



# **Macro-economic effects of cohesion policy funding in 2007-2013**

## **Executive Summary**

### **Work Package 14c: Regression discontinuity design**

### **Work Package 14d: Propensity score matching**

*Ex post evaluation of Cohesion Policy programmes 2007-2013,  
focusing on the European Regional Development Fund (ERDF)  
and the Cohesion Fund (CF)*



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WORK PACKAGE 14c: Regression discontinuity design

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## **Abstract**

This final report focuses on evaluating the impact of the EU Funds (EUFG, sum of structural and cohesion funds) on regional growth in terms of GDP, employment rate and gross fixed capital formation. The analysis is implemented with a counterfactual impact evaluation approach developed through two methodological instruments: the Propensity score matching (PSM), with multiple categorical treatment-status variables, and the Generalised Propensity Score (GPS) matching. The estimation sample covers the EU-27 Nuts-2 regions across the programming periods 1994-99, 2000-06 and 2007-13. The results of the analysis show that the EUFG have a significant role in stimulating regional growth and economic development, with higher average intensities of the EUFG in the Ob.1/Convergence regions that generate a positive effect on regional growth, compared to the counterfactual status of receiving the lower average EUFG intensity of the non-Ob.1/non-Convergence regions. The results also indicate that the marginal impact on regional growth of further increasing the intensity of the EUFG tends to be somehow higher, on average, for the regions that do not already receive an high intensity of the EUFG. Such last finding, however, is not fully conclusive due to some important data limitations that do not allow the analysis to estimate the exact conditions under which the different intensities of the EUFG produce desirable regional growth outcomes.

## EXECUTIVE SUMMARY

### OBJECTIVES

The present report presents the main findings of Work Package 14 on " Ex post evaluation of the ERDF and CF programmes in 2007-2013, focusing on the European Regional Development Fund (ERDF) and Cohesion Fund (CF)". It aims to assess the effects of Cohesion policy on economic growth in the EU-27 regions that have benefited – to various extents – from financial assistance in the programming periods 1994-99, 2000-06 and 2007-13. The study is focused on a counterfactual impact analysis based on two types of methodological instruments: the Propensity score matching (PSM) -including the Generalized propensity score (GPS)- and the regression discontinuity design (RDD).

The analysis includes different tasks and objectives:

1. Estimating the effects of EU Funds (EUF, sum of structural and cohesion funds) on regional growth in the EU-15 regions in the 1994-2006 period. The focus of the analysis is on both the average impact of the higher intensity of EUF in the Objective 1/Convergence regions and the heterogeneity of the treatment intensity. A new methodological approach is developed to estimate how the varying intensities of EUF affect regional growth;
2. Enlarging the analysis to include the estimates of the EUF impacts on various regional growth outcomes in the EU-27 regions during the three last programming cycles, using the available data (1994-2011) and providing some empirical evidence on the effects of EUF during the crisis;
3. Comparing different methodological approaches (PSM-GPS and RDD) for the counterfactual impact evaluation of EUF and assessing the robustness of the results through multiple estimation models.

To fulfil these objectives, a complex evaluation design, innovative in many ways, has been implemented. The evaluation comprises several activities: a literature review on the impacts of EUF in previous studies; the construction of a new, comprehensive dataset for the analysis at the NUTS-2 regional level; the development of an innovative method for evaluating the effects of the intensity of EUF in a RDD framework; the use of multiple different PSM, GPS and RDD models for comparing impact estimates and enhancing the robustness of the results.

## BACKGROUND AND MOTIVATIONS

***The impact of EU Funds (EUF) can be strongly heterogeneous***

The effect of the EU Funds (EUF) can be strongly heterogeneous by country, region and time. There are several factors that may affect the impact of EUF on different dimensions of regional growth. The use of counterfactual impact evaluation methods often captures only average effects, without explaining differences in the impacts across different regions.

***The intensity of the allocated Funds between regions can be a primary source of variability of the impacts***

The intensity of the EUF is highly heterogeneous across EU regions. For instance, in the period 1994-06 the region of North-Holland received an annual average per capita transfer close to €9, whereas the Região Autónoma dos Açores (PT) almost 85 times more (€773). Limiting the analysis to the regions with Objective 1 (Ob. 1) status during the entire period 1994-2006, and excluding those of Sweden and Finland, included among the Ob. 1 areas because of under-population criteria, the lowest amounts of the capita transfers (in the regions of Burgenland –AT- and Merseyside –UK-) is more than eight and half times lower than the maximum. Such high heterogeneity of the EUF intensities may indeed produce different impacts on regional growth outcomes.

***The differences in the intensity of EUF reflect the choice to allocate more resources to most disadvantaged regions***

The differences in the intensity of EUF reflect the choice to allocate more resources to the regions that are particularly in need of assistance and to the areas with relevant economic and social distress. It is therefore quite important to empirically estimate how the impacts of EUF vary across different intensities of the transfers.

***The relationship between the aid intensity and the impact of EUF is not known***

However, the relationship between the aid-intensity and the impact of the EUF is not known. Economists and policy makers ignore whether this relationship is always linear, that is, if increases of the EUF intensity would always determine a proportional boost of the relevant regional economic growth outcomes. In other words, we do not know if the marginal efficiency of EUF, using economic jargon, is constant or, in some parts of the relationship, it is increasing or decreasing.

***The dose-response function of the EUF transfers may not be linear and it may decrease after a certain point***

There are two reasons to suggest that the dose-response function of the EUF transfers may not be linear and may decrease after a certain point. First, the assumption of diminishing returns to investment (and to subsidised investments) implies that a larger number of investment projects carried out could be associated with a lower return to investments (or transfers). Note that the diminishing returns can follow a period of increasing returns, for instance when a complete transportation network is completed rather than only one or two road infrastructures. However, the effect of diminishing returns can be different across European regions, depending on the stage of development, the quality and quantity of social capital, and the potential demand.

***The assumption of diminishing return to subsidized investment may support this hypothesis***

***Another reason may be the limited absorbing capacity of the EUF transfers in less developed regions***

Second, a limited absorbing capacity of EUF transfers may be in place, especially in less developed regions. This may be due to a lack of administrative capacity. As pointed out by several authors (including the European Commission), this factor may prevent to fully translate into regional growth the potential

offered by the investment opportunities allowed by the EUF. In a recent paper, Rodríguez-Pose and Garcilazo (2015) note that the European Union (EU) adopted the view that poor institutions can undermine efforts to achieve greater economic cohesion and hinder the effectiveness of regional development strategies, as stated in the EU's Fifth Cohesion Report.

## THE NOVELTY OF THE RESEARCH WITH RESPECT TO THE PREVIOUS LITERATURE

***The novelty of the research is the link between the average impact of EUF and the intensity of the transfers...***

***...and the use of innovative methodologies for regional-level counterfactual impact evaluations***

***The previous literature is based on the Generalized propensity score (GPS) approach***

***The GPS is one of the methods proposed in the literature to address the problem of a continuous treatment...***

***... however, it may suffer from the strong heterogeneity of regions, which may not be fully captured by the observed covariates***

***We propose a more complete solution, using both the PSM-GPS approach and the continuous RDD***

The main difference between this study and the copious literature on EUF and regional growth is twofold. First, we want to verify if the average impact of the EUF on regional growth depends also on the heterogeneity of the transfer intensities, measured by the normalised amount of EUF distributed in each region. Second, the evaluation is based on counterfactual impact evaluation (CIE) methods that ensure the estimation of the actual causality links between regional growth and the EUF. Two different types of methodological approaches are used in the analysis: a) Propensity score matching (PSM), in terms of both Generalized Propensity Score (GPS) and PSM with multiple categorical treatment intensities; b) Regression Discontinuity Design (RDD), including a novel methodological development that, to the best of our knowledge, extends for the first time the RDD framework to the case of continuous treatments.

Although the literature on the impact evaluation of the EUF is abundant (for a recent review see Pellegrini et al., 2013), only two papers evaluate the effects of transfer intensity. Mohl and Hagen (2010), using the method of Generalised propensity score' (GPS), shows that EUF payments "have a positive, but not statistically significant, impact on EU regions' growth rates". Becker et al. (2012), using again the GPS but applying it to NUTS3 regions, estimate the relationship between the treatment intensity of EUF regional transfers and per capita growth for the two programming periods 1994-99 and 2000-06. They find that, overall, EUF transfers enable faster growth in the recipient regions as intended, but in 36% of the recipient regions the transfer intensity exceeds the aggregate efficiency-maximising level and in 18% of the regions a reduction of the transfers would not even reduce their growth.

From a methodological point of view, both papers use a GPS approach, a non-parametric method to estimate treatment effects conditional on observable determinants of treatment intensity. The GPS is one of the methods proposed in the literature to address the problem of a continuous treatment.

However, all the estimators based on propensity score matching procedures may suffer from the strong heterogeneity of regions, which may be fully captured by the observed covariates. Moreover, none of these papers have properly exploited the source of local randomness due to the sharp discontinuity in the assignment of the different transfer intensities (75% of average GDP criterion). We propose a more complete solution, using both PSM models (in terms of categorical PSM and GPS), and the continuous RDD, which allows a compelling evaluation strategy also in presence of a continuous treatment.

Our comparative analysis of the two approaches (PSM-GPS and RDD) shows that both methods have an important role. RDD is



typically a preferable choice because it exploits local randomness conditions near the cut-off ( $k$ ) of the intensity assignment rule. However, in the presence of small samples of regions near ( $k$ ), the PSM-GPS models are a viable option to ensure the balancing of the relevant control variables and a greater efficiency of the estimates.

## THE NEW DATASET

***A new, reliable and comparable dataset for EU-27 regions is an important result of the study***

This study is based on a new, reliable and comprehensive dataset, stemming from several sources. The spatial grid used in our work is defined by 259 EU-27 regions at level 2 of the NUTS classification. We use the NUTS-2 2006 classification with adjustments to include data from all the three past programming periods. This new dataset is an important result of the study.

***Data on EU Structural and Cohesion Funds payments, broken down by programming period and region, has been provided by DG REGIO.***

The data on the EU Structural and Cohesion Funds payments to Member States, broken down by programming period (1994-1999, 2000-2006 and 2007-2013) were provided by the European Commission-DG REGIO. Such data are very relevant as they provide a coherent and reliable measure of the total amount of EU Funds (EUF) payments received by each Member State. Moreover, they cover all the main funds, including the Cohesion Fund, the European Regional Development Fund (ERDF), the European Social Fund (ESF), the European Agricultural Guidance and Guarantee Fund (EAGGF) and the Financial Instrument for Fisheries Guidance (FIFG). In this data only the EUF payments are considered, without national or private co-financing of the projects, in order to evaluate the multiplier of EU regional policy.

***The dataset includes several outcome and control variables at the level of NUTS-2 regions***

The sources of our data are Eurostat and, in some periods, Cambridge Econometrics. These sources are broadly compatible, coming from the same national information. The data on the regional growth outcomes used in the analysis were obtained: from Eurostat for the GDP and GVA figures for the 2000-11 period; and from Cambridge Econometrics for the 1991-1999 GDP and GVA figures and the gross fixed capital formation and employment rate figures for the entire 1991-2011 period. Because, at the time of the empirical investigation, no reliable source of regional growth data was available beyond 2011, all analyses are capped at that year.

The data on the regional characteristics used as control variables in the analysis were provided by Eurostat, supplemented where necessary by data from Cambridge Econometrics, and they include the following information: employment (6 sectors), percentage of 25-64 year-olds with tertiary education, population (total and the share of population aged 65 and over), land size and population density.

In parts of our analyses we exclude from the sample four NUTS 2 regions whose initial level of per capita GDP was above 75 per cent of EU average, but were included in Ob. 1 for 'political reasons': Prov. Hainaut (BE), Corse (FR), Molise (IT), Lisboa (PT). For robustness of the results, in some models, we also

***For the RDD analysis we selected a restricted sample that includes the regions closest to the discontinuity threshold*** dropped two regions that were outliers in terms of the intensity of the 1994-2006 EUF<sup>1</sup>.(

For the RDD analysis we selected a restricted sample, which includes the regions closest to the discontinuity. Such sample is composed by 152 regions, 40 "treated" and 112 "non-treated".

## MAIN RESULTS

***A preliminary issue is how to measure the intensity of the geographic allocation of EU Funds (EUF)***

A preliminary issue addressed in our analyses is how to measure the intensity of the geographic allocation of the EU Funds (EUF). A normalisation is needed: The method used by the Commission for apportioning the resources to each Member State is mainly based on a financial allocation per inhabitant per year. For this reason, the average population of the NUTS-2 regions at the beginning of the programming period seems a "natural" normalisation variable. However, the initial GDP level has also been used (Mohl and Hagen, 2010; Becker et al., 2012). For this reason we replicated part of our analyses using both measures of EUF intensity.

***For the Eu-15, 1994-06 period, the RDD results show an impact of +0.7 percentage points (p.p.) in terms of annual per-capita GDP growth due to the higher intensity of EUF in the Obj1/Convergence regions***

The main result of this study is that the positive and statistically significant impact of EUF on regional growth is confirmed. In the case of the fully specified RDD model, over the period 1994-2006, in the EU 15 regions, the impact of receiving the higher average intensity of the Obj1/Convergence regions is equal to +0.7 percentage point (p.p) in the annual growth of per-capita GDP. This is compared to a counterfactual status of receiving the lower average intensity of the non-Obj1/non-convergence regions. In Pellegrini et al. (2013), with a different model specification, such average impact is equal to +0.9 (p.p.), close to our preferred RDD estimate. When we normalize the EUF intensity in terms of share of the initial (1994) GDP, our impact estimates are in the order of 1.1% of 1994 GDP.

***Similar results are produced by the PSM models: from +0.3 to +1.0 (p.p.) in terms of annual growth of per-capita GDP***

The results from the PSM models are similar, with impact estimates ranging from +0.3 to +1.0 percentage points in the annual growth of per-capita GDP caused by the higher average EUF intensity of the Ob.1/Convergence regions.

***However, the RDD results show that the positive impact of the EUF intensity on the growth of Objective 1 regions is decreasing the higher are the regional transfers***

However, the RDD results show that the positive impact of the EUF intensity on the growth of the Ob. 1 regions is decreasing the higher are the regional transfers. Eventually, the impact becomes negligible after a certain threshold of EUF intensity. Thus, the data suggest that the NUTS-2 regions with lower levels of EUF show a bigger impact on GDP per head of increases in EUF intensity than the NUTS-2 regions with higher levels of EUF. After a certain intensity threshold, additional EUF transfers are not, on average, associated with significantly higher regional GDP growth.

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<sup>1</sup> These two regions are Aragón in Spain (non-Objective 1/Convergence area) and Dytiki Makedonia in Greece (Objective1/Convergence area). The criterion for outliers is to have received funds above the average of their respective group (Objective1/Convergence or Non-Objective 1/Non-Convergence regions) plus 2.5 times the standard deviation.

***Positive impact of EUF on employment growth but not on GDP per person employed***

The RDD results also show a positive, statistically significant, and decreasing impact of EUF on the growth of regional GVA and the employment rate but not on the growth of GDP per person employed.

***The PSM results from the EU-27 analysis, 1994-2011 period, show an impact from +0.5 to +0.7 percentage points of annual per-capita GDP growth***

When the analysis is extended to the EU-27 regions and to all the three last programming periods (up to the year 2011), both the RDD and the PSM analyses require different model specifications. These specifications combine the three periods and include a different number of NUTS-2 regions in each period.

***PSM impacts on Gross fixed capital formation and employment rate changes are also positive but not statistically significant***

The PSM results from such enlarged EU-27 analysis show that the higher average EUF intensity of the Ob.1/Convergence regions causes an increase of the annual growth of per-capita GDP from +0.5 to +0.7 percentage points (as compared with the counterfactual status of receiving the lower average intensity of the non-Ob.1/non-convergence regions).

***The RDD results from the EU27 analysis, over the 1994-2011 period, show that the impact of the EU funds is almost halved, compared to the EU-15 analysis, 1994-06.***

For the gross fixed capital formation (annual per-capita growth) and the employment rate (annual change), the PSM impact estimates are also positive (+0.5 - +1.1 percentage points, and about +0.1 percentage points, respectively), though they are not statistically significant.

Similar results are estimated by the RDD model applied to the same EU-27 extension of the analysis. The impact of the higher EUF intensity on the Objective 1/convergence regions is positive but not statistically significant. However, adding into the analysis the last programming period, where the economic crisis is evident, has a substantial effect on the EUF impact, which is almost halved to +0.4 percentage points per year.

## CONDITIONS OF EFFECTIVENESS

***Counterfactual impact evaluations (CIE) of the EU Funds (EUF) on regional growth is challenging***

The counterfactual impact evaluation (CIE), at the NUTS-2 regional level, of the differential impacts of the varying EU-Funds (EUF) intensities on regional growth outcomes poses great challenges and faces the following data limitations.

***Multiple data-availability limitations are in place***

No comprehensive and consistent database, is available to summarize at the NUTS-2 level, the specific amounts of EUF devoted to the different types of programme interventions and/or investment projects implemented by each member-state over the three programming periods examined here. In other words, it is not possible to identify how much funding in each region went, for example, to business support as opposed to environmental or social infrastructure. The exact timing of the specific project implementations is also unknown. In addition, no comprehensive information is available on the intensities of the public aids from national and regional sources that may affect the NUTS-2 growth outcomes, together with the EUF.

***NUTS-3 level analyses faces severe data-reliability issues Due to the multiple data limitations, CIEs cannot offer conclusive evidence***

Moreover, only a limited number of NUTS-2 regions with comparable pre-intervention socio-economic scenarios, but different intensities of EUF, are available to the analysis. To overcome this limitation, elsewhere in the literature, the analysis has focused on the NUTS-3 regional level (which entails larger sample sizes). Apportioning at the NUTS-3 level the data on the EUF payments is however much less reliable: in many cases the EUF figures for the NUTS-3 areas would be the results

***Small sample sizes of NUTS-2 regions with comparable pre-intervention socio-economic scenarios, but different intensities of EUF***

of mere estimates based on some arbitrary apportioning criteria (such as population or GDP). Even more importantly, at the NUTS-3 level, the potential for relevant spill-overs into neighbouring areas is much greater than at the NUTS-2 level. For example, this could be the case of the EUF support to transportation and/or social infrastructures in the NUTS-3 areas of outward commuting that would also benefit the growth in neighbouring areas.

All of the above data limitations are binding for any type of comprehensive CIE analysis. Thus, also in our case, the empirical analysis cannot aim at offering conclusive evidence on the exact conditions under which the different intensities of the EUF produce desirable regional growth outcomes.

***An improved data availability scenario is needed for producing more specific empirical evidence***

In order to remove such limitation a much-improved data availability scenario is needed. In this regard, it can be recommended to make steps toward the possibility of linking the currently available database on the EUF payments with the detailed information on the single programmes submitted by the member-states (in terms of: scope and nature of the project; exact geographic location, amounts of national/regional co-funding).

***EU regional policy cannot be evaluated only with respect to GDP growth***

A richer dataset is also needed if the counterfactual evaluation wants to tackle the issue of the multifaceted outcome of the EU regional policy. Currently, GDP growth is just one of the many dimensions of EU regional policy, that is oriented to reduce economic and social disparities across European regions. Therefore effects on GDP are important but cannot exhaust the purpose of the EUF intervention.

***A robust empirical evaluation of the last programming period (2007-2013) calls for additional data (beyond the year 2011)***

Finally, we need additional information (beyond the year 2011) for a more robust empirical analysis of the last programming period (2007-2013), where the heterogeneity across regions is higher, due to the presence of new Member States and the largest economic crisis in Europe since WWII was in action. The empirical findings for this programming period will have to be confirmed when the complete data become available.

## LESSONS LEARNED FROM THE ANALYSIS

***EU Funds (EUF) have a significant role in stimulating regional growth and economic development.....***

The findings of this evaluation show that the EU Funds (EUF) have a significant role in stimulating regional growth and economic development. Our impact estimates indicate that the higher average intensity of the EUF in the Ob.1/Convergence regions generates a positive effect on various regional growth outcomes, compared to the counterfactual status of the lower average EUF intensity of the non-Ob.1/non-Convergence regions. These impacts are in line with the results of other studies cast in a counterfactual framework.

***...although, the marginal impact on regional growth of further increasing the intensity of the EUF seems to be higher for the regions that do not already receive an high intensity of the EUF***

Another important lesson that can be drawn from our results is that the marginal impact on regional growth of further increasing the intensity of the EUF tends to be higher on average for the regions that do not already receive a high intensity of the EUF. In other words, the marginal impact on growth of adding more EUF intensity tends to decrease for the regions with high EUF intensities. A great deal of caution, however, should be exerted in interpreting these results as

supportive of the hypothesis that diminishing returns to investment and/or limited absorption capacities may be in place to hamper the full economic-development potential of the high intensities of the EUF transfers.

***Because of the diversity of the objectives related to the EUF, and due to data limitations, caution should be exerted in drawing strong policy conclusions from the empirical evidence of the diminishing marginal impacts of the EUF***

This is for the following two reasons. First, the EUF transfers may have also other objectives apart from regional growth. Portions of the high EUF intensity of certain regions may be devoted to fulfil such diverse objectives, leading to a violation of the linearity in the relationship between EUF intensity and growth. Second, in regional-level counterfactual impact evaluation studies (CIE), like ours, the bulk of the empirical evidence comes from cross-sectional variation of the EUF intensities across the different regions. Variations of the EUF intensity within a same region are instead much more limited, as they are observed only across the three past programming periods. For this reason the analysis has to face the challenge that the regions with high EUF intensities could be the most problematic ones, where the effect on growth would be less than elsewhere for any given level of EUF. Our CIE analysis, through both the RDD and the PSM approaches, aims at controlling for such potential differences between regions, producing impact estimates that indicate the net impact of the varying EUF intensity, holding constant every other regional characteristic (i.e. mimicking the results of an experiment in which the impacts of the EUF are estimated by mean of comparing the growth outcomes of regions with different levels of funding but identical characteristics). In this study, however, only a small sample of NUTS-2 regions are close the cut-off of the Objective 1/Convergence eligibility (for RDD) and some regional features are unobservable in the available data (e.g. administrative and geo-physical characteristics, for PSM). For these reasons we cannot empirically confirm that a full balancing is perfectly achieved in our analysis between the regions with different levels of EUF intensity with regard to the characteristics that are not included in the data. This circumstance warrens further caution in extrapolating strong policy conclusions from the empirical evidence obtained within the data currently available.

***Further investigation of other important conditions under which the different intensities of the EUF produce desirable regional growth outcomes requires more information and data***

Moreover, the strong limitations in the current data-availability scenario on the EUF payments do not enable any type of CIE analysis, including ours, to further investigate other important conditions under which the different intensities of the EUF produce desirable regional growth outcomes. These conditions are, for example, the different compositions and scopes of the actual programme interventions, the duration of the project implementations (which may affect the temporal lag needed to observe the regional growth outcomes), and the intensities of the national or regional sources of public aids that may affect the regional growth outcomes in conjunction with the EUF.

***Linking the currently available EUF database with detailed information on the single programmes could be useful***

In order to overcome such data limitations it could be advisable to explore the possibility of linking the currently available EUF database with the detailed information on the single programmes submitted by the member-states for the EUF payments, as explicitly considered in WP13.

From our comparative analyses of the two main methodological approaches that are suitable for regional-level impact evaluations, the following lessons can be drawn. Both

***Both Propensity score matching (PSM) and Generalised propensity score (GPS) models, on the one hand, and Regression Discontinuity designs (RDD), on the other hand, have an important role in the impact evaluation of the EUF on regional growth.***

Propensity score matching (PSM) and Generalised propensity score (GPS) models, on the one hand, and Regression Discontinuity designs (RDD), on the other hand, have an important role in the impact evaluation of the EUF on regional growth. RDD is typically a preferable choice because it exploits local randomness conditions near the cut-off ( $k$ ) of the intensity assignment rule and does not require to explicitly measure and observe all the pre-intervention regional heterogeneity. In this respect, when the aim of the analysis is to estimate the varying impacts of a continuous variation of the EUF intensities, particularly relevant is the novel methodological development produced in this study that extends the RDD framework to the case of continuous treatments. In the presence of small samples of regions near the cut-off ( $k$ ) of the intensity-assignment rule, however, the PSM-GPS models are a very viable option to ensure the balancing of the relevant control variables and a greater efficiency of the estimates.

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