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Article

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What is the return on investing European Regional Development and Cohesion Funds? Difference-in-differences Estimator Approach[1]

*Mindaugas BUTKUS – Alma MAČIULYTĖ-ŠNIUKIENĖ – Kristina MATUZEVIČIUTĖ – Diana CIBULSKIENĖ**

Abstract

One of the ultimate goals of investing EU structural funds is to strengthen economic and social cohesion. Aiming to formulate and/or adjust funds allocation policy, it is crucial to find out whether previous investments had a positive return, i.e. the goal to diminish disparities has been achieved. This paper aims to supplement the empirical evidence of previous contributions in a few ways: (i) the analysis is based on NUTS 3 level data and different expenditure categories of various EU structural funds; (ii) the impact evaluation strategy relies on difference-in-differences estimator; and (iii) the effect is estimated on the dynamics of regional GDP disparities rather than on regional GDP growth. The research results revealed that all investments combined did not contribute to the reduction of regional disparities. The analysis of separate fund shows ambiguous results. The analysis of single expenditure category suggests that investment in productive environment and basic infrastructure had positive return and investing in human resources did not have significant effect.

Keywords: *European Regional Development Fund (ERDF), Cohesion Fund (CF), regional disparities, convergence, NUTS 3, difference-in-differences estimator*

JEL Classification: O47, O52, R11, R12, R15, R58

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Introduction

One of the main challenges for the European Union (EU) as a group of countries is economic and social disparities among regions. The European Commission (EC), paying special attention to the solution of this problem, set the reduction of existing economic and social imbalances between regions as one of the ultimate EU's Regional Policy strategic goals. EC was (and still is) reaching this goal by investing into the regions through Structural Funds (SF), especially through European Regional Development Fund (ERDF) and Cohesion Fund (CF). Many studies are trying to answer whether these investments had the expected return, i.e. whether the ERDF and CF support strengthen the cohesion of EU regions and corrected initial imbalance among them.

Previous studies (Mohl and Hagen, 2010; Becker et al., 2010; Pellegrini et al., 2013; Rodriguez-Pose and Novak, 2013; Coppola and Destefanis, 2015; Pellegrini, 2016; Becker et al., 2018, etc.) examining effect of 2000 – 2006 programming period have revealed that Cohesion Policy (CP) is effective and SF transfers had a positive impact on EU regions' economic performance. However, previous studies have several constraints. The first is that authors generally investigate returns on SF support examining its impact on the dynamics of macroeconomic indicators such as growth or employment. The results of studies that analyse outcome variables linked to growth or employment do not reveal the impact on regional convergence i.e. on more balanced territorial development, despite the fact that regional cohesion is the main objective of the EU CP, which is implemented through the ERDF and CF. We found only few studies (Kutan and Yigit, 2007; Kyriacou and Roca-Sagales, 2012; Piętak, 2018) examining the impact of ERDF and CF support over 2000 – 2006 on the dynamics of regional disparities. However, these studies are limited on scope because they are covering only NUTS 2 level regions in separate countries or test convergence just between countries.

In general, the effect of SF support over 2000 – 2006 is mainly evaluated at NUTS 1 and 2 level (except Fratesi and Perucca, 2014 and Gagliardi and Percoco, 2017), while recent studies (Bourdin, 2015; Hegerty, 2016; Butkus et al., 2018) show that the main problems of convergence over the last decade occur at NUTS 3 level. The possible reason of growing disparities between regions at NUTS 3 level is that EU Regional Policy is mainly focused on NUTS 2 and does not deal sufficiently with the problems within NUTS 2 regions what might cause an explosion of imbalances due to agglomeration effects. Therefore, it remains unclear whether SF support achieves EU Regional Policy goal to diminish disparities, especially at NUTS 3 level.

Studies by Mohl and Hagen (2010), Fratesi and Perucca (2014) and Pontarollo (2017), etc. have identified that effect of SF transfers hinges on expenditure

category and that some SF expenditures have no significant or even negative effect. For example, authors (Hagen and Mohl, 2008; Mohl and Hagen, 2010; Becker et al., 2010; 2013; Pellegrini et al., 2013; Dotti, 2016; Di Cataldo, 2017; Gagliardi and Percoco, 2017) analysing Objective 1, 2, and 3 payments find a positive impact on economic growth as these payments are directed to support social and economic development of lagging regions. On the other hand, the research by Coppola and Destefanis (2015) finds negative impact of the European Agricultural Guidance and Guarantee Fund (EAGGF) and the European Social Fund (ESF) on capital growth and ESF expenditures on employment growth. Research by Pontarollo (2017) that comprises funds for Objectives 1 and 2, CF, Urban and Interreg IIIA revealed the positive and strongly significant effect on investments in human capital and a negative but weakly significant effect on investment in infrastructure. Hence, SF support effect on growth as well as on convergence may depend on the expenditure category and intervention area.

In the light of revealed limitations of previous studies, our research aims to examine the impact of ERDF and CF transfers (considering separate Objectives and expenditure categories) over 2000 – 2006 programming period on disparities among NUTS 3 regions.

Our impact evaluation strategy relies on difference-in-differences estimator, two ERDF and CF treatment identification strategies and alternative post-policy periods. Data for the research on NUTS 3 disaggregation level covers all EU-25 regions.

The rest of the paper is structured as follows: the First Section covers a brief retrospective review of empirical investigations concerning the effects of the EU SF support over 2000 – 2006 programming period. Section 2 introduces aims and objectives of EU structural funds – ERDF, CF as well as other two – INTERREG III and URBAN II over 2000 – 2006 programming period to distinguish programs and expenditure categories primary allocated to diminish disparities among regions. Section 3 describes the research methodology, estimation/identification strategy and data. Section 4 presents the estimation results. The last section concludes the paper summarizing findings and limitations of the research.

1. Literature Review

Considering the importance of the CP, great attention in previous scientific studies and EC reports is paid to the evaluation and analysis of SF and CF returns. However, previous investigations do not fully disclose whether CP is effective. Table 1 summarises findings of previous research that covered programming period of 2000 – 2006. These studies most often examine the impact of SF support

on economic growth, measured as a change in per capita gross domestic product (GDP), productivity and/or employment in EU Member States (MS) at NUTS 1 and/or 2 regional level (Hagen and Mohl, 2008; Mohl and Hagen, 2010; Becker et al., 2010; Varga and Veld, 2010; Becker et al., 2013; Bouayad-Agha et al., 2013; Pellegrini et al., 2013; Rodriguez-Pose and Novak, 2013; Pinho et al., 2015a; 2015b; Rodriguez-Pose and Garcilazo, 2015; Dotti, 2016; Maynou et al., 2016; Pellegrini and Cerqua, 2016; Pellegrini, 2016; Di Cataldo, 2017; Pontarollo, 2017; Becker et al., 2018; Piętak, 2018).

Analysis of the abovementioned studies (see Table 1) revealed that SF and CF impact on regional economic growth is heterogeneous and this heterogeneity depends on various factors. First of all, it might depend on support receiving region *absorptive capacity and development level.* For example, Becker et al. (2013) examining impact of Objective 1 payment on economic growth in 251 EU-25 regions revealed that positive effect occurred in only about 30% of these regions characterised by a high absorption capacity. The treatment effect for regions with a very low level of absorption capacity is insignificant. Rodriguez-Pose and Novak (2013) evaluated impact of Objectives 1, 2, 5b and 6 conjunct payments on economic growth in a sample of 133 NUTS 1 and 2 regions and found that SF payments, in general, have a significant positive effect on growth, but greater effect manifests in more developed countries and in wealthier regions. It is in line with Becker et al. (2013) and Pinho et al. (2015a) findings which state that more developed countries are typically characterized by a high level of absorptive capacity. Pinho et al. (2015a) found that SF positively contributes to growth in 92 NUTS 1 and 2 regions of EU-12, but effect is higher in richer, highly-educated and more innovative regions. Contradictory results provided in the parallel study (Pinho et al., 2015b) are worthy of attention. Using a bigger sample of NUTS 1 and 2 regions (137 regions of EU MS, except Bulgaria and Romania) over the same 1995 – 2009 period, authors found that SF had a positive and significant impact on real per capita income only in regions with low levels of human capital and innovation. The similar results are indicated in the study by Gagliardi and Percoco (2017). Using data on 1233 NUTS 3 EU-10 and EU-15 regions, they revealed that SF expenditure had a positive effect on economic growth in lagging regions in which level of human capital and innovation is usually relatively low. Study concluded that this effect is mainly noticeable due to the successful performance of rural regions located near the main urban agglomerations. It suggests that the findings by Pinho et al. (2015b) and Gagliardi and Percoco (2017) are contrary to the traditional theoretical approach, according to which a higher level of human capital is associated with higher effectiveness of public spending.

Another factor that can influence SF effects is *government quality (also called as institutional quality)*. Rodriguez-Pose and Garcilazo (2015) evaluated SF and CF effects on economic growth in 169 NUTS 1 and 2 regions and found that SF and CF investment contributes to improving per capita GDP growth in EU regions, but the strength of the effect is influenced by government quality. Another interesting finding of the study is that government quality is a vital factor for the effectiveness of SF and CF investment when these investments have reached a certain level, suggesting that direction of support-growth relationship is conditioned on government quality. Dotti (2016) examined SF payment effects on NUTS 2 regions in France, Italy and Spain and on NUTS 1 regions in Germany and the UK and concluded that SF support can lead to regional economic growth, but it depends on the effective distribution of SF, that is linked to political behaviour which is related to government quality. Assessing the relationship between SF distribution, expressed by SF intensity differential index and productivity growth in regions of individual countries, Dotti (2016) found a strong positive correlation in Germany, average in Spain, strong and negative correlation in the UK. Statistically significant correlation in Italy was not found. Results of the study generalize negative strong correlation between SF distribution and regional per capita GDP, i.e. the increase of the SF payment intensity leads to the decrease in economic outcomes. Relationship between SF and CF returns and institutions quality is also identified by Kyriacou and Roca-Sagales (2012) who state that institutional quality is a key factor fostering or hindering the return on the EU's regional financial support.

Some authors linked return of SF support to the *transfer intensity*. Non-linear relationships between the SF treatments intensity and economic growth is identified by Becker et al. (2010), Pellegrini and Cerqua (2016) as well as Pellegrini (2016). Becker et al. (2010) conclude that an optimal transfer intensity is 0.4 percent of target regions GDP and a maximum desirable intensity – 1.3 percent.
Estimated return on SF and CF support might depend on whether the impact of one or several types in conjunct of payments by *Objectives* is assessed, since different Objectives payments can lead to different effects on regional growth. Hagen and Mohl (2008) investigating impact of Objective 1, 2 and 3 payments on EU-12 regional (NUTS 2) growth using panel data over 1995 – 2005 period revealed that SF has positive but statistically not significant effect. Mohl and Hagen (2010) also found that 2000 – 2006 Objectives 1, 2 and 3 payments in conjunction had no statistically significant effect on the growth rate in 126 NUTS 1 and 2 regions. But their study revealed that Objective 1 payments positively contributed to economic growth in EU regions. Significant and positive effect of Objective 1 payments on NUTS 1 and 2 regional growth is also identified by

Becker et al. (2010), Becker et al. (2013), Bouayad-Agha et al. (2013), Pellegrini et al. (2013), Dotti (2016), Di Cataldo (2017), Becker et al. (2018) and Piętak (2018). However, estimated positive effect is accompanied by some reservations and conditions: regional development level which is linked to absorptive capacity (Becker et al., 2013); outcomes variables (Becker et al., 2010; Becker et al., 2018); research model used (Pellegrini et al., 2013); effective distribution of SF, that is linked to political behaviour (Dotti, 2016). Di Cataldo (2017) highlighted that even if CP contributes to regions' economic growth "these outcomes may not be persistent, and may quickly disappear after the end of the period of high--intensity support".

It should be noted that Coppola and Destefanis (2015) determined that return on SF transfers depends not only on Objectives but also *on the type of the fund.* They identified that the strongest impact has the ESF (positive on productivity growth and negative on capital accumulations and employment). EAGGF transfers negatively affect all analysed variables. Pontarollo (2017) examining the case of the 202 EU-12 regions revealed that SF support effect depends *on intervention area.* Study shows positive impact of infrastructure expenditures on growth of gross value added (GVA) per worker and a weakly negative impact on per capita GDP growth. Moreover, expenditure on human capital has a positive impact on per capita GDP growth but has no significant effect on GVA per worker growth.

Analysis of research which focuses on CP effects by Objectives, types of fund or intervention area revealed that estimated return on SF support depends as well on the *outcome variable* considered by the study. Coppola and Destefanis (2015) evaluated impact of 1989 – 2006 SF payments on productivity growth, capital accumulation and employment in 20 Italian administrative regions and found that SF had weak, but significant impact on total factor productivity changes, but did not have an impact on capital accumulation and employment. Becker et al. (2010) analysing SF effects on per capita GDP and employment growth in EU-25 NUTS 2 and 3 regions over 1989 – 2006 also conclude that SF has no statistically significant effect on employment growth. Becker et al. (2018) using longer period (1989 – 2013) data on NUTS 2 regions found contradictory results. Their study revealed that SF have positive significant effect not only on per capita GDP growth, but also on employment growth. SF transfers effect on investments and on public investments were identified as insignificant.

The studies investigating SF and CF effects at NUTS 3 level, however, are rear. We found just two studies of this kind which involve 2000 – 2006 programing period. Fratesi and Perucca (2014) examined the impact of the SF support on economic growth at NUTS 3 level covering only Central and Eastern European

(CEE) countries which joined the EU in 2004. They were focussing on ERDF and CF and evaluated the effect of expenditures over 2004 – 2006 on GDP growth rate during 2006 – 2010. Authors also tested the assumption that effectiveness of SF support may depend on regional territorial capital, which includes regional market potential, infrastructure, tourist accommodation facilities, stock of private capital, urban/rural typology, etc. Research results revealed that "regional policy is not so much effective per se but its impact depends on the type and amount of territorial capital possessed by the region". SF support appeared to be more effective in regions which accumulated more territorial capital. Another study covering 2000 – 2006 period at NUTS 3 level, mentioned above, was carried out by Gagliardi and Percoco (2017) who found positive effect of SF expenditures on economic growth just in lagging regions.

Analysed studies reach common conclusion that CP positively contributes to regional economic growth, but it is necessary to clarify that effect hinges on SF intervention area, fund and other conditioning factors. Furthermore, although many previous studies have shown the positive impact of SF and CF transfers on regional economic growth, this does not necessarily mean that the objectives of EU CP have been fully achieved. Even regions that received support have developed, this does not necessarily lead to a decline in social and economic disparities between regions. We found only few studies (Kutan and Yigit, 2007; Kyriacou and Roca-Sagales, 2012; Piętak, 2018) examining the impact of SF and CF support over 2000 – 2006 on regional disparities. However, these studies are limited in scope, and their results cannot be treated as general. A study by Piętak (2018) covers 17 NUTS 2 regions of Spain. A study by Kutan and Yigit (2007) covers 5 EU countries and study by Kyriacou and Roca-Sagalés (2012) – 14 EU countries and both investigate SF support effect on convergence between countries. All three studies found positive SF effect on convergence, but in the case of Spain regions' impact is insignificant. It is also worth mentioning that Maynou et al. (2016) analysed SF and CF impact on EU-17 NUTS 2 regional growth and separately evaluated convergence between countries. They identified conditional convergence and in parallel positive effect of SF on regional economic growth. Taking into account these results, authors conclude that SF have positively contributed to per capita GDP growth in receiving regions thus allowing countries to reach convergence. Nevertheless, this can only be considered as a presumption, as convergence may have been caused by other factors.

Literature review revealed that there are no studies that would examine the return on SF payments in the light of regional disparities at NUTS 3 level. Thus, it remains unclear whether ERDF and CF support contributed to achieving EU Regional Policy goal of convergence, especially at NUTS 3 level. In general,

analysis of the previous studies allows to state that in order to correct CP aiming more effective SF allocation, it is necessary to clarify SF effects not only on economic growth but also on regional convergence taking into account treatment intensity, CP Objectives and expenditure categories at NUTS 3 disaggregation level.

2. Aims and Objectives of ERDF and CF

The central priority of CP is to remove the barriers of growth in the EU lagging regions. To achieve this goal, the lagging regions need to get additional EU support for creation of growth conditions, to strength their industrial base, to close the infrastructure gap in transport, energy, human capital, education and research (Samecki, 2009).

EC during the period of 2000 – 2006 was reaching this goal by investing into the regions through two SF: ERDF and ESF, and as well as through CF. Every EU region had a possibility to get support from ERDF and ESF. However, CF support was granted only for less developed regions.

The legal obligation in the EC (1957) to reduce economic disparities motivated the creation of the Cohesion Policy (European Parliament, 2017) when ERDF was launched. Even though the ESF and the EAGGF has existed since 1958, the creation of the ERDF marks the birth of the Cohesion Policy (Allen, 2005; Medve-Balinti, 2018). Beside these financial instruments, which are usually referred to as SF, another important building block of the policy is the CF. This fund was established in 1994, the aim of this fund was to provide funding for large environmental and transport infrastructure projects in those member states where per capita GNI was below 90% of the EU average (Medve-Balinti, 2018).

EU funds are allocated to a variety of policies and interventions: from the support for private firms to the building of transport infrastructure etc. (Fratesi and Perucca, 2014). ERDF and CF have specific aims, but they are closely related to each other. The aims are very general for all or specific EU Member States and regions, but the detailed aims of each priority and target indicators are detailed and specified in EU MS or regional funding programmes, according to the economic and social situation in each country or region.

Analysing how EU SF priorities have changed over time, we can state that in the first financing periods 1994 – 1999 and 2000 – 2006 the priorities of funding were oriented to promote the development and structural adjustment of lagging regions (NUTS 2 level), to support the social and economic conversion of regions with structural difficulties (NUTS 3 level), to support the modernisation and adaptation of systems and policies of employment, education and training.

Table 1

The Estimated Effect of SF and CF Investments over 2000 – 2006 Programming Period: Summary of Retrospective Studies

Researchers	Period	Fund	Sample size and level of regions	Objective	Research method*	Outcome variable	Main results
Kutan and Yigit, 2007	1980 – 2004	SF, CF	5 EU-15 countries, Country-level	not specified	Structural brake test	Economic growth and convergence	SF and CF transfers have significant positive impact on convergence in short-run and on overall growth due to capital accumulation
Hagen and Mohl, 2008	2005 – 2006	SF	NUTS 2 regions in EU15	1, 2, 3	Generalized propensity score	Economic growth	SF had positive but statistically not significant effect on growth
Mohl and Hagen, 2010	2000 – 2006	CF	126 NUTS 1 and NUTS 2 regions	1, 2, 3	FE, RE, GMM estimator	Economic growth	Obj. 1 payments promoted regional economic growth, but total amount of Obj. 1, 2 and 3 payments had no statistically significant impact on growth rate.
Becker et al., 2010	1989 – 1993 1994 – 1999 2000 – 2006	SF	193 – 285 NUTS 2 and 1015 – 1213 NUTS 3 regions of EU-25	1	DID-RDD	Economic and employment growth	Obj. 1 transfers had positive and significant effect on per capita GDP growth but there are no effect on employment growth.
Varga and Veld, 2010	2000 – 2006	SF, CF	NUTS 2, except NUTS 1 of Belgium, Germany, Netherlands, UK	1 and 2 in Germany and Italy	DSGE model with semi-endogenous growth	Economic growth	CP positively contribute economic growth in less developed regions. This effect become stronger in the medium and long run.
Kyriacou, Roca-Sagalés, 2012	1995 – 2006	SF, CF	14 EU countries, Country-level	not specified	FGLS, SUR	Convergence	Positive impact on convergence and depends on the level of transfer intensity/
Becker et al., 2013	1989 – 1993 1994 – 1999 2000 – 2006	SF	186-251 NUTS 2 regions of EU-25	1	A fuzzy RDD + HLATE	Economic growth	Positive impact on economic growth only on about 30% of the regions. The treatment effect is insignificant for regions with a low level of absorptive capacity.
Bouayad-Agha et al., 2013	1980 – 2005	SF	143 NUTS 1 / NUTS 2 regions of EU-14	1	GMM estimator	Economic growth	Positive impact on economic growth, especially Objective 1 programmes.
Pellegrini et al., 2013	1994 – 1999 2000 – 2006	SF, CF	NUTS 2 regions of EU-15	1	RDD	Economic growth	CP had a positive impact on economic growth, but estimated effect varies depending on model Yearly effect varies from 0.6% to 0.9%.
Rodriguez-Pose and Novak, 2013	1994 – 1999 2000 – 2006	SF	133 NUTS 1 / NUTS 2 regions of EU MS	1, 2, 5b and 6 in conjunction	Heteroscedasticity-robust FE	Economic growth	SF payments in general have significant positive impact on regional growth. Greater effect manifests in more developed countries and in wealthier regions.
Tomova et al., 2013	1980 – 2010	SF, IF	EU-27, Country level	not specified	Two stage OLS, FE	Socio-economic development	SF and IF together had positive impact on socio-economic development, but effect depends is conditioned on macroeconomic environment.

Accetturo et al., 2014	2000 – 2006	SF	NUTS 2 regions	1	RDD	Local endowments of trust and cooperation	The transfers reduce local endowments of trust and cooperation.
Fratesi and Perucca, 2014	2004 – 2006	ERDF, CF	NUTS 3 regions of 10 CEE countries	not specified	OLS	Economic growth	Regional policy is not much effective per se, but effectiveness depend on "territorial capital".
Coppola and Destefanis, 2015	1989 – 2006	SF (EAGGF, ERDF, ESF)	20 Italian administrative regions	not specified	FE	Productivity growth, capital accumulation and employment	SF had a weak, but significant impact on total factor productivity changes, but didn't have an impact on capital accumulation and employment. Effects depend on type of funds.
Pinho et al., 2015a	1995 – 1999 2000 – 2006 2007 – 2009	SF	92 NUTS 1 and NUTS 2 regions of EU-12	not specified	Growth model by FE	Economic growth	Positive impact on economic growth. The returns of SF is higher in richer, highly-educated and more innovative regions.
Pinho et al., 2015b	1995 – 2009	SF, CF	137 NUTS 1 and NUTS 2 regions of EU MS (except Bulgaria and Romania)	not specified	Growth model by FE	Economic growth	SF had a positive significant impact on real per capita income only in regions with low levels of human capital and innovation.
Rodriguez-Pose and Garcilazo, 2015	1996 – 2007	SF, CF	169 European NUTS 1 / NUTS-2 regions	not specified	Two-way FE	Economic growth	Positive impact on regional economic growth, but that above a threshold of cohesion expenditure and government quality
Dotti, 2016	2000 – 2006	SF	NUTS 2 regions of France, Italy and Spain; and NUTS 1 of UK and Germany	1	Correlation analysis	Economic and productivity growth	SF support can lead to regional economic growth and productivity growth, but it depends on the effective distribution of SF, that is linked to political behaviour.
Maynou et al., 2016	1990 – 2010	SF, CF	174 NUTS 2 regions of EU-17	not specified	Spatio-temporal econometric model	Economic growth and convergence	Funds have positively contributed to the GDP per capita growth of receiving regions, thus allowing them to reach (conditional) convergence
Pellegrini and Cerqua, 2016	1994 – 1999 2000 – 2006 2007 – 2013	SF, CF	208 NUTS 2 regions of EU-15	not specified	CC analysis and RDD model	Economic growth	Positive effect on economic growth. However, the effect depends on the intensity of transfers.
Pellegrini (EC report), 2016	1994 – 1999 2000 – 2006 2007 – 2013	SF, CF	263 NUTS 2 regions of EU-27	not specified	RDD	Economic growth	SF (expressed as ERDF plus ESF) and CF taken together have positive effect on regional growth. However, the effect depends on the intensity of transfers. Moreover, the effect for EU15 regions is lower comparing with EU27.
Di Cataldo, 2017	1994 – 1999 2000 – 2006 2007 – 2013	SF	208 NUTS 2 regions of EU-15	1	CC analysis and RDD model	Economic growth and unemployment	Positive impact on reduction of unemployment and on the promotion of economic growth, but this effect depends on funding intensity.
Gagliardi and Percoco, 2017	2000 – 2006	SF	257 NUTS 2 and 1233 NUTS 3 regions of EU-15 and EU-10	1	A fuzzy RDD	Economic growth	SF expenditures had positive effect on economic growth in lagging regions. However, this effect is mainly noticeable due to the successful performance of rural regions located near to the main urban agglomerations.

Pontarollo, 2017	2000 – 2006	SF	202 regions of EU-15	1, 2, CF, Urban and Interreg IIIA. 3 in conjunction	Semi-parametric model	Economic growth, productivity	SF support effect depends on intervention area. Expenditure on infrastructure had positive impact on GVA per worker growth, but had a weakly negative impact on per capita GDP growth. Expenditure on human capital had positive impact on per capita GDP growth, but did not had significant impact on GVA per worker growth.
Becker et al., 2018	1989 – 1993 1994 – 1999 2000 – 2006 2007 – 2013	SF	NUTS 2 regions	1 + convergence objective	A fuzzy RDD	Economic, employment growth, investment	SF transfers had positive impact on regional per capita GDP growth and employment growth, but effect on investment and public investment was insignificant.
Piętak, 2018	1989 – 2016	SF	17 NUTS 2 regions of Spain	1	The first difference GMM	Economic growth and convergence	Positive impact on economic growth. SF impact on convergence is positive but insignificant.

Note: *FE – Fixed effect; RE – Random effect, OLS – Ordinary least squares, HLATE – Heterogeneous local average treatment effects, GMM – Generalized method of moments, RDD – Regression discontinuity design, DID-RDD – Difference-in-difference regression discontinuity design, DSGE – Dynamic stochastic general equilibrium, FGLS – Feasible General Least Squares, SUR – Seemingly Unrelated Regression, CC analysis – Counterfactual causal analysis.

Source: Composed by authors.

All priorities were realised through some specific funds: (i) Objective 1 – ERDF, ESF and EAGGF; (ii) Objective 2 – ERDF and ESF; (iii) Objective 3 – ESF. In the next two funding periods (2007 – 2013 and 2014 – 2020) the priorities changed from financing of infrastructure, employment and social issues, to issues of economic growth, improvement of human resources quality and to promotion of research, technological development and innovation, to enhance access to and quality of information and communication technologies, to enhance the competitiveness of small- and medium-size enterprises (SMEs) and to support the shift towards a low-carbon economy in all sectors for achieving the main goal of EU: the strengthening of EU competitiveness. Over the current funding period (2014 – 2020) definition of EU funding has been changed from SF to ESI – European Structural and Investment funds. In the period of 2014 – 2020 the main goals compared to 2007 – 2013 have changed from convergence, regional competitiveness and employment to investments for growth and jobs. It shows the change of EU funding concept which currently is related to the implementation of Europe 2020 strategy goals.

Our research aims to evaluate whether priority of 2000 – 2006 funding period to enhance convergence was achieved, therefore description of SF is oriented to the main goals over this period.

ERDF during 2000 – 2006 was intended to help eliminate the main regional imbalances in the EU; therefore, it should have contributed reducing the gap between the regions of various development levels and the least-favoured regions and islands, including rural areas. ERDF should have contributed to social and economic regeneration of cities and urban neighbourhoods in crisis under the EU initiatives as well as to financing cross-border, transnational and interregional cooperation.

Cohesion Fund. All the regions of Objective 1 of the EU Member States with a GDP of less than 90% of the EU average were supported by a special solidarity fund called CF. It financed only the transport and environmental infrastructure projects, as well as technical support projects, including publicity and information campaigns. The CF financed projects only in some EU Member States in 2000 – 2004, it was namely Greece, Portugal, Ireland and Spain. The majority of their territory was covered by Objective 1. Only a few Objective 2 regions in Spain received assistance from the CF, which co-finances environmental protection and transport projects. Since 2004, new EU member states have been included: the Czech Republic, Estonia, Cyprus, Latvia, Lithuania, Hungary, Malta, Poland, Slovenia and Slovakia. The CF was allocated to countries rather than to regions (Fratesi and Perucca, 2014). In the period between 2000 and 2006, total resources available for commitments for Ireland, Greece, Portugal

and Spain were EUR 18 billion, and additional total resources available for commitments for Cyprus, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Slovakia and Slovenia in the period from the date of accession to 2006 were EUR 7.6 billion (Council regulation: establishing a Cohesion Fund, 2006).

INTERREG III is an EU initiative which aim was to stimulate interregional cooperation in the EU in 2000 – 2006. INTERREG III was the part of the ERDF. This phase of the INTERREG initiative was designed to strengthen social and economic cohesion across the EU, by fostering the balanced development of Europe through: (i) *cross-border cooperation* for developing cross-border social and economic centres through common development strategies; (ii) *transnational cooperation* by involving national, regional and local authorities to promote better integration within the EU by creating the large groups of European regions; and (iii) *interregional cooperation* by creating networks for improving the effectiveness of regional development policies and instruments through large-scale information exchange and sharing of experience. Particular attention has been paid to the integration of remote regions, which share external borders with the candidate countries. INTERREG III was made from three priorities and had a total budget of EUR 4.875 billion.

Urban II is the EU Initiative of the ERDF for sustainable development in the troubled urban districts for the period 2000 – 2006. The aim of Urban II was to promote the design and implementation of innovative development models for the social and economic regeneration of troubled urban areas. The programming documents during the period 2000 – 2006 of the regions eligible for priority Objectives 1 and 2 comprised integrated measures of social and economic development covering many urban areas. Through an integrated territorial approach, these measures should have contributed to the balanced development or conversion of the regions concerned. Furthermore, the measures financed under Objective 3 should also have strengthened social cohesion in the towns not covered by Objectives 1 and 2.

The common objectives of all financial support expenditure categories: (i) productive environment – financing of assisting SMEs, research and development and large businesses, of development telecommunications and the information society; (ii) human resources – financing of education and training, social inclusion decisions; (iii) basic infrastructure – financing of transport infrastructure, energy and the environment, partly reflecting the CF's support to the latter, environment and environmental expenditure in enterprises, social infrastructure (generalised information from Ex post evaluation of cohesion policy programmes 2000 – 2006, 2009).

The total public funds of the period 2000 – 2006 allocated to the programmes under consideration amounted to 313.8 billion EUR, of which 185.5 billion EUR were from SF and 128.3 billion EUR – from sources of national governments. The ERDF covered 122.8 billion EUR of the total expenditure: for Objective 1 programmes EUR 100.9 billion (82% of the total) and for Objective 2 – EUR 21.8 billion. 66% of the programmes in the EU-25 were of a regional nature, especially in EU15 countries – 74%. However, in the EU-10 most programmes were mostly sectoral (93%). Assessing the situation in different Objectives, it can be found, that: in the EU-10 were no regional programmes in Objective 1 regions; in the EU-15 countries most Objective 1 programmes were regional (except in Portugal and Ireland, where most programmes were sectoral, in Italy, Spain and Greece was a fairly even split between regional and sectoral programmes); in Objective 2, almost all programmes in EU-15 countries and most in the EU-10 were regional (Ex post evaluation of cohesion policy programmes 2000 – 2006, 2009).

3. Methodology and Data

The concern in our paper is to measure the intervention effect that EU's ERDF and CF had on regional disparities in terms of per capita GDP. We are aiming to measure the impact of all as well as of separate fund and expenditure category on the outcome. Because at a particular moment in time, each region is either under the particular intervention or not, but not both, there is no evaluation problem since we are able as well to observe the outcome variable for regions that were not affected by the intervention. There is a lot of literature describing development of the impact evaluation methods (for example: Khandker et al., 2010 and Gertler et al., 2016). Documented methods used in empirical economics for impact evaluation, following these references, can be grouped into seven categories, each of which provides an alternative strategy to construct the counterfactual.

The first one is the true randomised experiment. Being the most decisive method of evaluation due to control group (constructed as a random subset of the eligible population), experiments according to Blundell and Costa (2000) still have some drawbacks: (i) their implementation is expensive and thus they are quite rare in economics; (ii) experiments are not pervious to extrapolation beyond the population at hand and because of that cannot be easily used to propose new policy interventions; (iii) they require that control group would be completely unaffected by the policy intervention and thus rules out possible spillover effects (for the earliest developments on true randomised experiments, see for example, Cochrane and Rubin (1973), Fisher (1951), Bassi (1983; 1984) as

well as Hausman and Wise (1985) for the literature on the experimental data advantages).

The second widely used evaluation method is 'difference-in-differences' (DiD). Within the framework of this approach, an intervention itself is considered as an experiment, and the power of the method depends on finding a naturally emerging contrast group that could imitate (as best as possible) the features of the control group. It is constructed by comparing the difference in average outcome before and after the intervention for the treatment group with before and after contrast for the benchmark group. This approach can be used to estimate the average effect of the intervention on those regions which received funding (or those regions 'treated' by the policy), thus measuring the average effect of the treatment on the treated (Blundell et al., 1998). Following Khandker et al. (2010), the main advantage of DiD is that this evaluation method does not require to assume for conditional exogeneity or selection only on observed characteristics. It also allows to account for selection of unobserved characteristics. The main drawback, however, is that DiD requires to assume time-invariant selection bias.

The other five methods are the following: (i) the propensity score matching method (see Heckman et al. (1997) for overview of literature on this method) constructs a statistical comparison group that is based on a model of the probability of participating in the treatment, using observed characteristics; (ii) the selection method developed by Heckman (1979) relies on an exclusion restriction, which requires a variable that determines participation in the programme but not the outcome of the programme itself. In contrast to matching, which can be considered as 'selection on the observables', the selection method accounts for selection on the unobservables; (iii) the structural simulation method (see Blundell and MaCurdy (1999) for an overview of literature on this method) closely related to the selection method when behaviour can be reasonably modelled by some rational choice framework; (iv) instrumental variable method allows for endogeneity in individual participation, program placement, or both. With panel data, this method can allow for time-varying selection bias (see Khandker, 2006); and (v) regression discontinuity method uses program eligibility rules as instruments for exogenously identifying participants and nonparticipants and allows observed as well as unobserved heterogeneity to be accounted for (see Khandker et al., 2010).

Except in the case of true experiment, assignment to treatment would most probably be not random. Non-random assignment process would likely lead to some correlation between enrolment in the programme and the error term if equation is based on simple cross-sectional data. This is because decision for

regional funding is likely based on region's characteristics that might affect the policy target variable as well. If this is true, and we are unable (most likely) to simultaneously control all the factors affecting policy target variable and decisions to assign to treatment, then we should expect non-zero correlation between the error term and the participation variable. In this case, the econometric approach based on single cross-sectional data, which regress policy target variable on a set of regressors (including assignment to treatment), would not be valid. For the application of DiD estimator, we need at least one pre-policy set and one post-policy set of observations. If repeated cross-sectional data (panel data) is available, it is possible to estimate the treatment effect consistently without imposing abovementioned restrictive conditions (i.e. removing unobservable individual effects and common macro effects). However, this method relies on the two critically important assumptions of *common time effects across groups* and *no composition changes within each group*.

The selection of evaluation methods depends on a few criteria: (i) the nature of the intervention; (ii) the nature of the question to be answered and (iii) the nature of the available data. Having intervention on 'global' scale, aiming not just to estimate the effect of treatment on the treated but also to extrapolate findings to a new policy intervention and working with available repeated cross--sectional data, we believe the most suitable method DiD.

In case of homogeneous effect, DiD estimator can be constructed as:

$$\delta_1 = \left(\overline{gdp_{T,t2}} - \overline{gdp_{C,t2}}\right) - \left(\overline{gdp_{T,t1}} - \overline{gdp_{C,t1}}\right) \tag{1}$$

where $gdp_{T,t2}$ – 5-year average of per capita GDP over *post-policy period* for the region in *treatment group,* $gdp_{C,t2}$ – 5-year average of per capita GDP over *post-policy period* for the region in *control group,* $gdp_{T,t1}$ – 5-year average of per capita GDP over *pre-policy period* for the region in *treatment group* and $gdp_{C,t1}$ – 5-year average of per capita GDP over *pre-policy period* for the region in *control group*. Bar above variables indicates group average.

We use 5-year averages rather than data on yearly basis in the research to mitigate the problem that estimates based on annual data are dependent on business cycle fluctuations as well as because effect of policy intervention could appear with a lag. DiD estimator can be estimated and its significance tested running regression model:

$$\log\left(gdp_i\right) = \beta_0 + \delta_0 \,.\, t2 + \beta_1 \,.\, dT_i + \delta_1 \,.\, t2 \,.\, dT_i + \varepsilon_i \tag{2}$$

where $t2$ is dummy that is equal to 1 for *post-policy period* and equal to 0 for *pre-policy period*. dT_i – dummy that is equal to 1 if region belongs to the *treatment*

group and equal to 0 if belongs to the *control group*. β_0 is equal to average of regional per capita GDP 5-year averages (in form of natural logarithm) over *pre-policy period* in *control group*, i.e. $\overline{\log(gdp_{C,t1})}$. δ_0 is equal to $\overline{log\left(gdp_{C,t2}\right)} - \overline{log\left(gdp_{C,t1}\right)}$ and shows the average growth of regional per capita GDP 5-year averages in the *control group* over *post-policy period* compared to *pre-policy period*. β_1 is equal to $\overline{log\left(gdp_{T,t1}\right)} - \overline{log\left(gdp_{C,t1}\right)}$ and shows what was the average difference of regional per capita GDP 5-year averages between *treatment* and *control groups* over *pre-policy period*. δ_1 is DiD estimator (homogeneous impact of treatment on region) that shows how difference of regional per capita GDP 5-year averages between *treatment* and *control groups* changed over *post-policy period* compared to *pre-policy period*.

It is important to control other factors that explain a variation of regional per capita GDP. We would like to stress here that a shortage of data on common factors at NUTS 3 level motivates us to proxy them using regional typologies and local information what is quite usual in growth models (see Paas et al., 2004; Paas et al., 2007; Cardoso and Pentecost, 2011; Folfas, 2016; Kramar, 2016; Butkus et al., 2018) considering small scale territories. On the other hand, relying on the advantages of panel data, i.e. the same cross-sectional unit (region) appears over pre-policy and post-policy period, we can minimise the number of regressors by differencing the data over two periods and getting rid of any time constant effects. Equation (2) is augmented including controls c_j as – region industry mix (period-average share of value added created in agriculture, industry and services); capital region dummy, costal region dummy, port dummy; urban and rural dummies (intermediate region is set as a benchmark type) and 24 country dummies (Germany is set as a benchmark country) to account for different level of development:

$$\ln\left(gdp_i\right) = \beta_0 + \delta_0 \,.\, t2 + \beta_1 \,.\, dT_i + \delta_1 \,.\, t2 \,.\, dT_i + \sum_{j=1}^{k} \gamma_j \,.\, c_j + \varepsilon_i \qquad (3)$$

An important question when evaluating the impact of an intervention is whether we can assume homogeneous or heterogeneous treatment effects. We cannot expect that all regions will respond to a policy intervention in exactly the same way because the amount of the treatment is not constant across regions. That is, there will be heterogeneity in the impact across regions as well. Since regions belonging to the treatment group cannot be treated equally in terms of treatment amount, thus alternatively we will estimate DiD estimator for heterogeneous effect interacting *dT* with funding (treatment) intensity *Tint* (dedicated funds over 2000 – 2006 divided by GDP over the same period). If a region did not receive

funding, *dT* and *Tint* as well as their interaction are all equal to zero. If a region received funding *dT* is equal to one and its interaction with *Tint* is equal to *Tint*. Thus to estimate the effect of treatment intensity we can substitute *dT* with *Tint*:

$$\ln(gdp_i) = \beta_0 + \delta_0 \,.\, t2 + \beta_1 \,.\, Tint_i + \delta_1 \,.\, t2 \,.\, Tint_i + \sum_{j=1}^{k} \gamma_j \,.\, c_j + \varepsilon_i \qquad (4)$$

In contrast to estimators based on single cross-sections, no exclusion restrictions are required for the DiD estimator. However, it calls for strong restrictions on common trends and error composition that directly related to two main weaknesses of the DiD approach: (i) Lack of controls for unobserved temporary regional-specific conditions that influence the assignment to the treatment group. Even if using repeated cross-sectional data we are able to control the before-after comparability of the groups and hold the assumption that the composition of the groups remain the same over time, a faster GDP growth is expected to occur among the treated, even without policy intervention (due to convergence hypothesis we expect that growth of less developed regions (which probably will be under policy intervention) will be faster). Thus the DiD estimator is likely to overestimate the impact of intervention. (ii) The second one is related to the macro effect that has a non-constant impact across the two groups. This happens when the treatment and comparison groups have some (possibly unknown) characteristics that distinguish them and make them react differently to common macro shocks. Both weaknesses motivate us to alternatively use the differential-trend-adjusted difference-in-differences estimator (DTA DiD) proposed by Bell et al. (1999).

Our research is based on the data that covers all NUTS 3 level regions except for Romania, Bulgaria and Croatia, i.e. EU-25. The data used for the research is described in Table A1 (see Appendix A[2]). Since the programming period of 2000 – 2006 is under investigation, we used data over 1995 – 1999 for pre-policy period. Despite the $n + 2$ (EU Member States could spend the last allocation available until the end of 2008) and $n + 3$ (Central and Eastern EU Member States until the end of 2009) rules, 2007 – 2011 and 2008 – 2012 were considered as two alternative 5-year post-policy periods. The choice is grounded on two arguments: (i) since the absorption capacity increased progressively when the end of the programming period approached, effects of regional support could start to manifest already before spending all available allocation and (ii) considering later years as post-policy period could comprise effects of the support over the next programming period that started in 2007. Thus our post-policy periods

[2] Appendix A and B are available at: <http://www.su.lt/images/1_MOKSLAS_IR_MENAS/Projektai/Online_Appendix_A_and_B.pdf>.

start after 7 – 8 years from the launch of the 2000-2006 programming period, cover 2 – 3 years after the end of spending last allocation available and still intervene into first 5 – 6 years of 2007 – 2013 programming period. Table A2 (see Appendix A[2]) reports the division of regions into treatment and control groups according to different funds and expenditure categories. This division is made according to SWECO (2008) final report on ERDF and CF regional expenditure which provides data at NUTS 3 level and enables to assign regions into groups that received support according to particular fund and expenditure category. Table A2 provides the main descriptive statistics on funding intensity over policy intervention period as well.

4. Estimation Results

The estimation results regarding control variables are as expected and in line with the previous research on explaining the differences of regional per capita GDP (Rodríguez Pose and Novak, 2013; Pihno et al., 2015a; Becker et al., 2018). The size of estimated coefficients does not vary much from estimation to estimation, i.e. switching from 2007 – 2011 to 2008 – 2012 post-policy period or moving from DiD to DTA DiD estimator (see Tables in Appendix C[3]).

As the previous research highlighted, a higher share of agricultural sector is associated with lower per capita GDP and in contrary – more developed industry and service sectors in the region positively correlate with per capita GDP. The negative effect of agricultural sector is quite big in magnitude – a share of this sector bigger by one percent is on average associated with 2.1 – 2.4 percent lower per capital GDP. The positive effects of service and industry sectors are much lower – 0.4 – 0.5 and 0.6 – 0.9 percent, respectively. All these estimated effects are highly significant setting the construction sector as the benchmark sector. Per capita GDP in the regions where countries' capital cities are located is on average higher by 32 – 35 percent already controlling regional urban-rural typology. This is an evidence of huge positive agglomeration effect on economic activity and regional per capita GDP. Coastal regions seem to be more lagging behind compared with inland, but those having a port have an advantage. According to estimations, the positive effect of port offsets negative effect of costal location.

Table 2 presents estimated parameters on DiD and DTA DiD that directly correspond to the return on investing SF allowing to answer the question – what funds and expenditure categories contributed to the reduction of regional per capita GDP imbalances at NUTS 3 level for two alternative post-policy periods.

[3] Appendix C is available at:
<http://www.su.lt/images/1_MOKSLAS_IR_MENAS/Projektai/Online_Aappendix_C.pdf>.

T a b l e 2

Estimates of DiD and DTA DiD Based on Equations (3) and (4) for Two Alternative Post-policy Periods

Fund/expenditure category (exp. cat.)	Post-policy period 2007 – 2011				Post-policy period 2008 – 2012			
	Estimated DiD parameter		*Estimated DTA DiD parameter*		*Estimated DiD parameter*		*Estimated DTA DiD parameter*	
	(a)	(b)	(a)	(b)	(a)	(b)	(a)	(b)
All funds and all exp. cat.	–0.0178 (0.0273)	–0.0068 (0.0124)	–0.0177 (0.027)	–0.0102 (0.0124)	–0.0186 (0.0274)	–0.0146 (0.0124)	–0.0196 (0.0276)	–0.0199 (0.0124)
1. ERDF Objective 1 (all exp. cat.)	0.0610*** (0.0228)	–0.0232 (0.0152)	0.0596*** (0.0228)	–0.0290* (0.0152)	0.0571** (0.0229)	–0.0355** (0.0152)	0.0543** (0.0230)	–0.0438*** (0.0153)
1.1. Productive environment	0.0593*** (0.0228)	–0.0460 (0.0515)	0.0579** (0.0228)	–0.0567 (0.0516)	0.0554** (0.0228)	–0.0697 (0.0518)	0.0526** (0.0230)	–0.0881* (0.0521)
1.2. Human resources	–0.0247 (0.0277)	–0.4653 (0.5495)	–0.0394 (0.0277)	–0.6191 (0.5499)	–0.0529* (0.0278)	–0.7707 (0.5518)	–0.0643** (0.0279)	–0.9553* (0.5545)
1.3. Basic infrastructure	0.0560** (0.0228)	–0.0343* (0.0208)	0.0546** (0.0229)	–0.0426** (0.0208)	0.0520** (0.0229)	–0.0521** (0.0208)	0.0492** (0.0230)	–0.0639*** (0.0209)
1.4. Miscellaneous	0.0540** (0.0239)	–1.3000** (0.6219)	0.0516** (0.0239)	1.6361*** (0.6217)	0.0480** (0.0240)	–1.9867*** (0.6230)	0.0431* (0.0241)	–2.3281*** (0.6252)
2. ERDF Objective 2 (all exp. cat.)	–0.0446** (0.0218)	–0.0409** (0.1800)	–0.0440** (0.0219)	–0.0408** (0.1801)	–0.0430* (0.0220)	–0.0399** (0.1808)	–0.0422* (0.0220)	–0.0394** (0.1818)
2.1. Productive environment	–0.0452** (0.0219)	–0.4899* (0.2571)	–0.0446** (0.0219)	–0.4781* (0.2573)	–0.0436** (0.0220)	–0.4578* (0.2582)	–0.0428* (0.0221)	–0.4378* (0.2596)
2.2. Human resources	0.0363 (0.0299)	4.2009 (3.6857)	0.0353 (0.0299)	3.9843 (3.6896)	0.0355 (0.0301)	4.0821 (3.7050)	0.0358 (0.0302)	4.2781 (3.7259)
2.3. Basic infrastructure	–0.0475** (0.0222)	–1.0393** (0.4493)	–0.0464** (0.0222)	–1.0637** (0.4497)	–0.0454** (0.0223)	–1.0762** (0.4514)	–0.0451** (0.0225)	–1.1028** (0.4537)
2.4. Miscellaneous	–0.0267 (0.0228)	–7.4526* (4.3959)	–0.0277 (0.0229)	–7.6156* (4.4000)	–0.0281 (0.0230)	–7.6983* (4.4166)	–0.0288 (0.0231)	–7.8243* (4.4405)
3. Cohesion fund (all exp. cat.)	0.0927*** (0.0292)	0.1104*** (0.0397)	0.0926*** (0.0292)	0.1139*** (0.0397)	0.0892*** (0.0291)	0.1139*** (0.0398)	0.0864*** (0.0291)	0.1158*** (0.0400)
3.1. Productive environment								
3.2. Human resources								
3.3. Basic infrastructure	0.0927*** (0.0292)	0.1103*** (0.0400)	0.0926*** (0.0292)	0.1136*** (0.0400)	0.0892*** (0.0291)	0.1133*** (0.0401)	0.0864*** (0.0291)	0.1149*** (0.0403)
3.4. Miscellaneous	0.1688*** (0.0374)	3.6744* (1.8798)	0.1919*** (0.0374)	4.3987** (1.8801)	0.2107*** (0.0375)	4.9182*** (1.8861)	0.2266*** (0.0377)	5.8065*** (1.8946)

4. ERDF Urban (all exp. cat.)	0.0627	–0.5924	0.0604	–0.6713	0.0572	–0.7502	0.0516	–0.9312
	(0.0439)	(1.6051)	(0.0439)	(1.6067)	(0.0441)	(1.6129)	(0.0443)	(1.6217)
4.1. Productive environment	0.0553	–0.2182	0.0536	0.0363	0.0510	0.3800	0.0450	0.3119
	(0.0479)	(7.8170)	(0.0480)	(7.8247)	(0.0482)	(7.8556)	(0.0484)	(7.8986)
4.2. Human resources	0.0670	0.3003	0.0646	0.4219	0.0618	0.5725	0.0571	0.1389
	(0.0467)	(11.918)	(0.0467)	(11.929)	(0.0469)	(11.9749)	(0.0471)	(12.0396)
4.3. Basic infrastructure	0.0567	–1.0172	0.0539	–1.1773	0.0505	–1.3479	0.0445	–0.4137
	(0.0449)	(2.1938)	(0.0450)	(2.1959)	(0.0452)	(2.2042)	(0.0454)	(1.5716)
4.4. Miscellaneous	0.0381	–11.7064	0.0351	–13.3756	0.0315	–14.6943	0.0247	–17.6912
	(0.0458)	(26.3927)	(0.0458)	(26.4181)	(0.0460)	(26.5196)	(0.0462)	(26.6632)
5. ERDF INTERREG IIIA (all exp. cat.)	0.0074	–0.2473	0.0080	–0.2649	0.0069	–0.2965	0.0072	–0.3472
	(0.0229)	(0.2664)	(0.0229)	(0.2667)	(0.0230)	(0.2675)	(0.0231)	(0.2688)
5.1. Productive environment	0.0074	–0.1961	0.0080	–0.1308	0.0069	–0.0874	0.0072	–0.08835
	(0.0229)	(0.5973)	(0.0229)	(0.5979)	(0.0230)	(0.6000)	(0.0231)	(0.6032)
5.2. Human resources	0.0138	0.7935	0.0156	1.0614	0.0155	1.1462	0.0169	1.0526
	(0.0230)	(4.3542)	(0.0230)	(4.3584)	(0.0231)	(4.3744)	(0.0232)	(4.3977)
5.3. Basic infrastructure	0.0074	–0.6839	0.0080	–0.7882	0.0069	–0.9180	0.0072	–1.0749**
	(0.0229)	(0.4910)	(0.0229)	(0.4913)	(0.0230)	(0.4927)*	(0.0231)	(0.4949)
5.4. Miscellaneous	0.0078	–1.6353	0.0084	–1.7781	0.0072	–2.112	0.0074	–2.6948
	(0.0229)	(3.2862)	(0.0229)	(3.2889)	(0.0230)	(3.2994)	(0.0231)	(3.3151)
Productive environment (all funds ERDF + CF)	–0.0188	–0.0687	–0.0186	–0.0784	–0.0196	–0.0903	–0.0206	–0.1080
	(0.0271)	(0.0514)	(0.0272)	(0.0515)	(0.0273)	(0.0517)*	(0.0275)	(0.0519)**
Human resources (all funds ERDF + CF)	0.0090	–0.3473	0.0055	–0.4951	0.0014	–0.6364	–0.0014	0.8109
	(0.0219)	(0.5373)	(0.0219)	(0.5376)	(0.0219)	(0.5394)	(0.0220)	(0.5419)
Basic infrastructure (all funds ERDF + CF)	–0.0224	–0.0042	–0.0215	–0.0085	–0.0224	–0.0140	–0.0240	–0.0205
	(0.0257)	(0.0156)	(0.0257)	(0.0156)	(0.0258)	(0.0156)	(0.0260)	(0.0157)
Miscellaneous (all funds ERDF + CF)	–0.0025	–0.9356	–0.0045	–1.1621**	–0.0072	–1.4239**	–0.0104	–1.6525***
	(0.0253)	(0.5748)	(0.0253)	(0.5745)	(0.0254)	(0.5756)	(0.0255)	(0.5774)

Notes: Columns (a) report treatment effects estimated based on Equation [3]; columns (b) report treatment intensity effects estimated based on Equation [4]. Robust standard errors are reported in parentheses. *, ** and *** indicate statistically significant at the 10%, 5% and 1% levels, respectively. Table reports just estimated parameters on DiD and DTA DiD retrieved from estimations presented in Appendixes. Table A3 in Appendix B[2] mirrors Table 2 and could be used as an index to find corresponding estimation in Tables A4 – A11 in Appendix C[3]. Testing whether the development of per capita GDP is parallel in treatment and control groups over the 5-year pre-intervention period (see Table A2 in Appendix A[2]) revealed that we need to adjust for growth trend differentials. For example, considering all funds and all expenditure categories average growth rate of regional per capita GDP at constant prices over 1995 – 1999 was 2.36% and 2.62% for control and treatment groups, respectively. The difference in growth trends was used for the adjustment.

Source: Composed by authors.

The estimations show that all funds (ERDF + CF) and all expenditure categories combined did not positively contribute to the reduction of regional imbalances at NUTS 3 level in terms of per capita GDP. Despite the fact that all estimated coefficients are negative (what correspond to negative effect, i.e. contribution to growth of disparities) they are insignificant at standard significance level. The estimation shows that average per capita GDP in treated regions (1007 in total) over 1995 – 1999 was at 9.0 – 9.5 percent lower than in control group (244 regions in total) and this initial difference was not significantly reduced over post-policy period.

The estimations on particular funds show that ERDF Objective 1 (all expenditure categories combined) treatment positively contributed to reducing regional imbalances. The initial difference of per capita GDP at about 22 percent between treatment (414 regions) and control (837 regions) groups over pre-policy period was reduced on average to 16 percent over post-policy period. Positive effect becomes insignificant or (in some estimations) even negative effect starts to manifest if we use treatment intensity variable instead of treatment dummy. Our finding is in line with the results of Kyriacou and Roca-Sagales' (2012) investigation which revealed that SF tend to reduce within-country regional differences in terms of per capita GDP but excessive intensity of funding tends to raise regional disparities. Thus, it can be concluded that SF between 2000 and 2006 manifested misallocation effects and too high levels of transfers diminished potential positive return of SF. Similar results have been obtained by Dotti (2016) who analysed Objective 1 NUTS2 regions in France, Italy and Spain and NUTS1 regions in Germany and the UK. Research revealed that the increase of the SF payments' intensity leads to a decrease in economic outcomes in terms of per capita GDP and productivity (GDP per employee). According to Pellegrini's (2016) findings, "the positive impact of the intensity of treated NUTS 2 regions is decreasing and it becomes statistically negligible after a certain threshold".

Analysing estimations with single expenditure category of ERDF Objective 1 it becomes clear that not all expenditure categories equally contributed to reducing regional differences in per capita GDP. The estimations with treatment dummy show that Productive environment, Basic infrastructure and Miscellaneous expenditures had a positive return. The initial differences between treatment and control groups we reduced by approximately 5 – 6 percentage points comparing post-policy and pre-policy periods. Estimated parameter on DiD with treatment intensity suggests that expenditures on those three categories had a negative (or at best no) effect on regional imbalances at NUTS 3 level potentially implying that treatment intensity was too high. In most of the estimations

we did not find any positive (in two estimations we found statistically significant and negative) effect of investing in Human resources on diminishing regional differences. This finding contradicts the results obtained by Pontarollo (2017), according to which SF investment in Human resources has a significant and positive impact on per capita GDP and GVA per worker growth in most of EU-15 regions. His investigation also revealed that SF investments to infrastructure have a positive impact on GVA per worker growth in less developed regions and a weak negative impact on the per capita GDP and GVA per worker growth in the most developed regions. Contradictions to our results could be due to differences in regional level under considerations as well as due to the applied method.

The estimations with ERDF Objective 2 treatment (all expenditure categories) show that average per capita GDP in treatment group (539 regions in total) was at about 4 – 4.5 percent higher than in control group (712 regions) over pre-policy period and estimated difference is statistically significant. It suggests that ERDF Objective 2 funding was directed to NUTS 3 regions with relatively bigger on average per capita GDP. Nevertheless, estimated coefficients on DiD are negative implying that initial differences reduced over post-policy period. This finding has twofold insight: (i) ERDF Objective 2 treatment had a negative effect on per capita GDP in treated regions, but (ii) having in mind that treated regions had bigger per capita GDP this treatment reduced initial disparities. The estimations with treatment intensity show quite the same results.

Expenditures for Productive environment and Basic infrastructure in the framework of ERDF Objective 2 were directed to NUTS 3 regions with relatively higher per capita GDP. As the estimations with single expenditure category show treated regions over pre-policy period had on average 4.0 – 4.5 percent bigger per capita GDP compared with control group. As in case of all expenditures combined, estimated parameter on DiD is negative and statistically significant suggesting that treatment had negative effect on GDP growth in treated regions, but reduced gap between treated and control regions in terms of per capita GDP. On contrary, expenditures on Human recourses were directed to the regions that had on average 5.0 percent lower per capita GDP compared with regions in control group over pre-policy period, but estimated DiD parameter unambiguously show that treatment had positive but not statistically significant effect.

The estimations of return on investing CF (all expenditure categories) revealed that a group of treated regions (245 in total) had on average by 9 – 11 percent higher per capita GDP compared with regions in control group (1006 in total) over pre-policy period. Estimated DiD parameter being positive in all estimations strongly suggests that CF investments had a negative return in terms of regional disparities, but on the other hand – increased per capita GDP in treated

regions on average by 9 – 11 percent and this effect is the highest of all analysed funds. The negative correlation between per capita GDP over pre-policy period and treatment intensity over policy period in the estimates with treatment intensity reflects the core of the policy – to support regions lagging behind. It means, that despite the fact, that treated regions had higher per capita GDP than not treated, relatively more CF expenditures were directed to regions with lower per capita GDP among treated. Estimated positive parameter on DiD with treatment intensity show that more treated regions grew faster compared with less treated, but it does not change the fact that CF in general increased disparities at NUTS 3 level because not treated regions were less developed. The analysis of single expenditure category – Basic infrastructure of CF – shows quite the same picture, because the majority of CF was directed to this purpose.

DiD estimates on return of ERDF Urban and ERDF INTEREG IIIA investment are statistically insignificant (analysing combined as well as on single expenditure category). This finding suggests that these investments had no effect on diminishing regional disparities at NUTS 3 level. The estimates also show that per capita GDP in group of treated regions over pre-policy period was not significantly different from per capita GDP in control group.

The estimates of return on investing in Productive environment (ERDF + CF combined) are insignificant. Despite the fact that average per capita GDP in treated regions was lower by 9.5 percent compared with control group over pre-policy period, investments in Productive environment did not significantly contribute to the reduction of regional disparities at NUTS 3 level. The same conclusion could be drawn from estimates on the return on investing into Human recourses, Basic infrastructure and Miscellaneous investments from ERDF and CF combined, contrary to what we found analysing single funds. This, once again, shows that the same group of expenditures from various SF can have a way different effect on disparities dynamics.

The robustness of our estimates is assured by the fact that the results remained similar switching from 2007 – 2011 to 2008 – 2012 post-policy periods as well as using two alternative DiD and DTA DiD estimators.

Conclusions

The question whether support of ERDF and CF promoted harmonious development, strengthened cohesion of EU regions and corrected initial imbalance among them, i.e. investment had a positive return are widely discussed in scientific literature and still remains relevant. Review of scientific literature on the EU's regional support over 2000 – 2006 programming period revealed a variety

of results. According to previous studies, SF and CF transfers may lead to positive, negative or no impact on regional macroeconomic indicators. This heterogeneity of the results depends on (i) research methodology; (ii) diverse sample of regions and heterogeneity of funds covered by studies; (iii) SF expenditure category and intervention area; (iv) conditions in the regions (especially related to the level of human capital and institution quality). Literature review also revealed the main limitations of retrospective studies: (i) most of the investigations on SF and CF return do not consider lagged effect; (ii) studies generally include regions at NUTS 1 and 2 level, although dynamics of spatial imbalance at EU level more and more depends on what is happening between regions at NUTS 3 level; (iii) authors mostly investigated the impact of SF and CF support on economic performance, ignoring the impact on regional disparities, although this is one of the main goals of the EU CP.

Our estimation methodology is based on DiD, which relatively recently started to be used to evaluate impact of EU CP. Constructing the methodological framework to examine the return on EU SF transfers over 2000 – 2006 programing period we made an attempt to overcome limitatins of previous contributions in a few ways: (i) the analysis covers all eligible regions over programming period of interest, and remaining regions were used to form a control group, thus eliminating that 'selection' of particular group of regions could have an effect on estimation results; (ii) the research is based on data at NUTS 3 level, which previously was scarcely analysed; (iii) the analysis of intervention is broken down to single fund and separate expenditure categories taking in mind previous findings that not all funds and expenditure categories have the same effect; (iv) we examined the effect of policy intervention on post-policy period. In this way, we considered possible lagging effect and estimations avoided 'dummy' effect of transfers on regional GDP; and finally (v) our study focused on examining the effect of ERDF an CF transfers on the dynamics of regional disparities, which is an ultimate goal of EU CF, rather than on regional growth.

The estimation results for all funds and all expenditure categories combined confirm the previous research that there is no positive or negative return on investing SF if all expenditures and funds are considered together. It suggests that at the aggregate level the goal of EU CF to reduce the differences between regions was not fully reached.

The main aim of ERDF Objective 1 was to narrow the gap between the development levels of the various regions. The estimation for ERDF Objective 1 (all expenditure categories combined) shows that there is a positive return on investing SF and in general the aim was reached. The results indicate that CP had a positive impact on the decreasing gap between various regions. Our

estimations also confirm previous studies that there is a maximum treatment intensity exceeding which funding starts to have negative effect, The estimation results for single expenditure category of ERDF Objective 1 showed that not all expenditure categories equally contributed to reducing regional differences in terms of per capita GDP. It should be mentioned, that regions covered by Objective 1 primarily were regions corresponding to NUTS 2, and this can be one of the reasons why the aim of Objective 1 for different expenditure categories was not reached at NUTS 3 level.

The aim of Objective 2 was to support the economic and social conversion of NUTS 3 level areas facing structural difficulties but funds were directed to regions with higher per capita GDP. The estimation results for ERDF Objective 2 (all expenditure categories) show, that treatment had a negative effect on per capita GDP in eligible regions, but having in mind that treated regions initially had higher per capita GDP this treatment reduced initial disparities. Estimations with treatment intensity show quite the same results. This finding suggests that the aim of Objective 2 in all expenditure categories was not fully realized.

The aim of CF support was oriented only for the lagging regions to finance the large environmental and transport infrastructure projects and was more at country not region level. The estimation results for CF investments show that these investments had a negative return in terms of regional disparities – treated regions had on average higher per capita GDP than not treated, but relatively more CF expenditures were directed to regions with lower per capita GDP among treated. The regions that were treated more grew faster compared with less treated, but it does not change the fact that CF in general increased disparities at NUTS 3 level because not treated regions were less developed. The CF investments have not led to a different and self-sustainable development path, not reduced the differences between regions. In this case the aim of CF was not really and fully realised.

The estimates on the return of investing ERDF Urban and ERDF INTEREG IIIA funds are statistically insignificant, analysing combined as well as on single expenditure category, but aims of these funds were not directly oriented to the reducing differences among EU regions.

The estimates of the return on investing ERDF and CF combined to support Productive environment, Human recourses, Basic infrastructure and Miscellaneous expenditures groups are insignificant. It suggests that in general investments in these expenditure groups did not significantly contribute to the reduction of regional disparities at NUTS 3 level, contrary to what we found analysing expenditure categories for single fund. This, once again, shows that the same group of expenditures from various SF can have a way different effect on dynamics of disparities.

The estimation results in general show that the effectiveness of EU funding over 2000 – 2006 was mostly short-lived. The effects produced by EU regional policy were not long-lasting; rather they disappeared when the funding period has ended, especially when implemented financing projects were short-lasting with fading away effect in the long-run.

Our study has some limitations that could be addressed in further research. We did not control all factors that explain variation of regional per capita GDP, because data at NUTS3 level is rather scarce and thus we did not rule out the possibility that to some extent the results could be affected by omitted variable bias. The effect of policy intervention could be more delayed and some effects we did not find not because they do not exist, but because they will appear over longer period. The same assumption could be made to some of the effects that already appeared during policy intervention period and are not detectable over post-policy period. The heterogeneity of the intervention effect could be conditioned on other factors not considered in the research, for example, the quality of institutions in the region. As a proxy for funding intensity alternatively could be used per capita funding and considered as the non-linear effect of funding intensity on GDP growth in a form of inverted U-shape. The overlapping of the funding (treatment) according to different expenditure categories and funds could have led to not to some extent precise estimation of the intervention effect of a particular program. Overcoming of this problem calls for the development of alternative DiD estimator that would allow a multiple control and treatment groups. These and other possible limitations of the research could be considered as directions for future research on ERDF and CF convergence effects.

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