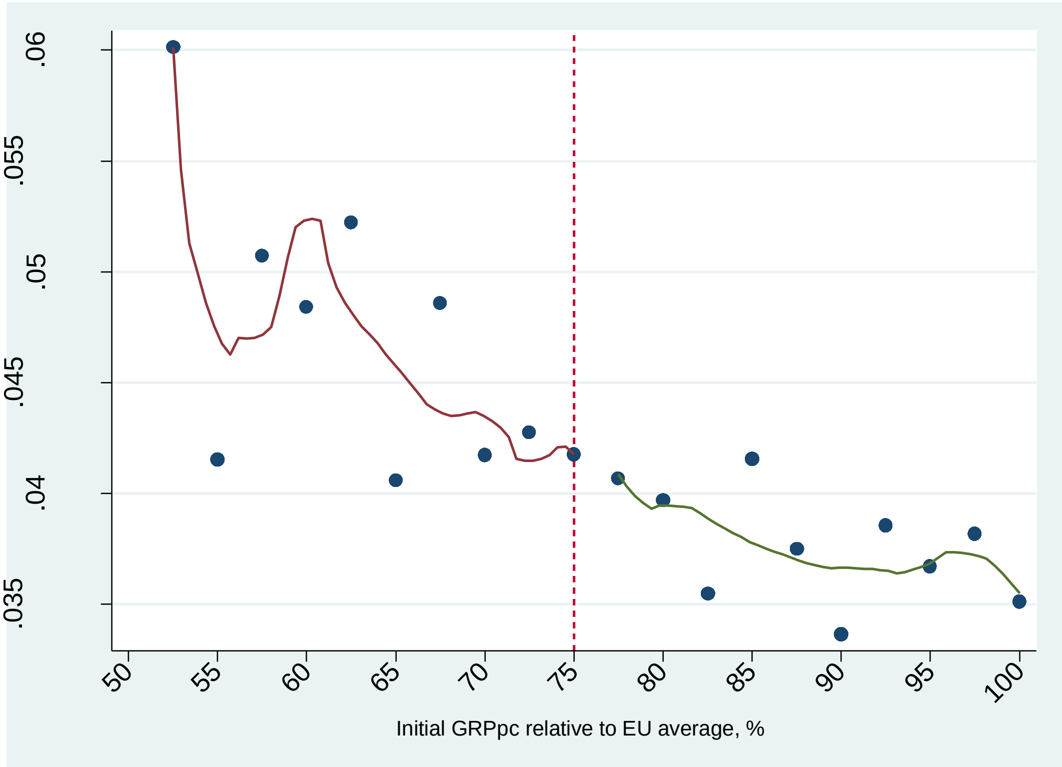
Table 3. Descriptive statistics

	All regions			
	Mean	Std. Dev.	Min	Max
GRPpc PPS, 1999	17851.17	7619.994	3199.999	102000
AAG GRPpc, 2000-2006	0.040225	0.018956	-0.03123	0.1957
Employment share, 1999	0.425797	0.103166	0.214505	0.943478
Agricultar share, 1999	0.075334	0.092418	0	0.652908
	Untreated regions			
	Mean	Std. Dev.	Min	Max
GRPpc PPS, 1999	20907.91	7278.421	7229.494	102000
AAG GRPpc, 2000-2006	0.035426	0.012554	-0.00109	0.107132
Employment share, 1999	0.448218	0.109987	0.235207	0.943478
Agricultar share, 1999	0.042389	0.040931	0	0.322068
	Treated regions			
	Mean	Std. Dev.	Min	Max
GRPpc PPS, 1999	12008.26	3977.119	3199.999	36800
AAG GRPpc, 2000-2006	0.049398	0.024854	-0.03123	0.1957
Employment share, 1999	0.38294	0.071288	0.214505	0.663492
Agricultar share, 1999	0.138309	0.125082	0	0.652908

Table 3 shows a range of statistical moments of the variables included in the sample, as well as for the subsamples of treated and untreated NUTS-3 regions. The included moments are the mean, standard deviation, minimum and maximum values of initial per-capita GRP (in PPS), the average annual growth rate (AAG GRPpc) during 2000-2006, as well as the covariates, the initial employment share (in total population) and the initial agricultural share (in total employment).

Some general observations can be learned from Table 3. First, the treated regions have a lower mean per-capita income compared to the untreated regions; in general they also grow faster than untreated regions. This gives credence to the hypothesis that poorer regions converge to richer, possible with the help of Object-1 transfers. However, the treated regions also have the lowest growth rate and the untreated regions have the highest growth rate during the period. Additionally, treated regions also show a greater span of growth rates. Secondly, treated regions in general have lower employment and higher share of agricultural industry. Further indicating the general *peripheral nature* of treated regions.

Figure 2. Average annual growth rate 2000-2006 and the 75%-threshold



Note: The figure shows average regional annual growth rates in equally sized 2.5% bins. The graph represents a 2nd -degree local polynomial functions.

Figure 2 plots NUTS-3 regions' average annual per-capita GRP growth rate against their initial per-capita GRP relative the EU average. The regions are plotted in equally sized bins of 2.5% based on their average growth rates and the trend is plotted as a 2nd-degree local polynomial function. Indeed, Figure 2 illustrates a clear discontinuity around the 75%-rule. Thus, RDD seems a fitting identification strategy in the case of the effect of the Objective-1 funds to promote growth. However, as pointed out by Lee and Lemiuex (2009), the graphical representations should not be considered alone, as different functional forms of the trends around the rule can give different answers as to the existence of a discontinuity. Instead, the graphical representation should be complemented with a range of estimations and sensitivity checks, testing the credibility of the jump.

5.2 Baseline estimations

Table 4 shows the baseline RDD estimations.[9] All estimations are done in a window consisting of regions with initial per-capita GRP of between 50 and 125% of the EU average. Outcome is the average annual per-capita GRP growth rate over the 2000-2006 period.

Table 4. RDD baseline estimations

	(1)	(2)	(3)
VARIABLES	Outcome	Outcome	Outcome
Objective-1 status	0.0155***	0.0159***	0.0140**
	(0.00254)	(0.00547)	(0.00616)
GRPpc, 1999		-0.00922	0.00168
		(0.00890)	(0.00886)
Employment rate, 1999		0.0479***	0.0111
		(0.0139)	(0.0120)
Agricultural rate, 1999		-0.0388***	-0.0269**
		(0.0123)	(0.0124)
Spatially lagged outcome			0.799***
			(0.164)
Constant	0.0340***	0.107	-0.0149
	(0.000883)	(0.0836)	(0.0817)
Country-specific effects	NO	NO	NO
Observations	885	885	885
Adj R-squared	0.0283	0.0784	0.200

White's robust HEC standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1, # p<0.15

[9] The first-stage estimations are shown in appendix 2.

In estimation (1) the average annual growth rate over the period is simply regressed on the Objective-1 treatment status. In this case it is evident that treatment yields a significant and positive effect on the growth rate. Regions that receive transfers on average grow 1.56 % (the exponent of the Objective-1 status estimate) faster than regions that do not. However, looking at the adjusted R-squared reveals that very little of the variation is explained by this specification.

Next in Table 4, estimation (2) adds the initial level of per-capita GRP, employment and agricultural specialization as covariates in the specification. In the two latter cases both variables are significant and show the expected sign. A higher employment is associated with a higher average growth rate and a higher specialization in agricultural industry is associated with a lower rate. The initial per-capita GRP have the expected sign but is shown to be insignificant at the 15%-level. The effect of Objective-1 treatment is still positive and significant and in terms of size comparable to estimation (1); regions that receive transfers on average grow about 1.6 % faster than other regions in the sample.

In chapter 3 it was suggested that growth spillovers have a strong localized-geographical component. Accordingly, finally in Table 4, estimation (3) adds the spatially-lagged growth rates of neighboring regions. Indeed, the spatially-autoregressive term is significant and positive implying that per-capita income growth among neighbors is strongly linked to a region's own average growth rate. This further implies the importance of economic linkages between regions giving rise to growth clusters, i.e. relative high-growth regions tend to be close to other high-growth clusters. This is in line with the findings of Dall'erba (2005), Dall'erba and Le Gallo (2008) and Ramajo et al (2008) among others. Further underlining the importance of spatial spillovers the explanatory power of the specification increases dramatically when including the spatial lag, as is evident when looking at the adjusted R-squared value of specification (3), 0.2 compared to 0.07 in estimation (2).

Furthermore, in estimation (3) initial per-capita GRP is still insignificant and now employment is also insignificant. That employment is insignificant when spatial growth spillovers are accounted for can imply that a region's own labor market is not as important in relation to its growth as its neighborhood. Instead, what is important is labor flows between regions in the entire regional cluster. Indeed, estimations show that including a spatial lag of the employment rate in a similar specification yields a significant and positive estimate.[10]

[10] See appendix 3 for the additional estimation including spatial lags of independent variables.

This can indicate the importance of labor mobility as a source of knowledge spillovers as pointed out by e.g. Glaesser et al (1992).

However, specialization patterns seem to still influence the growth outcome, as the agricultural rate is still significant and showing the expected sign in estimation (3). Lastly, Objective-1 status continues to be positive and significant, albeit somewhat smaller in size compared to the earlier estimates; now recipient regions grow at a 1.4% higher rate on average than non-recipient regions.

Table 5. Baseline RDD with country-fixed effects

	(4)	(5)	(6)
VARIABLES	outcome	outcome	outcome
Objective-1 status	0.0133***	0.00708**	0.00489#
	(0.00225)	(0.00278)	(0.00302)
GRPpc, 1999		-0.00731	-0.00828
		(0.00637)	(0.00621)
Employment rate, 1999		0.0102	0.00898
		(0.0140)	(0.0136)
Agricultural rate, 1999		-0.00972	-0.00976
		(0.0105)	(0.0102)
Spatially lagged outcome			0.288*
			(0.164)
Constant	0.0367***	0.106*	0.105*
	(0.00180)	(0.0583)	(0.0555)
Country-specific effects	YES	YES	YES
Observations	798	798	798
Adj R-squared	0.317	0.359	0.368

White's robust HEC standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1, # p<0.15

Table 5 shows similar specifications as Table 4, however adds country-specific effects to the estimations. Objective-1 status is significant at the 10%-level in specification (4) and (5) and at the 15%-level in specification (6). Thus, no strong conclusions should be drawn from the estimate in (6). However, they might indicate that with a larger sample and more efficient estimates the Objective-1 status would show stronger significance also in this specification. It seems clear that increasing the sample size over more budgetary periods is something that should be pursued in the future.

What is more, adding country-specific effects in Table 5 reduces the effect of Objective-1 status compared to the estimates in Table 4. This indicates the country affiliation of a region plays a crucial role in the efficiency of the Objective-1 transfers. Also note that the explanatory power of the specifications have increased in Table 5 compared to Table 4.

In addition, the added country-specific effects in Table 5 explains so much of the variation in growth rates that adding it removes the significance of all covariates except the spatially lagged outcome, though this is markedly reduced in size. This further emphasizes the importance of country affiliation on regional growth outcomes. Namely, spatial spillovers are weaker between countries, indicating that there are still some barriers to spillovers and/or factor mobility between countries in the EU.

The results thus far indicate that Objective-1 transfers can be important to stimulate the average growth of regions, with an average treatment effect of about 0.5-1.5 % higher growth rate for treated regions depending on specification. In size these estimates are comparable to the ones found by Becker et al. (2010), employing a similar RDD for the period 1989-2006. However, the transfers are not nearly as important for the growth outcome of regions as country affiliation. Likewise, neither the initial income level nor other initial covariates are important when spatial growth spillovers and country dummies are included.

5.3 Changing the parametric function of the forcing variable

Up to now it has been assumed that the forcing variable, per-capita GRP in 1999, has the same linear functional form at either side of the 75%-threshold. However, this is not necessarily the case. For example, it is possible that the perceived discontinuity really is indicative of nonlinearity instead of a jump at the threshold (see e.g. Angrist and Pischke 2009, p. 254f.). In that case it is possible that the estimated effect of the Objective-1 transfers do not really show the average effect of treatment, but rather an unaccounted nonlinearity. Thus, it is important to control for this possibility.

In Table 6 specification (7) and (8) are analogue to specification (3) and (6) in Table 4 and 5, respectively, with the addition of the quadrat of the forcing variable. The size and significance of the average treatment effect of Objective-1 status in specification (7) and (8) are in parity with the estimates in the corresponding estimations above. Including country-fixed effects more than the halves the average effect of Objective-1 treatment and reduces the spatially-autoregressive term in size by about three fourths.

Table 6. RDD with symmetric polynomial

	(7)	(8)
VARIABLES	Outcome	Outcome
Objective 1 status	0.0122*	0.00459#
	(0.00646)	(0.00291)
GRPpc 1999	-0.414#	-0.442**
	(0.256)	(0.175)
2^{nd}-order polynomial of FORCE	0.0215#	0.0224**
	(0.0130)	(0.00907)
Occupation rate 1999	0.00998	0.00654
	(0.0118)	(0.0137)
Agricultural rate 1999	-0.0263**	-0.00849
	(0.0122)	(0.00996)
Spatially Lagged outcome	0.810***	0.297*
	(0.172)	(0.162)
Constant	2.000	2.197***
	(1.253)	(0.847)
Country-specific effects	NO	YES
Observations	885	798
Adj R-squared	0.218	0.372

White's robust HEC standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1, # p<0.15

In addition, in estimation (8) the forcing variable and its quadrat are significant and the signs indicate a negative exponential relationship between initial per-capita GRP and the average annual growth rate. The signs of these variables are the same in specification (7), which are significant at the 15%-level. Also, looking at the adjusted R-squared the specification in Table 6 explains more of the sample variation than the previously discussed correspondent estimations. Thus, it seems important to add the quadrat to the specification.

Furthermore, allowing the forcing variable to have a different intercept at any side of the threshold do not seem to increase the explanatory power of the specifications, regardless if the quadrat is included or not. The size, sign and significance of estimates, as well as the explanatory power of the specification, are in line with the ones presented in Table 6.[11]

5.4 Sensitivity and robustness checks

So far the regions included in the estimations have been in a fairly large window around the 75%-threshold. However, as discussed above, even though this increases the efficiency of estimates in the RDD the size of the window also increases the risk of biased estimates, due to the regions included not being fully comparable. Thus, it is important to control the sensitivity of the estimates to changing the size of the window (Lee and Lemieux 2009).

In Table 7 the window around the 75-% threshold is decreased to four subsamples. Firstly, to a window containing regions with per-capita GRP of 50-110% relative the EU average; secondly, to regions within a 50-100% window; thirdly, to a window of regions within the 60-90% window; and, lastly, to a window containing regions within a window of 70-80% of the EU average per-capita GRP.

As can be seen in panel (I) in Table 7, which is analogue to specification (7) in Table 5, the significance and size of the estimates decrease after each consecutive reduction in window size, until the 70-80% -window where both the significance and size of the estimate suddenly jumps. Before this the size of the estimates are in line with previous estimates.

Thus, looking at Table 7, there seem to be strong treatment effect just around the 75%-threshold. Possible explanations for this can be that either lower- or higher-income regions bias the previous estimates downwards. It is, for example, possible that low-income regions lack the absorptive capacity, due to lacking local institutions or competences. This can hinder their ability to really take advantage of the Objective-1 transfers (cf. Caragliu and Nijkamp 2008; Rodriguez-Pose and Crecenzi 2008). As discussed in Chapter 2, both endogenous growth theory and NEG point to that human capital, e.g. education level or skills, as of outmost determinants in the growth outcome of regions. Also, Rodriguez-Pose and Fratesi (2004) found that Structural Fund payments aimed at promoting e.g. education is more efficient compared to other funds. Moreover, it is equally plausible that the effect of Objective-1 transfers on high-income regions is relatively weaker. Indeed, neoclassical theory would predict something similar; as these regions have a higher capital-labor ratio the effects of further investments in physical capital through the Objective-1 transfers would increase growth to smaller extent due to diminishing returns.

[11] The estimations are presented in appendix 4.

Table 7. Changing the window around the 75%-threshold

(I) Estimated model as in specification (7) in Table 5		
Window, %	Objective-1 status	Observations
50–110	0.0111288** (0.0054773)	719
50–100	0.0140639# (0.0094591)	601
60–90	0.0071783 (0.0135122)	363
70–80	0.0251221* (0.0146519)	146

(II) Estimated model as in specification (8) in Table 5		
Window, %	Objective-1 status	Observations
50–110	-0.0001345 (0.0037067)	618
50–100	-0.001521 (0.0043252)	502
60–90	0.0093878 (0.0092392)	279
70–80	0.0130335 (0.0227057)	103

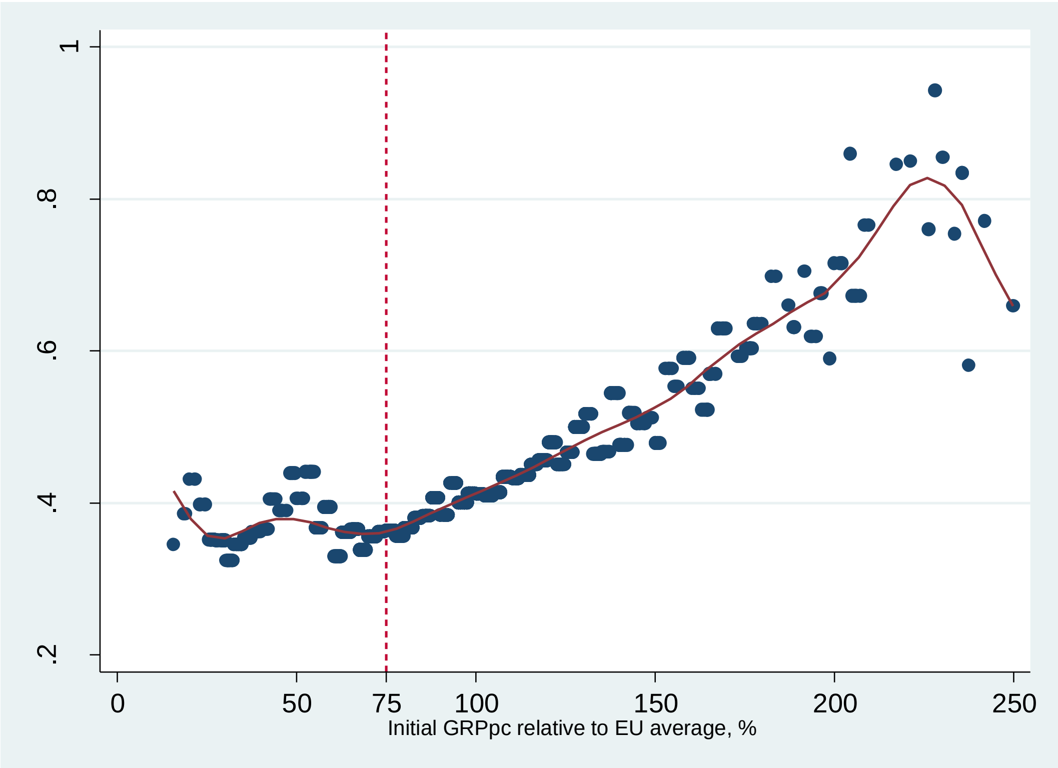
White's robust HEC standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1, # p<0.15

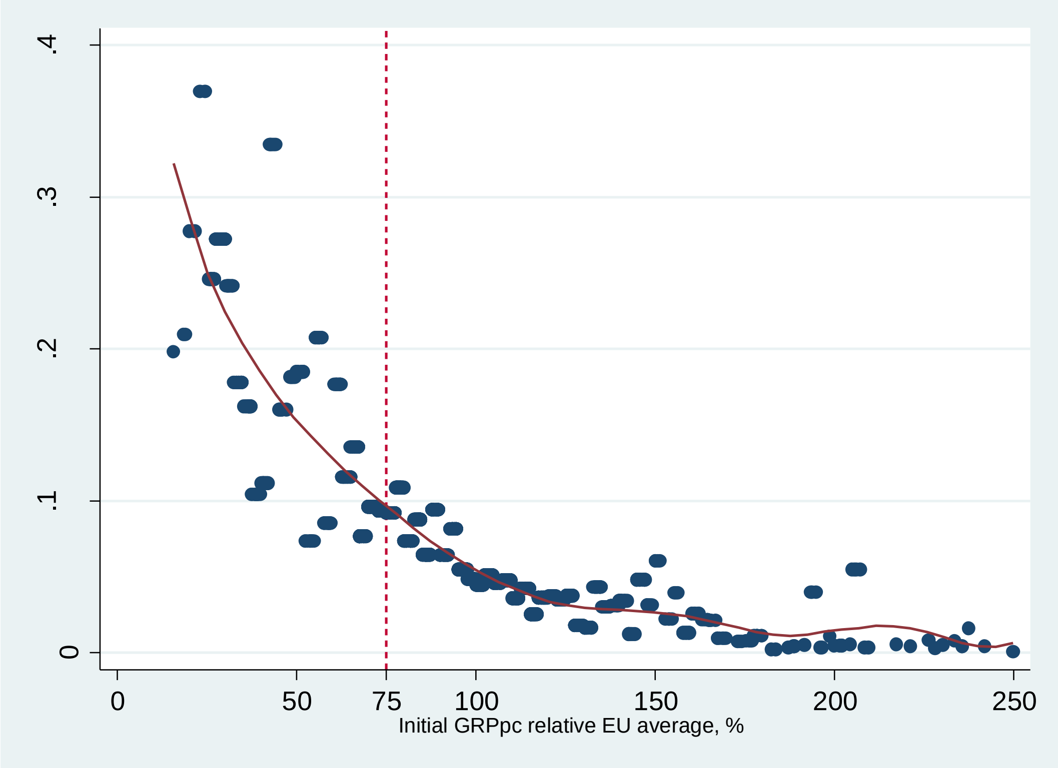
Turning to panel (II) in Table 7, which is analogue to specification (8) in in Table 6, thus accounting for country-fixed effects, all significance of the estimates disappear. Moreover, the signs of the estimates in two largest windows change to negative, albeit their sizes are minuscular. However, around the two smallest windows, 60-90% and 70-80%, the sign becomes positive again and the size is comparable to previous estimates on the average treatment effect, although the estimates are still insignificant. Yet, without making any real interpretation, the results shown in panel II somewhat corroborates those found in in panel I of Table 6.

Additionally, the results in panel II of Table 7 once again point to the importance of country affiliation. Country-specific effects seem to capture most variation in the treatment effect of the Objective-1 transfers. These results point to national institutions and the general economic policies being the real determinant of effectiveness of regional transfers. Indeed, as discussed above, Martin (1999) pointed to several policies usually determined at the national level when discussing a good regional policy, e.g. increased competition on labor and goods markets or educational policies.

Another assumption underlining RDD is that the included covariates should not be affected by the threshold. If this is the case the detected treatment effect in the estimations above could be an artifact of one of the covariates also "jumping" at the threshold (Imbens and Lemieux 2009). Figure 3 plots the covariates, employment and agricultural share around the 75%-rule, in equally sized 2.5% bins. As is evident no "jump" can be detected neither for employment nor agriculture. Thus, the RDD-estimations seem credible and robust.

Figure 3. Covariates and the 75%-threshold

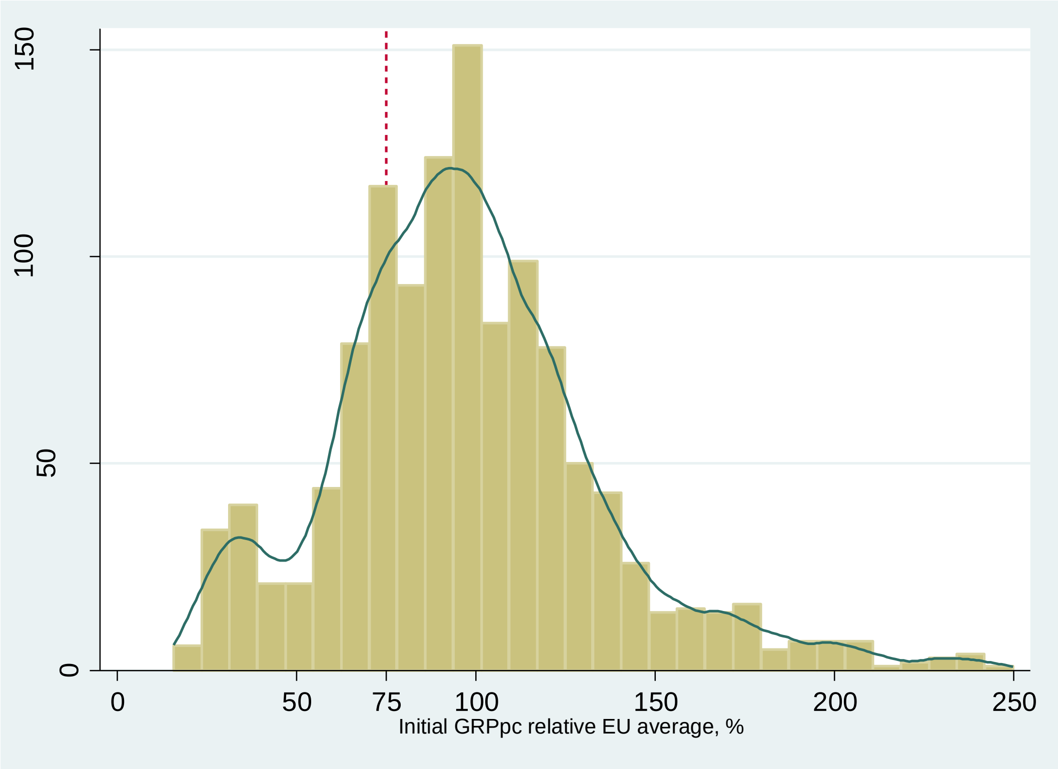




Note: The figure shows respective covariate in equally sized 2.5% bins. The graph represents a 2nd -degree local polynomial functions.

Lastly, RDD can be biased if the distribution of observations differs markedly or are not randomly assigned on either side of the threshold (Ibid). Figure 4 plots the distribution of regions based on their per-capita GRP relative to the EU average. No systematic differences in distribution can be detected around the 75%-rule. To make this clearer the kernel density distribution is plotted as well, as can be seen no large change happens in the distribution around the threshold. Thus, the RDD-strategy seems robust in this case as well.

Figure 4. Distribution of regions and the 75%-threshold



Note: The figure show the kernel density function with Epanechnikov kernel and where a bandwidth that minimizes the mean integrated square error is chosen.

5.5 The long-term effects of Objective-1 transfers

As pointed out by Becker et al (2010) it is possible that the effect of Objective-1 transfers accumulate over time. To test if this is the case the growth outcomes of regions that also received Objective-1 transfers in the budgetary period of 1994-1999 are investigated.

In Table 8 specification (I) and (II) corresponds to specification (7) and (8) in Table 6, however only considers the subsample of regions that received Objective-1 transfers in the 1994-1999 budgetary period. For most variables the estimates are in line with those reported above. However, in specification (I) the estimate of the average treatment effect is insignificant, which in itself is not surprising since, as was discussed above, the older member states have relatively higher per-capita incomes and it would be expected that these would grow slower due to diminishing returns. However, the treatment effect is significant when considering specification (II).

Thus, when taking country-specific effects into consideration the average long-term treatment effect among regions of the old EU member states is significant. The size of the estimate suggests that, when taking country-specific effects into account, regions that received transfers in the 1994-1999 period grew about 0.5% faster on average. Thus, some old member states in the EU15 have been "better" at absorbing Objective-1 funds, to such a degree that the transfers explain the longer-term growth of their regions outcomes. However, a general long-term effect cannot be found when looking only at regions. This once again emphasizes the importance of country policies and institutions in absorbing regional transfers, particularly in the longer term time perspective.

Table 8. Long-term effects of Objective-1 transfers

VARIABLES	(I) Outcome in 2000-2006	(II) Outcome in 2000-2006
Objective-1 status in 1994-1999	0.00604	0.00531*
	(0.00578)	(0.00297)
GRPpc 1999	-0.369*	-0.409**
	(0.213)	(0.175)
2^{nd}-order polynomial of FORCE	0.0189*	0.0208**
	(0.0108)	(0.00908)
Occupation rate 1999	0.00389	0.00703
	(0.0110)	(0.0137)
Agricultural rate 1999	-0.0176	-0.00896
	(0.0118)	(0.0100)
Spatially Lagged outcome	0.982***	$0.242^{\#}$
	(0.135)	(0.164)
Constant	1.802*	2.041**
	(1.043)	(0.849)
Country-specific effects	NO	YES
Observations	841	784
Adj R-squared	0.199	0.334

White's robust HEC standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1, $^{\#}$ p<0.15

6. Conclusion

This thesis aims to investigate the effect of regional transfers on the growth performance of EU NUTS-3 regions during the 2000-2006 budgetary period. The theoretically predictions, as well as the prior empirical evidence, on how transfers affect regional growth are varied. Neoclassical theory show how transfer can speed up the convergence process, either in an absolute or a conditional sense, due to diminishing returns to capital investments. On the other hand, endogenous growth theory and NEG show that the existence of increasing returns and/or agglomeration economies can imply that regions need not converge. Instead, a situation where relatively high-income regions continue to grow faster than low-income regions, i.e. diverge, is a possibility.

Consequently, if these divergence forces are stronger than convergence forces, regional transfers may fail in their aim to promote regional income cohesion. A line of theoretical models show how transfers to low-income regions may even damper overall aggregate growth in the economy due to the existence of agglomeration economies and endogenous growth dynamics. Specifically, in the presence of positive externalities to investments in human capital and innovation giving rise to increasing returns, scale economies to production and transactions costs a trade-off between, on the one hand, aggregate growth and, on the other, regional income equity emerges. Martin (1999) shows that, in such a world, regional transfers may actually worsen overall welfare in the economy as it diverts capital from regions where it is productive to regions where it will be less productive. Therefore, since the welfare effects of regional transfers are ambiguous, it is argued that investigating the outcomes of said transfers are of great importance.

Empirically, the prior results on the effect of regional transfer on regional growth performance in Europe are varied. Mohl and Hagen (2010) point to several problems afflicting the prior empirical literature. Foremost is the problem of endogeneity and thus biased estimates on account of omitted variables or simultaneity. This thesis tries to account for these problems by employing a quasi-experimental RDD-method, exploiting the arbitrary set 75-% rule for Objective-1 fund eligibility, to compare the per-capita GRP growth effect of transfers on recipient NUTS-3 regions to the growth of comparable non-recipient regions during the 2000-2006 budgetary period. The analysis is similar to that carried out by Becker et al. (2010), but focuses on more disaggregated regional data, accounts for spatial spillovers and explicitly looks at the long-term effects of transfers.

The findings point towards a positive effect of Objective-1 funds to promote per-capita income growth in recipient regions. This is in line with several recent contributions to the literature (see e.g. Ramajo et al. 2008; Becker et al. 2010; Mohl and Hagen 2010; and Becker et al. 2012). However, when country-specific effects and spatial spillovers are controlled for the estimates are reduced by almost two thirds. This is interpreted as country association being of great importance in explaining the effectiveness of the transfers in promoting growth. Moreover, the spatial spillovers are reduced in size when country affiliation is accounted for, raising questions on how strong growth spillovers over national borders in the EU really are. The estimates in are robust to various sensitivity checks.

Furthermore, when reducing the window around the 75%-threshold the effect of Objective-1 transfers first lessens. However, in the smallest window, containing regions with a per-capita GRP of 70-80% of the average per-capita GRP in the EU, the treatment effect suddenly becomes much stronger. Moreover, when accounting for country affiliation the treatment effect of the transfers becomes minuscular, until the smallest windows when the estimates suddenly become positive (however, still insignificant). One possible explanation for this pointed out in the literature is the absorptive capacity of regions (see e.g. Caragliu and Nijkamp 2008; Rodriguez-Pose and Crecenzi 2008). This is related to the ability of the recipient regions to use their allotted funds on productive investments. Thus, it is possible that a subset of relatively high-income recipient regions share certain intuitional characteristics that make them more absorbent to the Objective-1 transfers.

The findings discussed above are corroborated by the findings when looking at the long-term effects of the funds. Here no general treatment effect among recipient regions that received Objective-1 transfers during the 1994-1999 budgetary period is found. However, when country-specific effects are accounted for the treatment effect is suddenly becomes significant, possibly indicating that regions in some countries have been able to utilize transfers to generate a stronger growth outcome during the period. Thus, this further point to a subset of countries or regions that do better at exploiting regional transfers.

The findings point towards an interesting future line of research. Who are these successful regions and countries and what are their characteristics? To characterize such successful and less successful regions can have important policy implications as it point towards a possible "not-all-shoes-fit" policy approach to regional transfers. For instance, there can be reason to, in conjunction with the transfers, also promote other institutional changes among recipient regions. The policies pointed out by Martin (1999), as generally important for the effectiveness of regional transfers, could be examples on such institutional changes that should be promoted.

Lastly, it should be pointed out that, on account of the chosen RDD identification strategy, the above results have a strong internal but a weak external validity. To try to remedy this and get more general results increasing the number of budgetary periods considered is essential. Also, adding more covariates to ensure the internal validity of the results is important. Moreover, as not all Objective-1 funds are used, obtaining data on the real usage of the funds in each region is imperative if the aim is to study the real effect of the funds in promoting growth in the future.

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Appendix 1

The spatial weighting matrix assigns each region a neighborhood where the neighbors are thought to share spatial dependency. In this thesis a weight matrix based of inverse-squared geographical distance in kilometers between regional centroids is used.

Specifically, a distance-based weight matrix, W, is specified where the distance is the squared-inverse of the great-circle distance between each region's centroid. Moreover, a critical cut-off point is implemented, above which spatial dependence is assumed to be zero. Lastly the distance matrix is row-standardized[12] so that each row sums to one, this done so that it is the relative and not the absolute distance that matters. This will also give bounded estimates of the spatial-autoregressive coefficients, making these easier to interpret. Hence, the spatial weight matrix is defined as,

$$W = \begin{cases} w_{ij} = 0,\ if\ i = j \\ w_{ij} = \frac{1}{d_{ij}^2},\ if\ d_{ij} \leq D \\ w_{ij} = 0,\ if\ d_{ij} > D \end{cases}, \qquad (A.1.1)$$

where the element w_{ij} is the spatial interaction between region i and j, d_{ij} is the great-circle distance in kilometers between regions i and j's centroids and D is the critical cut-off point.

[12] That is, $w_{ij} = \frac{w_{ij}}{\sum_j w_{ij}}$.

Appendix 2

Table A2.1. First-stage regressions corresponding to estimations 1-4 in Table 4

VARIABLES	(1) Outcome	(2) Outcome	(3) Outcome
Pr(treatment)	0.8535***	1.0605***	1.0514***
	(0.04278)	(0.10559)	(0.10084)
GRPpc, 1999		-0.0190404	-0.0478377
		(0.15546)	(0.15083)
Employment rate, 1999		0.063275	0.0687259
		(0.25183)	(0.27061)
Agricultural rate, 1999		-0.135154	-0.126366
		(0.13855)	(0.14595)
Spatially lagged outcome			-1.144681
			(1.58118)
Constant	0.0708764	0.1514031	0.4747841
	(0.019781)	(1.488249)	(1.449894)

White's robust HEC standard errors in parentheses

*** $p<0.01$, ** $p<0.05$, * $p<0.1$, # $p<0.15$

Table A2.2. First-stage regressions corresponding to estimations 5-6 in Table 5

	(4)	(5)	(6)
VARIABLES	Outcome	Outcome	Outcome
Pr(treatment)	0.9135487***	1.217705***	1.203832***
	(0.07535)	(0.08752)	(0.07928)
GRPpc, 1999		0.2776288[#]	0.2211809
		(0.17196)	(0.160456)
Employment rate, 1999		-0.37056	-0.3169
		(0.41556)	(0.41039)
Agricultural rate, 1999		-0.03449	0.02658
		(0.36817)	(0.36839)
Spatially lagged outcome			-4.4573
			(3.17541)
Constant	0.0498623	-2.4824[#]	-1.779282
	(0.08627)	(1.611236)	(1.508758)

White's robust HEC standard errors in parentheses

*** $p<0.01$, ** $p<0.05$, * $p<0.1$, [#] $p<0.15$

Table A2.3. First-stage regressions corresponding to estimations 7-8 in Table 6

	(7)	(8)
Variables	Outcome	Outcome
Pr(treatment)	1.063533	1.195135
	(0.10109)	(0.07842)
GRPpc, 1999	3.428328	23.25475
	(4.808267)	(4.484512)
2nd-order polynomial of FORCE	-.1796449	-.0885114
	(0.248893)	(0.23076)
Employment rate, 1999	.0786526	-.5253654
	(0.273522)	(0.414645)
Agricultural rate, 1999	-.1327368	.0565799
	(0.143654)	(0.37181)
Spatially lagged outcome	-1.242793	-4.94549
	(1.61017)	(3.14355)
Constant	-16.33784	-10.35661
	(23.2548)	(21.8188)

White's robust HEC standard errors in parentheses

*** $p<0.01$, ** $p<0.05$, * $p<0.1$, $^{\#}$ $p<0.15$

Appendix 3

Table A3.1. Baseline RDD with spatial lags of independent variables

VARIABLES	(1) outcome
Objective 1 status	0.00438
	(0.00336)
GRPpc 1999	-0.0163***
	(0.00601)
Occupation rate 1999	0.0380***
	(0.0144)
Agricultural rate 1999	-0.0340**
	(0.0158)
First order spatially lagged GRP	-0.0185**
	(0.00932)
First order spatially lagged employment rate	0.0461***
	(0.0177)
First order spatially lagged agricultural rate	0.00981
	(0.0269)
Constant	0.343***
	(0.0935)
Observations	885
Adj R-squared	0.147

White's robust HEC standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1, # p<0.15

Appendix 4

Table A4.1. RDD with asymmetric polynomials

VARIABLES	(1) outcome	(2) outcome	(3) outcome	(4) outcome
Objective 1 status	0.0118#	0.0158#	0.00440#	0.00446
	(0.00716)	(0.00966)	(0.00299)	(0.00319)
FORCE, below threshold	0.00218	0.197	-0.00237	-0.223
	(0.00789)	(0.766)	(0.00629)	(0.442)
FORCE, above threshold	0.00198	0.164	-0.00277	-0.227
	(0.00796)	(0.725)	(0.00624)	(0.422)
Occupation rate 1999	0.0125	0.00574	0.00786	0.00644
	(0.0119)	(0.0139)	(0.0136)	(0.0139)
Agricultural rate 1999	-0.0243*	-0.0300*	-0.00689	-0.00694
	(0.0131)	(0.0153)	(0.0100)	(0.00994)
Spatially Lagged outcome	0.814***	0.787***	0.286*	0.291*
	(0.173)	(0.180)	(0.161)	(0.162)
2^{nd}-order polynomial of FORCE, below threshold		-0.0113		0.0112
		(0.0410)		(0.0236)
2^{nd}-order polynomial of FORCE, above threshold		-0.00787		0.0116
		(0.0367)		(0.0215)
Constant	-0.0188	-0.843	0.0508	1.137
	(0.0728)	(3.575)	(0.0564)	(2.067)
Country-specific effects	NO	NO	YES	YES
Observations	885	885	798	798
Adj R-squared	0.220	0.181	0.373	0.373

White's robust HEC standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1, # p<0.15