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Table of contents

2. Spatial spillovers and Cohesion Policy effectiveness: an ex-post evaluation for NUTS-3 Italian regions

3. An empirical evaluation on the effects of re-programming EU Cohesion Funds on regional growth in Italy

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The most important thing that an adult can do towards a young person is to send him to ***school***.

Introduction

I. Motivation

Huge public disbursements, numerous financed projects, deployment of a complex administrative machine to manage them. Nevertheless, the effectiveness of European cohesion policy continues to stimulate an intense debate.

The discussion on cohesion policy is widespread in Europe for different reasons. First, it is one of the main EU investment policies. For instance, during the 2014-20 programming period, EU cohesion policy was the second investment policy in terms of allocations, after the Common Agricultural Policy (CAP).

Second, the lack of a unified fiscal policy at European level attributes to Structural Funds the role of acting directly against regional imbalances.

Moreover, recent studies have stressed the importance of investigating the determinants of citizens' satisfaction with cohesion policy (Capello and Perucca, 2019) and its impact on the creation of the European identity (Borz *et al*., 2022) as well as on the political consensus towards the European Union (Rodríguez-Pose and Dijkstra, 2020).

While policy makers seek to implement strategies to make EU regional policy more widespread and effective, the international scientific literature has made many methodological advances to empirically evaluate its impacts.

The two (interrelated) macroeconomic objectives of cohesion policy are the promotion of structural (long-run) economic growth of lagging regions and the mitigation of territorial inequalities.

A careful reading of the EEC Regulation No. 724/75 of the European Council, which established the European Regional Development Fund (ERDF), introduces many issues which are addressed in this thesis.

Primarily, there is an explicit mention to the concept of *additionality* when it states that "the Fund's assistance should not lead Member States to reduce their own regional development efforts but should complement these efforts" (Regulation preamble).

In addition, the Fund is supposed to cushion the repercussions of the *progressive realization of economic and monetary union*.

However, despite the *five* (concluded) programming periods of European cohesion policy[1], with increasing allocation of resources and administrative efforts to manage them, we still observe significant regional development gaps, as highlighted by the 8th Report on Economic, Social and Territorial Cohesion (European Commission, 2022).

Italy, in particular, is characterized by strong territorial imbalances, although it has always been one of the main beneficiary countries.

Our thesis moves from this motivation. Its main objective is to investigate some of the potential causes of ineffectiveness (or low effectiveness) of the European cohesion policy, (at least) in the Italian case.

The recent international literature has progressed on the methodologies side by isolating the contribution of cohesion policy to regional and subregional economic growth, in taking into account the confounding factors and trying to resolve the issues of endogeneity and causality (see, for instance, Pellegrini *et al.*, 2013).

Another strand of literature has implemented the analysis of the conditioning factors that may mediate cohesion policy effectiveness. Indeed, the policy may be more effective in those areas already endowed by favourable socio-economic contexts (as argued by Fratesi and Perucca, 2014 and Fratesi and Perucca, 2019). If this is the case, cohesion policy could exacerbate territorial inequalities.

As it will be detailed in the section II of the Introduction, further channels of ineffectiveness (or low effectiveness) of the Structural Funds are the potential *displacement effects* they may generate on which the thesis is focused.

II. Cohesion policy and its potential displacement effects

The displacement (or crowding-out) effect is one of the possible aftermaths of the public intervention in the economy and it is a relevant concept in economics.

According to the Neoclassical Theory, the increase of government expenditure causes an increase of the interest rate. This implies the reduction in private investments, discouraged by the higher interest rate.

[1] Starting from the 1988-Reform of the Structural Funds: 1989-93; 1994-99; 2000-06; 2007-13; 2014-20.

On the contrary, the Keynesian School does not hypothesize that an expansionary fiscal policy may generate a crowding-out effect due to the elevated sensitivity of the demand for money to changes in the interest rate (horizontal LM). This would make fiscal policy always effective in stimulating the economy.

In our context, the Structural Funds are associated to a crowding-out effect whenever their presence produces an unfavourable economic outcome which may affect their effectiveness.

Cohesion policy may be a source of many potential displacement effects spanning from those most directly linked to the neoclassical conceptual definition of crowding-out effects, to the more indirect ones.

Indeed, it may generate a crowding-out between public and private investments (through the interest rate channel). This leads to one of the main failures of public incentives for firms (see for instance, Bergström, 2000 and Marino *et al.*, 2016). In this case, the firms could be able to invest their own resources efficiently and effectively without government aids (Metcalfe and Georghiou, 1992).

Secondly, the cohesion intervention may substitute the domestic ordinary policy. In this case, the presence of cohesion funds would have the final effect of reducing the ordinary public intervention in the regional economies.

Cohesion policy may further give rise to a displacement strictly concerning its effectiveness in terms of spatial fallout of its benefits mostly in the areas neighbouring to the treated ones. Indeed, despite these territories are not directly treated, they are linked to the directly treated ones through their spatial proximity or through their economic linkages such as inter-regional (inter-provincial) trade.

Moreover, during the policy implementation period, some resources, addressed to the usually long-run policy objectives, may be re-programmed and diverted toward the cushioning of the economic effects of short-run pressures. In this framework, the displacement concerns the policy purposes (structural long-run goals vs. countercyclical short-run intervention).

Our thesis originates from this conceptual context and tackles three potential displacement effects associated with regional policy implementation in the Italian economy.

In details, the first Chapter sheds light on the degree of cohesion policy's additionality with respect to ordinary domestic spending by evaluating if cohesion policy complements ordinary investment or displaces it.

In order to discover potential heterogeneities among types of interventions, the analysis discriminates ordinary and cohesion policy by sector of public spending.

The second Chapter produces an ex-post impact evaluation of the European cohesion policy in contrast with the national one, by disentangling the direct effects of the two policies on the treated areas from the indirect effects captured by neighbouring territories.

The objective of the analysis is to ascertain whether the potential positive effects of spatial spillovers translate into crowding-out effects if the policy becomes more effective in the areas close to the treated ones.

The third Chapter empirically explores the effects of EU Funds' diversion to face short term needs such as those related with economic crises or other types of global shocks. Indeed, the two most recent completed programming periods were crossed by several shocks. By consequence, part of the Structural Funds was reprogrammed.

We use a dynamic macroeconomic perspective to simulate the medium-run effects of Funds' diversion.

The remaining part of this Introduction presents an overall survey of the recent literature on the impact assessment of EU cohesion policy in section III. Section IV produces a more specific literature review which deals with the topics of the three chapters, points out the gaps in the literature and generates the framework in which our contributions are inserted. Lastly, section V describes the organization of the thesis and summarizes the issues analysed in each chapter and the empirical approaches used.

We leave the most relevant results, some policy implications and the potential developments of the three chapters to concluding remarks.

III. An overall literature review on cohesion policy assessment

One third of the European budget is invested in cohesion policy[2]. This would be enough to justify the multitude of empirical studies assessing its impact on regional economic growth.

Furthermore, the relevance of cohesion policy, and the persistency of regional and subregional territorial disparities, supports the need to check its effectiveness.

The empirical analyses should be functional to trace (and correct) any potential programming and implementation drawbacks.

However, as noted by Fratesi and Wishlade (2017), although academic analyses are acknowledged by European policy makers, who explicitly cite them in cohesion reports[3], it is unlikely that the academic literature will have an impact on the setup of subsequent programming periods since ex-post evaluations are generally produced when the regulatory framework of the new programming period is already in force.

An ex-ante assessment of the macroeconomic impact of EU cohesion policy, at both country and regional levels, is provided by RHOMOLO (Lecca *et al.*, 2018), the spatial dynamic general equilibrium model developed by the European Commission[4].

According to the simulations from RHOMOLO, the 2021-27 programming period would increase the European GDP by 0.5% by the end of the policy implementation period in contrast to the no-policy scenario (Christou *et al.*, 2023).

The effectiveness of the policy is, however, strongly questioned.

Most analyses deal with the detection of the factors which mediate the regional policy impact. Ederveen *et al.* (2006) enumerates as positive conditioning factors openness to trade, good institutional quality and low corruption.

Institutional quality is, indeed, one of the most recurrent conditioning factors traced by empirical studies. Cohesion policy appears to be more effective if mediated by high performing institutions (Rodríguez-Pose and Garcilazo, 2015; Arbolino *et al.*, 2019; Arbolino *et al.*, 2020; Mendez and Bachtler, 2022; Barbero *et al.*, 2023).

[2] The amount allocated has been increasing during the most recent programming periods. 347 billions in the period 2007-13; 351.8 in 2014-20 and 392 in 2021-27.
[3] European Commission (2014; 2017 and 2021).
[4] The RHOMOLO model was developed by the Joint Research Centre (Seville site) in collaboration with the DG Regio.

Other analyses identify alternative context indicators that influence the Funds' impact such as human capital (Fratesi and Perucca, 2014 and Becker *et al.*, 2013).

Therefore, from this strand of literature emerges that cohesion policy may have heterogeneous outcomes depending on the socio-economic context.

Another related strand of literature specifically speculates on this issue by demonstrating that the outcome of heterogeneity depends on where the Funds are spent (Gagliardi and Percoco, 2017; Bourdin, 2019; Bachtrögler *et al.*, 2020; Crescenzi and Giua, 2020; Di Caro and Fratesi, 2021; Calegari *et al.*, 2023). Indeed, if the effectiveness of the Funds were higher in the most performing regions, this would diminish the re-equilibrium mission of cohesion policy itself.

The effectiveness might also depend on the regional capacity to intercept local vulnerabilities and to select consistently the most fruitful projects. This involves administrative efficiency in the design and in the policy implementation phase (Bachtler *et al.*, 2013; Terracciano and Graziano, 2016 and Medve-Bálint, 2018), but also specific absorption capacity of EU Funds and its determinants (Kersan-Škabić and Tijanić, 2017; Incaltarau *et al.*, 2020; Moreno, 2020; Komorowski *et al.*, 2020; Cunico *et al.*, 2022).

Other authors have questioned specifically the causal relation between cohesion policy and growth by means of more accurate identification strategies. The application of these methodologies aims at uniquely isolating the contribution of the policy to the growth of the treated areas. Nevertheless, these methods are subject to external validity issue, i.e., to what extent the results are generalizable beyond the context of the specific study[5].

For instance, Hagen and Mohl (2008) employed a dose-response approach, together with a generalized propensity score method, to isolate the impact of the EU Funds from 1995 to 2005 in a sample of 122 NUTS-1 and NUTS-2 (EU-15) regions. They concluded that cohesion policy had a positive but not statistically significant effect on the growth rate. At a firm-level, Bachtrögler and Hammer (2018) applied propensity score matching techniques on a sample of treated firms in the 2007-13 programming period. They found that, on average, treated firms increased workers and capital stock.

The regression discontinuity design (RDD) is another counterfactual approach used to infer on the causal impact. It was used by Becker *et al.* (2010) to compare the growth of treated with that of non-treated regions in 1989-93, 1994-99 and 2000-06

[5] We would thank one of the external evaluators for this observation.

programming periods. Their findings revealed that the treatment effect on per capita GDP was positive and statistically significant. Pellegrini *et al.* (2013) employed the RDD on 1995-06 period to contrast the performance of regions having a per capita GDP level just below the eligibility rule (75% of European average) with that of regions having a per capita GDP level just above, under the assumption that the two groups of regions have quite similar features and that they would have differed only in the treatment.

According to their findings, the treatment had a positive and statistically significant impact on economic growth. Gagliardi and Percoco (2017) used RDD to analyse the causal impact of cohesion payments on NUTS-3 regions' growth during the 2000-06 programming period, by taking into account the heterogeneity of treated territories, in terms of different urbanization level (cities, small cities, rural areas) and of different distance from urban areas. The authors found heterogeneity of impacts depending on higher or lower proximity to cities (the rural areas close to urban agglomerates performed better). Crescenzi and Giua (2020) employed the policy-change-boundary, as RDD threshold, by comparing treated NUTS-3 territories with non-treated ones from 2000 to 2014. From their results, cohesion policy was predominantly effective in Germany and in the UK. In Italy, Structural Funds lost effectiveness after Great Recession. At a firm-level, Crescenzi *et al.* (2020) evaluated the impact of the Collaborative Industrial Research (CIR) programme on firms' performance through a RDD by finding low effectiveness for improving additional investments, in terms of value added and employment of treated firms.

IV. The thesis contribution to the literature: the specific context and our novelties

In summary, the recent international literature stresses the importance of identifying the conditions under which cohesion policy is more effective.

Furthermore, cohesion policy may generate crowding-out effects which can significantly influence its effectiveness. The thesis quantifies three of them, namely, in turn, the possibility of crowding-out ordinary domestic policy, the potential displacement effects generated by spatial spillovers and the trade-off between long-term goals and short-term objectives.

The research question addressed in the first Chapter is whether the cohesion interventions have an effect on domestic funds. This is an unintended effect of cohesion policy since its specific objective is the mitigation of interregional disparities. Therefore, cohesion funds should not be used in substitution of ordinary disbursements but in an additional fashion.

Indeed, to foster regional economic growth, and to reduce regional disparities, EU cohesion policy may be complemented by national cohesion interventions or by fiscal policy, especially during recessions.

Some recent works deal with the ex-post impact assessment on regional economic growth of fiscal policy in combination with EU cohesion policy (Furceri, Mazzola and Pizzuto, 2021) or in contrast with it (Coppola *et al.* 2020 and Destefanis *et al.*, 2022).

In detail, Furceri, Mazzola and Pizzuto (2021) demonstrated that, in a sample of OECD countries (1990-2014 time span), expansionary fiscal policy, combined with cohesion spending, encouraged regional resilience to negative country level shocks.

Focusing on the Italian regions, Coppola *et al.* (2020) showed that, during the period 1994-2013, European cohesion funds had a greater impact (as measured in a regional panel convergence model) than both ordinary and national cohesion funds on the growth of regional per capita GDP. These results were confirmed by Destefanis *et al.* (2022) by contrasting, through a Bayesian REs-PVAR and for the Italian regions, the GDP multipliers of different types of expenditure, during the period 1994-2016. This analysis highlighted strong heterogeneity on the value of the multipliers across the regions and that the EU Funds had the highest multiplier compared to the other national government disbursements.

The interaction between cohesion policy and ordinary fiscal policy is the focus of the additionality principle. This principle states that the European cohesion funds should not replace domestic ordinary funds.

Therefore, the first Chapter of the thesis relates to the strand of the literature which deals with the evaluation of the degree of additionality in the implementation of cohesion policy.

The fulfillment with the additionality rule is officially assessed by the European Commission in three different moments according to a procedure that will be described in Chapter 1.

The scientific literature has made some progress in evaluating additionality but the analyses on this topic are pretty few.

The assessment has mainly taken place at a country (NUTS-1) level, with an EU-27 sample in 1982-2006 (Mohl, 2016) and an EU-15 sample in 1990-2006 (Wostner and Slander, 2009) and 1993-2005 (González-Alegre, 2012).

For single country exercises, Szitásiová *et al.* (2014) and Janský *et al.* (2016) provided a program-level evaluation of cohesion funds' additionality in Slovak municipalities for 2006-2010 period and in Czech municipalities for 2007-2014 period, respectively.

Del Bo and Sirtori (2016) focused on Italian regions by tracing sectoral and regional displacement effects, in a time series framework for 1996-2011 period.

The findings of these studies are quite heterogeneous. In summary, Wostner and Slander (2009) and González-Alegre (2012) traced the fulfillment with the rule. Mohl (2016) found no significantly positive effects of EU cohesion policy on public investments. Szitásiová *et al.* (2014), Janský *et al.* (2016) and Del Bo and Sirtori (2016) discovered heterogeneity in the additionality fulfilment depending on units and sectors.

The lack of unambiguity among the results might be due to the sample under analysis, the period considered, the techniques adopted in addressing the identification of causal relation and the presence of confounding factors.

The novelty of our thesis, with respect to this literature, in particular in the first Chapter, is the assessment of the ex-post compliance with the additionality principle in Italy during the most recent concluded programming periods (2007-13 and 2014-20) by adopting a regional (NUTS-2) panel perspective and disaggregating public spending by sector of interventions.

The sectoral breakdown was deemed as necessary to investigate the specific sectors in which cohesion spending shows a complementary, neutral, or substitutive role to national domestic investments.

The analysis is addressed by considering the potential endogeneity of cohesion variables.

The influence of confounding factors is mitigated by including, as controls, regional and sectoral (potential) drivers of domestic spending.

A second important cause of displacement effects is given by the spatial spillovers which are explicitly relevant at NUTS-3 level.

The second Chapter of the thesis relates to the strand of the literature which deals with the ex-post impact assessment of Structural Funds when spatial effects are in place as potential mediators of policy effectiveness.

As argued by Cerqua and Pellegrini (2017), in a study that analysed the potential welfare-enhancing role of business incentive programs on underdeveloped regions (in terms of spatial spillovers on the territory), the policies oriented to stimulate the economic growth of lagging regions are suitable to generate spatial externalities and the policy evaluators should take them into account when estimating the impact of territorial policies.

However, spatial spillovers can be positive or negative (De Castris and Pellegrini, 2012) and their detection may be very useful for the policy design.

In recent years, several papers have tried to shed light on the role of spatial spillovers generated specifically by European cohesion policy. The methodologies applied in this case have been different. The list includes, in different programming periods, and usually at NUTS-2 level, exploratory spatial data analyses-ESDA (Ramajo *et al.*, 2008), country-specific interregional input-output models (Pérez *et al.*, 2009), spatial RDD (Crescenzi and Giua, 2020), spatial autoregressive models (Dall'Erba and Le Gallo, 2008; Hruza *et al.*, 2019; Gambina and Mazzola, 2023), spatial error models (Falk and Sinabell, 2008), spatial Durbin models-SDM (Fiaschi *et al.*, 2018; Breidenbach *et al.*, 2019; Antunes *et al.*, 2020) and spatial difference-in-differences model with SDM specification (De Castris *et al.*, 2023).

The spatial spillovers detected by these applications are often not negligible but the evidence toward strong displacement effects is not clear since the results of these studies are heterogeneous.

By employing a spatial Durbin model to Italian NUTS-3 (provinces) regions, the second Chapter compares the direct effects of EU cohesion policy on treated areas with its indirect (spillover) effects on neighboring territories.

Our additional contributions to the current literature in the second Chapter are the following.

First, the chapter contrasts the direct and the (spatial) indirect impacts of *EU* cohesion policy with those related to the *national* cohesion policy.

Indeed, in some countries, national cohesion interventions accompany European ones. In Italy, the government design of domestic regional policy is different from the European one regarding programming procedures, selection criteria and investment typologies. However, similarly to the EU cohesion policy, the national one has a strong territorial character, which is suitable for the spatial propagation of its economic effects.

The analysis on which cohesion resources create greater spillovers is worth to be investigated and there is a gap in the empirical scientific literature on this specific matter.

Second, due to the possible heterogeneity inside regions, we choose the NUTS-3 scale. We scrutiny the two most recent completed programming periods (2007-13 and 2014-20) that were crossed by a global exogenous shock. Indeed, we also capture the 2008-Great Recession years and we broaden the analysis to the post-crisis period.

Global downturns may impact on the effectiveness of territorial policies and on the relevance and directions of their spillovers. According to this, as a third contribution, we look whether the 2008-crisis exerted an influence on cohesion funds' outcomes.

Few analyses in the literature have considered spatial effects at NUTS-3 level and extended to the investigation the post Great Recession period.

The third Chapter of the thesis tackles a different and quite recent source of displacement. It quantifies the medium-run impact of the ERDF re-programming occurred during the 2007-13 and the 2014-20 programming periods. The re-programming consisted in the diversion of allocations from long-term objectives to cover short-run aims caused by the Great Recession, environmental disasters, Covid-19 outbreak, spending problems and so on.

The strand of literature closest to this issue investigates the impacts of recent crises on cohesion policy effectiveness as in Merler (2016), Bachtrögler (2016), Becker *et al.* (2018), Di Caro and Fratesi (2023). These studies, indeed, did not draw unambiguous conclusions about the impact of the crises on Fund's effectiveness.

With respect to the Italian case, De Blasio and Ciani (2015) attributed their findings of EU policy low effectiveness[6] to the Funds' diversion towards the sectors mostly affected by the post 2008-Great Recession.

[6] The analysis was conducted for Southern Italy during the 2007-20 period.

By contrast, Arbolino and Di Caro (2020) studied the resilience of Italian regions during the crises by analysing whether EU Funds have reduced the employment losses during the Great Recession and whether this experience may have possibly been repeated against Covid-19.

We study a related but different issue. As said before, the ERDF re-programming not only concerned the emergencies linked to the 2008-crisis but also natural disasters and spending problems. In a policy-making perspective, the crucial question is to ascertain whether it is sustainable to use cohesion funds to face these events or to prefer for this role short-run disbursements which are specifically designed to cover the economic (and social) costs. In the international literature, this is an under-researched topic.

Additional contributions of the third Chapter relate to the empirical methodology used.

We adopt a macroeconometric perspective by estimating an impulse response function to quantify the medium-run effects of Funds' re-orientation in the Italian regions (NUTS-2) following the re-programming shocks occurred during the 2007-13 and the 2014-20 programming periods. We evaluate the effects of both aggregate and sectoral diversions and control for endogeneity in the re-programming exercise.

Overall, the thesis employs several innovative data sources.

The first Chapter uses, in an integrated way, the Territorial Public Account (*Conti pubblici territoriali,* CPT) database for information on sectoral *ordinary* spending and the *Opencoesione* (OC) database for data on the *cohesion* investments.

The CPT database registers the disbursements of all public administrations towards NUTS-2 Italian regions by consolidating all the expenditures from different sources pertaining to each region and by splitting them into thirty sectors whose definitions are consistent with the sectoral classification in the public administrations' budget.

Instead, *Opencoesione* is a project-level database that allows to publicly monitor the planning and financial state of play of each project. The projects are thoroughly described according to their features and the thematic objectives they address. The spatial detail is at the municipality level.

In the context of the first Chapter, the sectoral level of OC is relevant, but OC and CPT use different sectoral definitions. Therefore, we combine the two databases by using some recent reports released by the Italian territorial cohesion Agency (Agenzia per la coesione territoriale, 2021) matching the thirty CPT sectors with the sectoral domain of OC in order to separate, from the overall CPT expenditures, those having cohesion purposes.

As for the second Chapter, one of its peculiarities is the detection of the outcome and spatial spillovers of the European and national cohesion policy by including in the analysis *only concluded* projects, extracted from OC database. We went in this direction for conceptual and methodological reasons. Accounting data (such as payments or commitments) may introduce bias and misleading results in policy evaluation when referred to ongoing or blocked projects. Instead, completed projects are able to generate full economic effects. We imputed them to the year of completion.

Moreover, by using this sub-set, we were able to reduce the endogeneity of cohesion variable since the policy decision becomes contingent to the economic conditions of previous years.

The choice to implement the analysis at a provincial NUTS-3 level (instead of NUTS-2 level) moved also from the purpose of mitigating an additional source of endogeneity of cohesion policies. The treatment decision depends strongly on (NUTS-2) regional economic performance and it is not established directly at the provincial level. For instance, some provinces, having a per capita GDP level above the 75 percent of the European average, could still be assigned high shares of European funds if they are administratively included in a lagging (NUTS-2) region and vice versa.

As for the third Chapter, to retrieve the information on regional re-programmings year-by-year, we used the *Annual Implementation Reports* of ERDF-ROPs produced by the Management authority (*Autorità di Gestione*). These relevant documents specify both the aggregate and the sectoral re-programmed amounts and the relative motivations of each re-programming exercise.

III. Structure of the thesis

The three chapters of the dissertation are autonomous but connected with the unique theme of the evaluation of displacement effects. The chosen order of the chapters reflects somehow moments in which the policy is performed.

Conceptually, additionality pertains to the (ex-ante) decision process; the evaluation of the policy impact is done ex-post but relates to the policy implementation process; lastly, the re-programming concerns the unexpected future changes to face the variation in macroeconomic conditions.

The rest of this section provides a summary of each chapter and a description of the methodologies applied.

The first Chapter starts with a brief introduction which highlights the regional and sub-regional income heterogeneity and the North-South imbalance and its evolution over time. Then, the chapter explains the framework of the 'additionality principle' from both a theoretical and an administrative points of view and reviews the methods used in the literature to evaluate additionality. We adopt a sectoral detail and perform a panel estimation concerning the Italian NUTS-2 territories. Our cohesion variable encompasses EU Funds, national co-financing to EU Funds and national cohesion policy. The spending categories capture two relevant dimensions of regional development strategy, namely, human capital and transport infrastructure expenditure, by separating Education vs. Training expenditure on one side and Road vs Non-Road Transport Infrastructures on the other. The panel model is estimated for each considered sector and it evaluates the influence of cohesion policies on ordinary one by controlling for macro regional features and for sectoral dimension to mitigate the influence of confounding factors besides the regional fixed effects. For robustness, we estimate different model specifications according to the sectoral variables included. Given the non-negligibility of endogeneity (particularly in the form of reverse causality), we select some potential instruments for cohesion policy and test their inclusion and exclusion restrictions. We perform the endogeneity tests of the cohesion variable to select the proper estimation technique (fixed effects or 2SLS fixed effects).

The second Chapter initially reviews the literature on the ex-post evaluation of EU cohesion policy which focuses on the detection of spatial spillover effects.

The chapter firstly presents some descriptive statistics on the Italian provinces and then illustrates the empirical strategy. In particular, it provides new evidence on the impact of EU cohesion policy in contrast with national one. Through the estimation of a spatial Durbin model, we discriminate, from the total policy impact, the direct effects on the growth of treated provinces and the indirect spillover effects on the growth of neighboring areas. The chapter investigates also the role played by Great Recession on policy effectiveness.

To reduce the influence of confounding factors, we consider several control variables such as population density, specialization indices, trade openness and human capital. To test the robustness of the results we augment the SDM specification with additional elements of territorial capital (infrastructural, natural, relational and social capital).

Finally, the third Chapter overviews the re-programmings occurred in the Italian regions during the two most recent concluded programming periods (2007-13 and 2014-20). European cohesion policy concentrates on projects (potentially) relevant to enhance sustained (long-term) growth of underdeveloped areas.

The *Regional Operational Program* (ROP) is the official programmatic document containing the distribution of allocation in each thematic area. The most relevant element of the ROP is the context analysis which outlines the structural needs of the region. Indeed, the planned amount is calibrated around the structural bottlenecks of each region.

However, during the policy implementation period, the ROPs might be subjected to any adjustment as a consequence of economic crises, natural disasters and any other (unpredictable ex-ante) events. Thus, the Funds may be re-programmed and diverted very often to cover counter-cyclical (short-term) needs.

The chapter quantifies the medium-run effects of the re-programming. We compute the impulse response functions of regional per capita GDP following the planned shock through Jordà method that calculate the forecasts through their direct estimation for each (local) time horizon. The model controls for lags of dependent and shock variables. To test the robustness of the results we augment this equation with regional-specific control variables and apply Romer and Romer (2010) narrative approach to avoid that the potential re-programming endogeneity could bias the results.

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Chapter 1

Cohesion Policy and ordinary spending in Italian regions: a sectoral ex-post assessment of the additionality principle

Summary of the Chapter

This chapter investigates the European cohesion policy additionality with respect to national ordinary policy during two recent programming periods (2007-13 and 2014-20) for the 20 Italian regions. Despite the additionality principle in force, the cohesion treatment may have distorted the domestic allocative process. We deal with an ex-post regional and sectoral panel evaluation of European cohesion funds' additionality to ordinary policy, addressing the issue of endogeneity. In particular, we focus on two important dimensions of regional growth, such as human capital and transportation spending, by looking at the relationships between ordinary and cohesion policy in four sectors, defined as *Education*, *Training*, *Road Infrastructures* and *Other Transport Infrastructures*. The policy variables are computed by combining data from two databases: *Opencoesione*, which includes information on Italian cohesion projects in the last two programming periods before the current one and *Conti pubblici territoriali* which refers to Italian regionalized public spending by sector. There are relevant differences on the results among sectors. Those related to human capital display a sort of crowding-out effect. On the contrary, cohesion policy appears to be complementary for growth to domestic expenditures in transportation infrastructures.

1.1 Introduction

Cohesion policies are focused on enhancing regional economic convergence by financing investment projects mainly addressed to the lagging territories.

At supranational level, European funds have the goal of favoring economic, social and territorial cohesion in the European Union, by mitigating inequality between countries and regions.

Many revisions of the European regional policy occurred over time to improve its effectiveness and efficiency in facing the challenges of the various programming periods.

The 1988 Reform of Structural Funds addressed specifically the implementation process with the enforcement of the additionality principle for which EU funds should not be used to replace domestic resources.

Additionality has a relevant theoretical background since it claims to avoid a potential pitfall occurring when cohesion treatment displaces national 'ordinary' capital account expenditures. Conversely, a desirable effect would be to create a stimulus for national investment policy.

If distortions occur, the recipients of the EU Funds would use them not for cohesion purposes but mainly for other unrelated projects (Mohl, 2016). The additionality principle has been described in the literature as conducive to more proaction in the control of the funds by the European Community (Bernet, 1995).

This chapter deals with the evaluation of the additionality principle. Indeed, a conclusive opinion about its impact does not emerge from the scientific literature and the policy debate.

Our novelties with respect to the existing literature are the following.

We produce an ex-post empirical evidence of the compliance with the additionality principle in Italy by analysing the two most recent (completed) programming period (2007-13 and 2014-20).

We apply, for the first time in the literature on the Italian investigation, a sectoral breakdown of cohesion and ordinary spending in a panel data specification at the regional (NUTS-2) level.

The sectoral analysis allows us to discover the potential differences between expenditure sectors and, by specify a panel model, we can control for the heterogeneous regional typologies in terms of development level and specific sectoral characteristics.

The work employs two jointly combined different data sources, the Italian database on cohesion policy expenditure (*Opencoesione*) and the Italian database on the overall regionalized public spending (*Conti Pubblici Territoriali*). In the existing literature there are no empirical studies which use these two databases in an integrated way[7].

Lastly, since in our panel model, the ordinary expenditure is explained by the cohesion one, and by some regional and sectoral control variables, the endogeneity of the cohesion variable may be an issue. Indeed, cohesion funds might depend on both ordinary funds and explanatory control variables. Therefore, we specifically examine the endogeneity of the cohesion variable before proceeding to model estimation.

The analysis concerns two macro sectors of public spending: human capital and transportation infrastructures, which are both important dimensions of the regional growth strategy.

The rest of the chapter is organized as follows. Section 1.2 describes the regional heterogeneity of the Italian economy. Section 1.3 discusses the implementation of the European cohesion policy and the additionality principle and section 1.4 reviews the econometric methods used in the literature to evaluate additionality. Section 1.5 discusses our empirical strategy while section 1.6 summarises the results and section 1.7 concludes with the policy implications.

1.2 The Italian economy: income heterogeneity and the North-South gap

As known, Italy is characterized by a (persistent) North-South imbalance. The studies investigating its origin do not reach the same conclusions. For instance, Daniele and Malanima (2011) state that the gap was not already present during Italy's unification (1861), but it emerged 20 years later. On the opposite, Felice (2014) estimates a North-South imbalance of 18% already in the first years after the unification.

[7] As pointed out by the Italian *Agency for territorial cohesion* (Agenzia per la coesione territoriale, 2021).

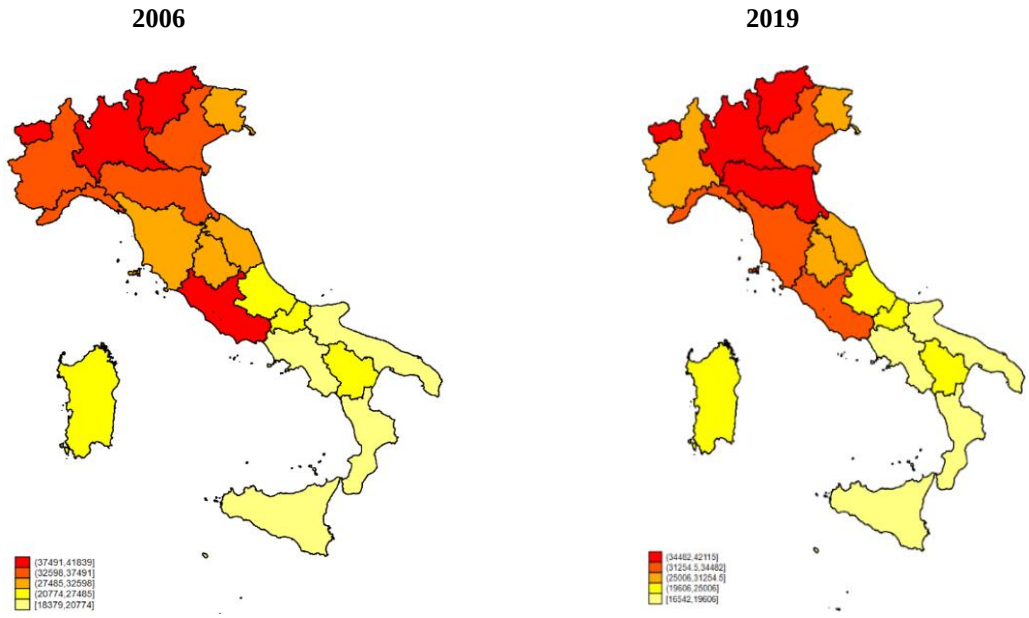
The recent picture of the Italian regional divide is highlighted in figures 1.1 and 1.2[8].

In terms of real per capita GDP levels (figure 1.1), we can see that the income is mainly concentrated in the North of Italy with negligible differences between the two years.

Figure 1.2 displays the overall improvement in regional employment rate, from 2006 to 2019, which is more marginal in the South.

Table 1.1 and 1.2 show some regionalized descriptive statistics (mean, standard deviation, minimum and maximum values) for real per capita GDP and employment rate (20-64 years range).

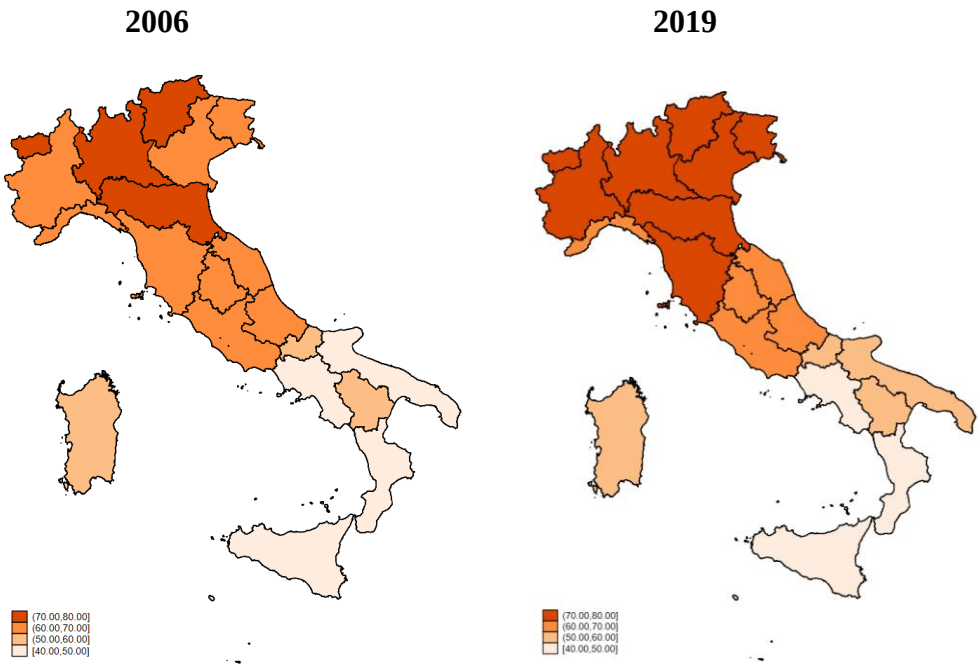
Figure 1.1: Quantiles of real per capita regional GDP, years 2006 and 2019



Source: Our elaborations.

[8] We have selected these years since they correspond to the end of 2000-06 and 2014-20 European programming period. The year 2019, and not 2020, was included to control for COVID effects.

Figure 1.2: Ranges of regional employment rate (20-64 years), years 2006 and 2019



Source: Our elaborations.

Table 1.1: Descriptive statistics of real per capita GDP in Italian regions in the 2006-2020 period

Region	***Mean***	***Std. Dev.***	***Min***	***Max***
Piemonte	30072	1520	28082	32815
Valle D'Aosta	38545	2217	34708	41839
Lombardia	37752	1351	35154	39796
Liguria	31402	1565	28623	34277
Trentino-Alto Adige	40057	940	38475	42115
Veneto	31714	1298	29586	34041
Friuli-Venezia Giulia	30256	1277	28851	32811
Emilia-Romagna	34551	1434	32043	37205
Toscana	30401	1098	28537	32355
Umbria	25659	1929	23259	29205
Marche	26827	1406	24792	29654
Lazio	34543	2308	30980	38624
Abruzzo	24573	837	22916	26015
Molise	20952	1594	19024	23902
Campania	18594	1069	17116	20629
Puglia	17936	692	16854	19245
Basilicata	20827	1248	19249	22836
Calabria	16922	951	15288	18514
Sicilia	17976	1114	16184	19973
Sardegna	20573	844	18852	21897

Source: Our elaborations.

Table 1.2: Descriptive statistics of employment rate in Italian regions for the 2006-2020 period

Region	***Mean***	***Std. Dev***	***Min***	***Max***
Piemonte	68.49	1.33	66.42	70.78
Valle D'Aosta	71.51	0.99	69.84	73.47
Lombardia	70.59	1.41	68.92	73.39
Liguria	66.64	0.93	64.68	67.68
Trentino-Alto Adige	73.95	1.44	71.41	76.55
Veneto	69.68	1.37	67.57	72.65
Friuli-Venezia Giulia	68.90	1.58	67.03	71.98
Emilia-Romagna	72.77	1.45	70.63	75.39
Toscana	69.23	1.37	67.67	71.69
Umbria	67.27	1.30	65.09	69.40
Marche	67.78	1.29	65.39	69.76
Lazio	63.91	1.03	61.96	65.69
Abruzzo	60.78	1.55	57.98	63.08
Molise	55.67	2.19	51.27	58.57
Campania	44.83	1.71	42.72	48.35
Puglia	48.63	1.53	45.74	50.59
Basilicata	52.92	1.60	49.96	54.80
Calabria	45.41	2.44	42.11	49.79
Sicilia	45.39	2.22	42.38	49.12
Sardegna	54.76	1.67	51.65	57.35

Source: Our elaborations.

Figure 1.3 shows the evolution of the regional convergence process by analysing the regional per capita GDP as a percentage of the national average.

European policy defines as 'lagging regions' the NUTS-2 territories with per capita GDP less than 75 percent of the European average. These regions are included in the Convergence Objective[9]. The economies with a per capita GDP between 75% and 90% of the European average are defined as 'transition regions'. Instead, the so called 'more developed regions' have a per capita GDP higher than 90% of the European average.

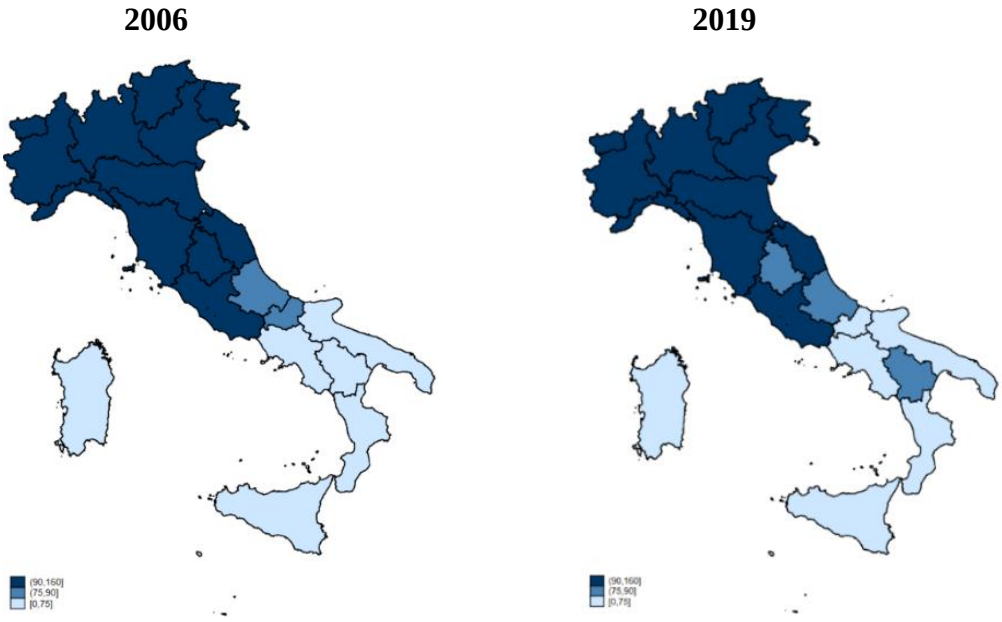
In 2006, all southern Italian regions underperformed with per capita incomes between 0-75 percent of the national average (figure 1.3) and two central-southern Italian regions (Abruzzo and Molise) in the intermediate level. In 2019, an improvement was recorded by only one southern region (Basilicata).

Figure 1.4 assesses the convergence process compared to European average. In 2006, Northern and Central Italy experienced high income levels compared to the EU

[9] Former Objective 1 in 2000-2006 programming period.

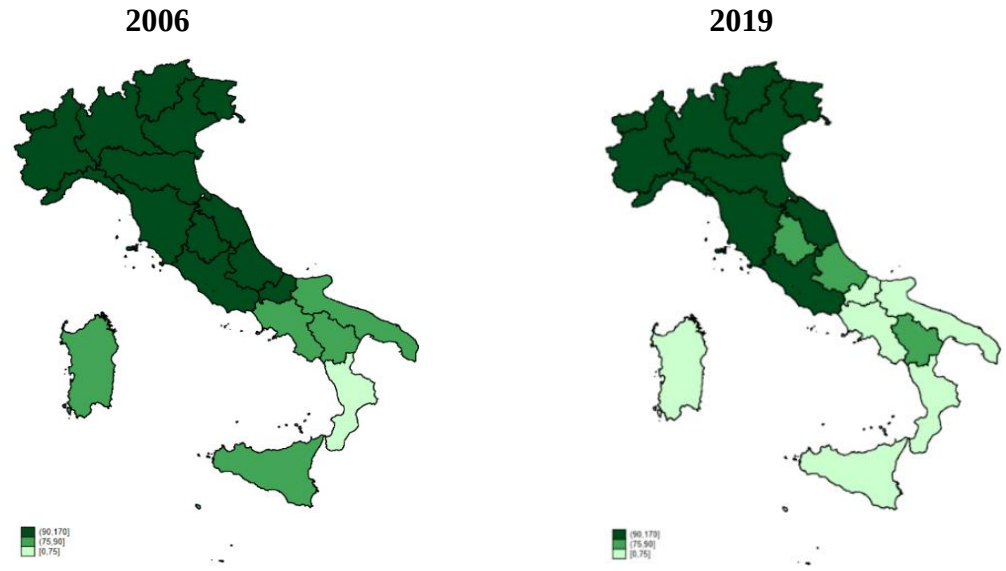
average. Southern regions were predominantly in transition. At the end of the 2014-20 programming period almost all southern regions were lagging.

Figure 1.3: Real per capita GDP in percentage of national average: years 2006 and 2019



Source: Our elaborations.

Figure 1.4: Per capita GDP (PPS) in percentage of EU average: years 2006 and 2019



Source: Our elaborations.

Strong inequalities among Italian regions still persist and cohesion policies may be instrumental for regional convergence.

However, the gaps may be interpreted also as a proof of ineffectiveness of cohesion funds. We would like to investigate whether this ineffectiveness may be related to the distorted use of the Funds especially in the application of the additionality principle.

1.3 The EU Cohesion Policy: motivations, strategy and the additionality principle

Approximately one third of the EU budget is allocated to Structural Funds for each programming period. In details, during the 2007-13 programming period 347 billion were invested while in 2014-20 programming the allocations increased to 352 billion. The budgeting of the *new* cohesion policy (2021-27) is 392 billion.

The policy is mainly implemented through three funds, the European Regional Development Fund (ERDF), the European Social Fund (ESF) and the Cohesion Fund (CF). The ERDF has the general aim of increasing growth and employment as well as fostering territorial cooperation. The ESF is entirely devoted to improving human capital quality and employment opportunities. Lastly, the CF is addressed to environment and cross-border transportation networks and it is not extended to all member states but only to countries with per capita gross national income below the 90% of EU-27 average.

In addition, since 2013, the Youth Employment Initiative (YEI) is complementary to the ESF as directed to young people not in education, employment or training (NEETs) living in regions with youth unemployment higher than 25%.

Table 1.3 shows the 2007-13 and 2014-20 total payments by beneficiary country and the relative percentage on the overall expenditure. The considered funds are ERDF, ESF, CF and YEI[10].

[10] We excluded the European Agricultural Fund for Rural Development (EAFRD) and the European Maritime and Fisheries Fund (EMFF) since they have more specific purposes.

Table 1.3: EU Funds: total payments by countries in 2007-13 and 2014-20 periods

Country	***2007-13 period***		***2014-20 period***	
	Payments (Millions)	*% of total*	*Payments (Millions)*	*% of total*
Austria	1133	0.34	148	0.22
Belgium	2017	0.61	351	0.53
Bulgaria	6400	1.93	1418	2.15
Cyprus	612	0.18	219	0.33
Czech Republic	25295	7.65	3815	5.80
Germany	24750	7.48	3481	5.29
Denmark	509	0.15	75	0.11
Estonia	3233	0.97	925	1.40
Greece	20210	6.11	3253	4.94
Finland	1588	0.48	422	0.64
France	13202	3.99	2839	4.31
Croatia	744	0.22	634	0.96
Spain	34341	10.38	4578	6.96
Hungary	24418	7.38	5776	8.78
Ireland	750	0.22	190	0.28
Italy	25981	7.85	4412	6.70
Lithuania	6774	2.04	1624	2.46
Luxembourg	50	0.01	14	0.02
Latvia	4530	1.37	696	1.05
Malta	803	0.24	106	0.16
Netherlands	1653	0.50	231	0.35
Poland	67091	20.29	17387	26.43
Portugal	21411	6.47	5587	8.49
Romania	16986	5.13	2858	4.34
Sweden	1600	0.48	446	0.67
Slovenia	4101	1.24	453	0.68
Slovakia	10910	3.30	2359	3.58
United Kingdom	9504	2.87	1466	2.22

Notes: Data are at constant prices (2015). The 2014-20 period was considered until 2018 year due to data availability. The payment amount may depend both on the allocations and on management quality of each country.
Source: Our elaborations based on European Commission database ('Cohesion Data'), accessed April 2023.

The European programming divides the cohesion interventions by thematic areas, functional also to the evaluation process. For instance, table 1.4 reports the thematic breakdown of financial allocations in 2014-20 period.

As we may see, the main focus of the intervention was on energy efficiency and sustainable transport networks to fight climate change; on research and innovation applied to businesses; and on employment and human capital quality measures.

The area labeled 'Fostering crisis repair and resilience' was strengthened during the 2020 pandemic and was included in the 'REACT-EU' (Recovery Assistance for Cohesion and the Territories of Europe) interventions which mainly addressed some key issues such as those devoted to the improvement in green transition, digital economy, business development, health care systems and labor market efficiency.

Table 1.4: EU cohesion policy 2014-2020: details of planned financing by theme

Theme	***Funds***	***Planned*** *(Millions)*	***Theme % on total budget***
Infrastructures in transport and energy	ERDF-CF	67112	12.80
Research and innovation	ERDF	61922	11.81
Competitiveness of SMEs	ERDF	58006	11.06
Sustainable and quality employment	ESF-YEI-ERDF	55008	10.49
Social inclusion	ESF-ERDF	52043	9.92
Low-carbon economy	ERDF-CF	51464	9.81
Educational and vocational training	ESF-ERDF	45713	8.72
Environment protection and efficiency	CF-ERDF	42407	8.09
Fostering crisis repair and resilience	ERDF-ESF	42079	8.02
Technical assistance	ERDF-ESF-CF	16533	3.15
Information and communication technologies	ERDF	16209	3.09
Climate change adaptation and risk prevention	ERDF-CF	9219	1.76
Efficient public administration	ESF-ERDF	5958	1.14
Outermost and sparsely populated	ERDF	829	0.16

Source: Our elaborations on European Commission 'Cohesion' (2014-20) data.

To improve the real impact of European Structural and Investment Funds, the European Commission has introduced a large set of measures during the different programming periods: a better specification of the objectives (European Parliament and Council, 2006), a strengthening of the monitoring activity by the EU Commission, the identification of managing authorities in charge of the efficient management and of the implementation of Operational Programs (OPs) and the provision of formal rules governing the Funds' allocation, starting from the 1988 Reform (Regulation n. 2052/88[11]).

[11] The so-called 'Delors package' constitutes its conceptual background.

These rules refer to the principle of concentration, programming, partnership and additionality.

The principle of 'concentration', in its current definition, concerns the clustering of resources, objectives and expenditure. It envisages that the Funds must be directed mostly to the poorest regions and countries, that the objectives must be relevant for a more competitive, smarter, and greener Europe and that the yearly allocated funds must be spent up to three years later (n+2 or n+3 rule).

The principle of 'multi-annual programming' conceives a strategic planning procedure for the attainment of the objectives and emphasizes the alignment of each project to the European priorities.

The 'partnership' principle states that in each policy operational phase (design, management, implementation, monitoring and evaluation) all economic agents should be involved following a bottom-up approach.

Lastly, the 'additionality' principle asserts that EU Funds should not be used in place of structural, public or similar, expenditure by member states in recipient regions (art. 15 Regulation EC No. 1083/2006[12]).

Conceptually, the establishment of this last rule would prevent the non-neutrality of cohesion policy on the public allocation process and the reduction of public expenditure by the central government and decentralized entities.

The issue of 'spending additionality' involves both administrative and theoretical aspects, the first relating to formal definition of the types of expenditures that must be included in the additionality accounting and the second investigating the economic content of 'additional' expenditures.

As for administrative issues, three categories are identified as eligible structural expenditures (as well as technical assistance): a) 'basic infrastructure' including transportation, telecommunications, energy, water supply, environmental protection and health; b) 'human resources' such as expenditures on education, training, research and development; c) 'productive environment' which includes support to industry, services and tourism[13].

[12] The legislative sources of the previous programming periods are the following: art. 9 Regulation CEE No. 2082/1993 and art 11 Regulation CE No. 1260/1999.
[13] Agriculture and rural development are excluded since not eligible to the main structural funds.

The additionality principle does not solely concern national expenditure but encompasses all public expenditure including investment by regional and local authorities.

Moreover, the heterogeneous characteristics of the Member States are taken into account. For instance, expenditures from public companies are considered as eligible and the accounting system is discussed with the European Commission to avoid double-counting[14]. In Italy, the verification of additionality is done at the level of the so-called Enlarged Public Sector (*Settore pubblico allargato*) which includes investment by the State, by regions, by local authorities and by public companies.

Up to the 2014-20 programming period, the compliance evaluation took place at the national level. No check was made on the potential crowding-out effect at regional and sectoral levels.

The additional contribution of this chapter to the ongoing debate is an assessment of the degree of cohesion policy additionality achieving a higher level of detail. We provide new empirical evidence on this issue through a sectoral-panel assessment of cohesion funds' additionality focusing on the two recent (2007-13 and 2014-20) programming periods. The econometric framework combines in a new way existing data sets and distinguishes between two sources of disbursements (cohesion vs. ordinary resources).

We increase the estimation accuracy by controlling for some variables, potentially suitable to influence sectoral domestic spending, as well as for the endogeneity of cohesion variables.

We analyse human capital and transport infrastructure expenditures by applying a breakdown between *Education* and *Training* spending on one hand and by *Road Infrastructures* and *Other Transport Infrastructures* on the other.

[14] The practical details are reported in the Annex A of Commission methodological guidelines (European Commission, 2006).

1.4 Assessment methods of additionality: a brief literature review

The debate on the effectiveness of regional policy has always been intense and the EU Funds have often been criticized in many aspects concerning both the policy design and the implementation phase. One of the most relevant criticisms, as summarized by the so-called Barca Report (Barca, 2009), concerned the risk that cohesion policy could merely act as an income redistribution policy across regions with no real impact on their long-term growth.

If cohesion funds do not generate added value, the regional policy would be distortive and inefficient, reminding the lessons of Smith (1776) on the efficient allocation of resources by the market that would imply, in this case, a regional convergence process without specific (exogenous) action by the government.

One of the potential causes of cohesion policy ineffectiveness may be a misallocation of the Structural Funds due to non-compliance with the additionality principle.

From a theoretical point of view, the additionality principle has a long-standing conceptual framework. As noted by Del Bo and Sirtori (2016), its economic motivation is associated with the so-called 'fly-paper effect'. The fly-paper effect[15] has been empirically assessed by Henderson (1968) and Gramlich (1969). These two works are very relevant in policy-making literature since they have empirically demonstrated that if, in a municipality, per capita income and exogenous grants-in-aid increase by the same amount, the impact on local public spending is different and it is higher in the case of increasing external aid. Consequently, the public expenditure is stimulated more by the enhancement of an exogenous variable[16] rather than by the growth of a variable capturing regional economic conditions. However, it should be emphasized that the fly-paper effect is an ex-post empirical evidence. In our specific case, the additionality principle is ex-ante imposed by the European policy maker and the allocative decisions about regionalized ordinary spending may not be in line with the prescription.

[15] The author of this coding is Arthur Okun, who commented the empirical works of his colleagues as 'Money seems sticks where it hits' (Inman, 2008).

[16] In our case, cohesion funds cannot be considered as fully exogenous a-priori since the treatment is endogenous to the regional economic conditions (i.e., per capita GDP).

As highlighted by Brandsma *et al.* (2013), in order to eliminate the uncertainty regarding regional policy impact, it is crucial to consider explicitly the so-called policy implementation details, including additionality.

Over the years, and with the use of more and more sophisticated techniques, the assessment of additionality has become an important dimension of the more general evaluation of the effectiveness of the cohesion policy.

Formally, the additionality principle is assessed by the European Commission in cooperation with member states at three different stages and only for the convergence regions. At a first stage, the ex-ante evaluation is carried out at the beginning of each programming period. Indeed, as a general rule, the level of domestic expenditure must be kept at least equal to the level of annual average expenditure in real terms of the previous programming period. At a second stage, three years later, the mid-term evaluation checks whether the annual average expenditure is at least equal to the one that was agreed in the first phase. At this stage, the spending target is checked and revised if necessary. At a third stage, in the last phase, it is assessed whether there have been any differences between the ex-ante agreed level of public expenditure (or revised in mid-term evaluation) and the one calculated ex-post. In presence of discrepancies, the Commission proceeds with financial corrections.

Some contributions in the literature have dealt with evaluating the additionality principle using different econometric methodologies. Our literature review starts with the papers using an aggregate national (NUTS-1) sample and moves then to those that concern regional (NUTS-2) and sub-regional (NUTS-3) levels.

Wostner and Slander (2009) used EU-15 country data to analyse additionality from 1990 to 2006. Structural domestic spending at all government levels was regressed on European Funds and on some control variables. From the fixed effect panel estimation, the authors concluded that the European Structural Funds were totally additional with no substitution effect. González-Alegre (2012) also employed the EU-15 NUTS-1 sample in the period 1993-2005 by analysing, with panel fixed effect and GMM, the influence of cohesion policy on central, regional, and local government expenditures. The results found that cohesion policy was associated with an increase in public investments by around 60%.

The panel results by Mohl (2016) concluded that, during the 1982-2006 period and for EU-27 countries, no significantly positive effects of EU payments on public investments occurred.

Del Bo and Sirtori (2016) evaluated regional and sectoral displacement effects on the Italian regions for the 1996-2011 period with a research design focusing on time series methodology (AR (1) with a time trend). The results suggested a strong heterogeneity across regions. Overall, the southern and north-eastern regions had the most pronounced substitution effects while the sectoral displacement effect was negligible.

Szitásiová *et al.* (2014) evaluated the additionality principle with respect to public education improvement programs in Slovakia for the 2006-2010 period at the municipal level using a survey on treated municipalities. They analysed whether the recipients decreased their capital spending after receiving European support. The main result was the occurrence of a substitution effect in 10% of the municipalities. In particular, cities and more developed regions reduced domestic expenditure after support, while less developed areas complied with the additionality principle.

Janský *et al.* (2016) evaluated additionality on Czech municipalities for the period 2007-2014 by types of expenditure (investments, human resources, and operational costs) and by Operational Programs (OPs). The main OLS results were that, overall, the principle was fulfilled with some heterogeneity among the various OPs.

This chapter is part of the debate on the additionality degree of cohesion policy since it deals with some (unresolved) conceptual and methodological issues.

For the first time in literature, we evaluated for Italy the cohesion funds' additionality during two recent programming periods at regional (NUTS-2) and sectoral levels adopting a panel approach.

The sectoral breakdown may highlight potential differences in the degree of complementarity of cohesion funds with respect to domestic ordinary spending.

Methodologically, the sectoral-panel approach allows us to reduce the omitted-variable bias due to the inclusion of regional and sectoral determinants of government spending.

Moreover, we deal extensively with the potential endogeneity of the cohesion variables through instrumental variables (IV) techniques and Generalized Method of Moments (GMM).

One of the peculiarities of our work is the combined use of two unique databases available for the Italian public expenditure: *Opencoesione* (OC) and the Territorial Public Accounts (*Conti Pubblici Territoriali*, CPT).

In summary, this work aims to achieve a disaggregated analysis over several dimensions: the region-by-region (and the year-by-year) detail, the breakdown between ordinary policy and the cohesion one, and the sectoral distinction among public spending.

1.5 Empirical framework

1.5.1 Data and policy variables

The lack of sectoral analyses in the literature on additionality evaluation, particularly in a panel framework, is mainly due to the scarce availability of data concerning the last two (completed) programming periods. This approach requires, on the one hand, the regional and sectoral breakdown of public expenditure (both for ordinary and cohesion purposes) and, on the other hand, the availability of time-series expenditure data. To overcome this limitation, in this chapter we use two different data sources. For cohesion policy expenditure we rely on *Opencoesione*, a database managed by the *Dipartimento per le politiche di coesione*, in collaboration with the *Agenzia per la coesione territoriale* and the *Ragioneria Generale dello Stato*. This database contains information on expenditure in the two most recent (completed) programming periods (2007-13 and 2014-20).

Opencoesione (OC) is a project-based database where each project is monitored by location, sector, investment typology, state of the advancement both of expenditure flows and of project execution, for starting and completion years.

Data on domestic spending are extracted from *Conti pubblici territoriali* (CPT), an Italian database which includes the regionalized spending by all public administrations (as well as national or local public enterprises). In detail, this database traces all the overall expenditure flows of public administrations towards NUTS-2 territories. The payments are recorded according to the cash criterion (‘actual realization’ of the payments).

The CPT database differs from the other official Italian data, such as the *National Accounts* produced by the National Institute of Statistics (ISTAT), since the CPT database

does not carry out any accounting reclassifications. To regionalize the expenditure, this database attributes the flow to the region where the public intervention is localized following a bottom-up process based on actual reconstruction of all aggregates (Agenzia per la coesione territoriale, 2007). For the spending flows linked to the production of goods and services (and to the increase in the stock of non-financial capital), the regionalization is carried out on the basis of the physical location of the employed production factors. Instead, for the financial flows, the regionalization is linked to the site of the beneficiary.

Public spending is classified by function. The consolidation method avoids the occurrence of duplications excluding the expenditure from a public administration to another one dealing only with 'final expenditures'. Public spending is split into thirty sectors whose definition matches the sectoral classification in public administrations' budget (Agenzia per la coesione territoriale, 2007).

The Italian accounting system evolved by introducing this method exactly to systematize the expenditure flows from public administrations to the regions, in order to fulfil the European additionality constraint (Agenzia per la coesione territoriale, 2007). Initially, the compliance was proved with the ex-ante additionality table included in the *Quadro Comunitario di Sostegno (QCS)*. The article 2 of Law 64/1986 highlighted the relevance of coordination between ordinary and extraordinary (cohesion) interventions.

CPT and OC databases are different in terms of data aggregation methods and sectoral definitions. Therefore, the combined use requires a preliminary alignment exercise.

In this work we refer to some recent reports by the *Agenzia per la coesione territoriale* (Agenzia per la coesione territoriale, 2021) matching the thirty CPT sectors with the sectoral domain of OC in order to separate, from the overall CPT expenditures (the primary expenditure carried out by national, regional and local administrations as well as public enterprises) those having cohesion purposes.

Summarizing, the *Agency* selects all the projects in the OC sector which appears, at a first stage, the most compatible with the counterpart CPT sector. Secondly, as a check of the first stage, they carry out a textual search in the projects titles to avoid including in the considered sector projects belonging to another CPT sector. Finally, the *Agency* runs a keyword-based text search tracing all OC projects belonging to the corresponding CPT

sector. Furthermore, a part of OC projects was selected on the basis of their result indicators reported on *Opencoesione* database which were surely referable to the specific considered CPT sector.

As for the payments to the beneficiary, the *Agency* attributes a payment tranche to the year of the monetary disbursement.

From the information in the *Agency* publications, we calculated the raw data on cohesion policies payments, in order to separate ordinary policy from cohesion resources (including European cohesion policy, national co-financing and domestic cohesion funds).

To our knowledge, as it was also specifically pointed out by the *Agency* itself (Agenzia per la coesione territoriale, 2021), there are no current empirical analyses in the literature which employ both databases in a combined way.

The two data sources used are very relevant for economists and regional scientists since they allow to use data on all public expenditures allocated to regions at the same time disentangling ordinary policy from cohesion one. As known, these two policies have different purposes and address specific policy objectives.

In summary, CPT is a comprehensive database on sectoral regionalized annual public spending which aggregates ordinary and cohesion expenditures. On the other hand, OC contains only data having cohesion purposes.

By combining the two sources in a methodologically sound way, we are able to discriminate between the two types of policy for each sectoral and regional unit of analysis.

Clearly, this methodology is fully applicable to the Italian case giving the availability of data at a fine level of detail for this country.

However, an extension of the analysis to other European countries is theoretically feasible in case of data availability of public expenditure by sector and type of source (ordinary vs cohesion).

Due to its strong regional inequalities (see section 1.2), Italy is one of the main recipients of the EU cohesion policy (see section 1.3).

Moreover, the mitigation of inter-regional disparities has also been a strong policy objective of the national government. Indeed, economic and social cohesion has a legal foundation in Italy[17].

Foremost, the Italian government contributes to reinforcing the European cohesion policy through the (binding) national (and, to a lesser extent, regional) co-financing to the EU Funds by the *Fondo di rotazione per l'attuazione delle politiche comunitarie*. The co-financing share depends on the level of regional development. For the 2007-13 programming period, the co-financing was at least 25% for the Convergence objective regions. For the Competitiveness objective regions, the national co-financing had to be no less than 50%. Instead, in the 2014-20 programming period, the national co-financing varied from 50% to 85% depending on the category of the region, the priority axis and the specific structural Fund.

Moreover, the Italian government implements its regional policy with a specific development and cohesion fund (*Fondo di sviluppo e coesione* or FSC) established with the 2003 budged with the previous name of *Fondo per le aree sottoutilizzate* (FAS). The peculiarity of the FSC is its multi-annual nature since it has a programming period that coincides with the European one.

Two additional funds, specifically aimed at territorial cohesion, are the *Piano di azione e di coesione* (PAC, in the 2007-2013 period) and the *Piano operativo complementare* (POC, in the 2014-20 period).

The presence of a specific domestic cohesion policy allows the extension of the additionality evaluation to comprehensive cohesion resources (i.e., including both European and national).

1.5.2 Econometric strategy

Our research objective is to assess whether the allocation of Structural Funds and Italian cohesion policy may bias policy choices on ordinary spending allocation in the different sectors.

[17] The two legislative references are the article 119, paragraph 5 of the Italian Constitution and the Article 174 of the Treaty on the Functioning of the European Union.

For this purpose, we have implemented, for different sectors, a regional panel model in which public expenditure net of cohesion funds is explained by the cohesion policy and by a set of control variables suitable for explaining the sectoral domestic decisions. By including controls, we also reduce the omitted-variable bias related to the exclusion of sectoral determinants of government spending.

One of the main problems concerning public policy analysis is the treatment of potential endogeneity. This is not a negligible issue in our case given that we want to detect the causal impact of the European (and national) regional policy on ordinary one, trying to ascertain the occurrence of crowding-out effects across sectors. It is therefore crucial to correctly identify the parameters of interest.

Hence, in order to select the appropriate econometric estimation technique, after the model specification, illustrated in section 1.5.3, we deal extensively with the endogeneity issue (sections 1.5.4 and 1.5.5) before proceeding with model estimation (section 1.6).

1.5.3 Model specification

We focus on human capital and transportation network expenditure. In the *CPT* database they are split into *Education* and *Training* on the one hand and *Road Infrastructure* and *Other Transport Infrastructure*, on the other. Table 1.5 details the typology of expenditure included in each sector.

The period under scrutiny spans from 2009 to 2018[18] and we consider 20 NUTS-2 level Italian regions[19].

Following Gonzàles-Alegre (2015), the dependent variable is the regionalised annual public expenditure net of cohesion policies, in percentage of regional GDP. The main explanatory variable is the cohesion policy annual payments as defined in section 1.5.1, also expressed in percentage of regional GDP (see Gonzàles-Alegre, 2015).

[18] The last available year for the *Road Infrastructure* sector is 2017.

[19] Though most of the regional databases in Italy allows to distinguish between the two autonomous provinces of Trento and Bolzano inside the Trentino Alto Adige region, this breakdown was not available for the databases used in our analysis. So, we combined the two provinces into one region.

Table 1.5: Definition of sectors and expenditure typology

Sector of analysis	***Italian Label on CPT***	***Typology of expenditure***
Education	Istruzione	- Administration and functioning of public schools and university (net of research) - School and university building - Ancillary education services - Support to the right to education and educational trips.
Training	Formazione	- Training and careers guidance and relative structures - Technical teaching aids - Promotion of the territorial rebalancing of the professional and training structures improving quality and efficiency.
Road Infrastructure	Viabilità	- Construction, use and maintenance of street and highways - Installation of bridges, tunnels, and parking - Public lighting - Management of licensing activity.
Other Transport Infrastructure	Altri Trasporti	- Construction, use and maintenance of all transport infrastructure except streets and highways - Local public transport (including local public transport by road) - Management of licensing activity.

Source: Agenzia per la coesione territoriale, 2007

More specifically, the model follows the equation:

$$OP_{it} = \beta_0 + \beta_1 CP_{it-1} + \beta_2 RD_{it-1} + \beta_3 \mathbf{SV}_{it-1} + v_{it} \qquad (1.1)$$

$$v_{it} = u_{it} + a_i$$

$$i = 1, \ldots, N; \quad t = 1, \ldots, T$$

where, OP_{it} is the ordinary policy which includes the comprehensive regionalized public expenditure net of cohesion resources, CP_{it} is the cohesion policy variable including the European Structural Funds, the national cohesion ones and the national co-financing related to EU Funds, RD_{it} is a regional development variable (i.e., the logarithm of real per capita gross domestic product) included in all the sectoral regressions, **SV** is a matrix of controls of sectoral/regional endowments which represent the indicators used for allocating national public spending to a specific sector/region and v_{it} is the composite error including the zero-mean random error term (u_{it}) and the regional-specific effect (a_i).

To test for the robustness of the results to the change in the sectoral variable, we estimated different model specifications which vary according to the chosen endowment indicator.

For *Education*, we considered three endowment variables, capturing the sectoral dimension in a region in terms of number of students (sectoral model specification (a) in table 1.6), classes (sectoral model specification (b)) and schools (sectoral model specification (c)) at both primary and secondary education levels. The endowment variable was defined in percentage of the school population ranging between 5 and 19 years. The implicit assumption is that the increase in the regional endowment, as previously defined, would increase the maintenance costs of school infrastructure and of all the other related spending financed by ordinary policy.

The sectoral variables chosen for the *Training* sector were the percentages of employed (sectoral model specification (a) in table 1.6) and non-employed (sectoral model specification (b)) involved in education and training activities over the population between 25 and 64 years. We also used the percentage of population between 25-64 years participating in lifelong learning (sectoral model specification (c)).

For the *Road Infrastructure* sector, we used the length in kilometers of the provincial and regional roads divided by the population (sectoral model specification (a) in table 1.6) or, alternatively, the number of road accidents per 1.000 inhabitants (sectoral model specification (b)).

Finally, for the *Other Transport Infrastructure* sector, we considered the railway[20] index expressed as the number of kilometres of the railway network per 100.000 inhabitants (sectoral model specification (a) in table 1.6) and two indicators representing the demand (sectoral model specification (b)) and the supply (sectoral model specification (c)) of local public transportation (LPT): the number of passengers carried by local public transportation (LPT) per inhabitant and the number of kilometers travelled for 1000 inhabitants available in LPT of provincial capitals[21].

All data are extracted from Italian National Institute of Statistics (ISTAT) databases.

[20] We cannot use airport and port indicators given the heterogeneity in the transportation mode among the Italian regions.

[21] This number is obtained by multiplying the number of kilometers travelled per years by local transportation vehicles times their average capacity and then dividing it by the population multiplied by 1000.

1.5.4 The cohesion policy endogeneity: methodology

The three potential sources of endogeneity are the measurement errors associated to sample selection, omitted variables and reverse causality. For the estimation accuracy of our estimates, all three may be non-negligible, especially the last one. Indeed, the funds spent annually could be influenced by ordinary policy. Also, a potential cause of endogeneity may come from the other explanatory variables of the model.

To reduce the occurrence of endogeneity, we lagged each control variables by one year. The same was done for the cohesion variable. Furthermore, we treated its potential endogeneity in a much more detailed way.

Endogeneity arises when the causal relation is not well specified. Given an equation with a vector of exogenous (X_{1it}) and a vector of endogenous explanatory variables (X_{2it}):

$$y_{it} = \alpha + \beta X_{1it} + \beta X_{2it} + u_{it} \tag{1.2}$$

A regressor x_{it} is endogenously determined (belonging to the vector X_{2it}) when it is correlated with the model error term, i.e., one of the classic OLS hypotheses, namely, $\text{Cov}(x_{it}, u_{it}) = 0$, is not in force.

The consequence of endogeneity is the bias and inconsistency of OLS estimates for all the explanatory variables coefficients (i.e., not only for those involving the endogenous variable) which will lead to misleading conclusions.

The IV approach allows us to detect endogeneity in order to use two-stage least-squares (2SLS) if endogeneity occurs. The application of the IV procedure requires a vector of instruments Z_{it} not included in the main equation (the so-called excluded instruments) satisfying two constraints, namely:

(a) Relevance (inclusion restriction)

(b) Exogeneity (exclusion restriction)

The first condition states that the instrument must be highly correlated with the potential endogenous variable, namely that $\text{E}(z_{it}\, x_{it}) \neq 0$. The validity of this condition can be verified through the *F*-statistic of the first-stage regression obtained by regressing the endogenous variable x_{it} on the instrument z_{it} and on all the exogenous variables (belonging to the vector X_1).

The literature (Stock *et al*., 2002) asserts that if we employ only one instrument, the *F*-test must be greater than 10. In general, it would be better to obtain a value above 18. Many empirical studies have demonstrated the improper application of 2SLS with a weak instrument (low relevance) due to the inefficiency of the estimations (Bound *et al.*, 1995; Staiger and Stock, 1997; Stock *et al.*, 2002).

The second condition claims that the instrument must not be in a causal relation with the dependent variable, namely that $E(z_{it}\, u_{it}) = 0$. Therefore, z_{it} must affect y_{it} only through the instrumented variable x_{it}. The exclusion restriction is not testable empirically in an explicit way (Wooldridge, 2009). There is no specific test evaluating instrument exogeneity if the model is exactly identified (number of instruments equal to number of potential endogenous variables). In applied economic analyses, the procedure is to employ instruments conceptually unrelated (or less related) with the dependent variable.

Instead, if the model is overidentified (number of instruments greater than the number of potential endogenous variables) we can perform the Hansen and Sargan test[22] (Hansen, 1982; Sargan, 1988), namely $J = nR^2 \sim \chi^2_q$.

In our context, we tested the cohesion variable endogeneity by performing the Durbin-Wu-Hausman (DWH) test to ascertain whether the model in eq. (1.1) would be better estimated by 2SLS or IV or simply by OLS techniques.

We started the analysis by looking for some sector-specific variables, conceptually viable as instruments for the cohesion policy variable. We looked for variables having strong correlation with cohesion policy by being, at the same time, exogenous to ordinary policy.

Then, we tested econometrically whether the potential instruments would satisfy both the constraints. An empirical proof on the instruments exogeneity (*J*-test) was needed in our context since the test used to detect the cohesion endogeneity (Durbin-Wu-Hausman test) performed in section 1.5.5 is powerful exclusively with highly exogenous instrument (instruments validity).

[22] The test is equal to nR^2 where n is the number of sample units, R^2 is the R-squared obtained from the regression of 2SLS residuals on all exogenous variables. The test is distributed as a χ^2 with q degrees of freedom corresponding to the number of overidentification restrictions (the number of instruments minus the number of endogenous variables). Under the null hypothesis, the instruments are all unrelated to error u. If we reject H_0 the instruments are correlated with the error and therefore they should not be used (Wooldridge, 2009). The test is consistent when coefficients are corrected for heteroskedasticity and autocorrelation (HAC-Consistent estimation).

We used as instruments those regional indicators which are taken into account in the design of Regional Operational Programs (ROPs) as context indicators. We employed sector-specific indicators because they are actually used to guide the sectoral allocation of regional policy. In this sense they can be considered as potential instruments for cohesion policy disbursement at regional/sector level.

The selected instruments for regional policy differ from the sectoral variable set (**SV**) included in the equation (1.1) of our model and described in section 1.5.3 since the SVs represent the sectoral dimension in terms of endowment and we used them to (potentially) explain the domestic ordinary policy (our dependent variable).

Instead, the instruments for regional policy are context indicators extracted from a specific ISTAT database (*Banca dati indicatori territoriali per le politiche di sviluppo*) which is used in the ROPs' design. This should conceptually ensure a high correlation (inclusion restriction[23]) between regional policy and the sectoral context indicators used.

We use the one-year lag of the instruments with respect to cohesion policy since these indicators are indeed predetermined for cohesion policy decisions.

For robustness, we also considered a delay of three years with respect to the cohesion policy variable to take into account a longer lag between decision and policy operationalization. Therefore, the instruments are lagged two years (z_{t-2}) and four years for robustness (z_{t-4}) with respect to the ordinary policy.

Beside the conceptual motivation, the delay of instruments has also an econometric basis. The delay could make the instruments more exogenous with respect to the dependent variable, since ordinary and cohesion policies follow different programming rules. Therefore, it is likely that a delay at least of two periods for the instruments with respect to ordinary policy makes them even less related to it. This requirement is crucial when only an instrument is used to test the cohesion endogeneity since, as known, the exclusion restriction with a single instrument is not econometrically testable.

We selected two instruments for each sector. The definitions of the sectoral instruments follow:

[23] The inclusion restriction is econometrically checked through the *F*-test reported in table 1.6.

For *Education* sector:

- *Junior High School*: share of population between 15 and 19 years with at least a lower secondary school diploma (z_1^E);
- *School drop-out*: share of dropouts in the second year of upper secondary school (z_2^E).

For *Training* sector:

- *Drop-out in training activities*: share of population between 18 and 24 years with at most a junior high school diploma, which has not completed a vocational training course (z_1^T);
- *Youth unemployment*: youth unemployment rate for 15-24 years range (z_2^T).

For *Road Infrastructure* sector:

- *Openness to international trade*: exports plus imports as a percentage of GDP (z_1^R);
- *Labor productivity*: value added of transport sector per worker (z_2^R).

For *Other Transport Infrastructure* sector:

- *Openness to international trade*: exports plus imports as a percentage of GDP (z_1^O);
- *Labor productivity*: value added of transport sector per worker (z_2^O).

Table 1.6 reports the *J*-test (exogeneity/overidentification restrictions) and the *F*-test (relevance/inclusion restriction) for each sector.

We calculated *J*-test using both instruments (number of instrument greater than endogenous variable). In the case of rejection of the null hypothesis, at least one of the instruments should be considered as endogenous.

In this circumstance, the test does not clearly tell which of the two instruments is endogenous (they may be both), but the failure to reject the null hypothesis is a proof of instruments exogeneity (Wooldridge, 2009) and we can use the instruments to test them for the cohesion endogeneity test (as in the section 5.2.3). For each model specified in equation 1.1 we reported the *J*-test calculated with alternative delays of *Zs* (two- and four-year delay with respect to the dependent variable: z_{t-2} and z_{t-4}).

From the analysis of this table, it emerges that in all sectors, except for *Training*, the instruments are highly correlated with the cohesion variable (see the *F*-test relevance

or inclusion restriction) and strongly exogenous to ordinary policy since we accept the null hypothesis of the *J*-test (exclusion restriction).

Therefore, the instruments in the *Education*, *Road Infrastructure* and O*ther Transport Infrastructure* sectors overcame both constraints and could be used in the cohesion endogeneity tests. Despite an ambiguous conclusion for *Training* (low value of the *F*-test), we proceeded to calculate the cohesion endogeneity test also for this sector.

Table 1.6: Exogeneity test of sectoral instrumental variables

	Instruments	***z_{t-2} J-test***	***z_{t-4} J-test***
Education	*Junior high school* (z_1^E)	(a) J = 1.43 (0.231) F = 27.39	(a) J = 0.06 (0.813) F = 27.24
	School drop-out (z_2^E)	(b) J = 1.54 (0.214) F = 26.67	(b) J = 0.04 (0.833) F = 26.39
		(c) J = 1.58 (0.208) F = 28.67	(c) J = 0.04 (0.849) F = 28.28
Training	*Drop-out in training activities* (z_1^T)	(a) J = 0.37 (0.543) F = 3.33	(a) J = 0.50 (0.480) F = 3.17
	Youth unemployment (z_2^T)	(b) J = 0.62 (0.431) F = 2.20	(b) J = 0.58 (0.444) F = 3.18
		(c) J = 0.27 (0.601) F = 2.89	(c) J = 0.50 (0.478) F = 3.11
Road Infrastructure	*Openness to international trade* (z_1^R)	(a) J = 0.61 (0.433) F = 18.53	(a) J = 0.11 (0.744) F = 20.57
	Labor productivity (z_2^R)	(b) J = 0.12 (0.728) F = 18.27	(b) J = 0.00 (0.986) F = 20.32
Other Transport Infrastructure	*Openness to international trade* (‘z_1^O)	(a) J = 0.21 (0.648) F = 42.10	(a) J = 0.55 (0.457) F = 39.26
	Labor productivity (z_2^O)	(b) J = 0.15 (0.697) F = 29.98	(b) J = 1.21 (0.270) F = 28.07
		(c) J = 0.00 (0.971) F = 31.02	(c) J = 0.46 (0.498) F = 28.88

Notes: For each sector, model (eq. 1.1) changes its specification according to the sectoral control variable. They are for *Education*, (a): students, (b): classes, (c): schools; for *Training*, (a): employed involved in training, (b): non-employed involved in training, (c): adults involved in lifelong learning; for *Road Infrastructure*, (a): roads endowment, (b): road accidents; for *Other Transport Infrastructure*, (a): railway, (b): LPT (demand), (c): LPT (supply).

1.5.5 Testing cohesion policy endogeneity

Endogeneity must always be verified before proceeding to the estimation through 2SLS. Indeed, if a potentially endogenous variable is in fact exogenous, the 2SLS estimates are less efficient than OLS and they generate misleading conclusions since this method calculates very large standard errors (Wooldridge, 2009).

To test the endogeneity of the cohesion variable, we performed the so-called Durbin-Wu-Hausman (DWH) test.

Assuming, as regressors, an endogenous (x_{1it}) and two exogenous variables (x_{2it}, x_{3it}):

$$y_{it} = \beta_0 + \beta x_{1it} + \beta x_{2it} + \beta x_{3it} + u_{it} \quad (1.3)$$

the initial step of the test is the first-stage regression with the potentially endogenous variable as dependent variable and, as regressors, the explanatory variables of equation (1.3) and the instruments. With two instruments[24] z_{1it}, z_{2it}, the first-stage regression is the following:

$$x_{1it} = \beta_0 + \beta x_{2\,it} + \beta x_{3it} + \beta z_{1it} + \beta z_{2it} + v_{it} \quad (1.4)$$

Under the hypothesis of instruments' exogeneity[25], z_{1it} and z_{2it} are unrelated to u_{it}, and x_{1it} is unrelated to u_{it} if and only if v_{it} and u_{it} are independent. Writing the relation between u and v_{it} as: $u_{it} = \gamma v_{it} + e_{it}$, we test if $\gamma = 0$ to conclude the independence between u_{it} and v_{it}.

In turn, we must consider the estimated residuals of the first-stage regression (1.4), and add them as additional explanatory variable of (3):

$$y_{it} = \beta_0 + \beta x_{1it} + \beta x_{2it} + \beta x_{3it} + \gamma \hat{v}_{it} + r_{it} \quad (1.5)$$

The endogeneity test is the *t*-statistic associated to the coefficient of the estimated residuals of first-stage regression. If we accept the null hypothesis at 5% of statistical significance, we conclude that cohesion is exogenous in equation (1.1).

The results of the endogeneity test, its *p*-value in parenthesis, and the related *F*-test for instruments relevance, are reported in tables 1.7-1.10 for each sector using an instrument at a time and both instruments simultaneously.

[24] The test is equivalent including a single instrument or more than two.
[25] The condition of instruments exogeneity is tested through the Sargan-Hansen *J*-test preliminarily to the DWH endogeneity test, as we did in section 1.5.4.

From table 1.7 to 1.10, we conclude that the cohesion variable is exogenous at 5% significance level for *Education*, *Road Infrastructure* and *Other Transport Infrastructure* regardless of the included instrument and of the considered delay. Therefore, for these three sectors the implementation of 2SLS was discarded and we proceeded with the estimation through OLS with regional fixed effects.

The results for the *Training* sector (table 1.8) are inconclusive for two reasons. First, the *F*-test for the inclusion restriction presents a low value. Second, the endogeneity test of the cohesion variable depends on the instrument used. Thus, we estimated the model (1.1) using both a 2SLS setting and an OLS one to see if the results differ depending on the applied methodology. However, the 2SLS results should be treated with caution since the literature does not suggest the application of 2SLS with a weak instrument due to the inefficiency of the estimations (see section 1.5.4).

Table 1.7: Endogeneity test (DWH) for the *Education* sector with instruments at t-2 and t-4

Instrument / Models	***(a)***	***(b)***	***(c)***
Junior high school – z_1^E	*t-2* DWH = -0.23 (0.821) F = 36.35 *t-4* DWH = 1.39 (0.181) F = 36.50	*t-2* DWH = -0.21 (0.835) F = 35.48 *t-4* DWH = -0.29 (0.774) F = 35.29	*t-2* DWH = -0.28 (0.786) F = 37.81 *t-4* DWH = -1.42 (0.172) F = 37.64
School drop-out – z_2^E	*t-2* DWH = 1.55 (0.139) F = 36.63 *t-4* DWH = 1.79 (0.090) F = 36.51	*t-2* DWH = 1.71 (0.104) F = 35.68 *t-4* DWH = 1.90 (0.072) F = 35.35	*t-2* DWH = 1.55 (0.137) F = 38.40 *t-4* DWH = 1.88 (0.076) F = 37.83
Both z_1^E and z_2^E	t-2 DWH = 0.61 (0.551) F = 27.39 *t-4* DWH = 1.55 (0.138) F = 27.24	*t-2* DWH = 1.21 (0.242) F = 26.67 *t-4* DWH = 1.04 (0.310) F = 26.39	*t-2* DWH = 1.42 (0.172) F = 28.67 *t-4* DWH = 1.07 (0.298) F = 28.28

Notes: The model specification varies according to the sectoral variable: (a): students, (b): classes, (c): schools.

Table 1.8: Endogeneity test (DWH) for the *Training* sector with instruments at t-2 and t-4

Instrument / Models	***(a)***	***(b)***	***(c)***
Drop-out in training activities – z_1^T	*t-2* DWH = 1.04 (0.313) F = 3.07 *t-4* DWH = 1.32 (0.203) F = 2.98	*t-2* DWH = 2.40 (0.027) F = 2.35 *t-4* DWH = 2.08(0.051) F = 2.41	*t-2* DWH = 1.35 (0.192) F = 2.77 *t-4* DWH = 1.37 (0.186) F = 2.72
Youth unemployment rate – z_2^T	*t-2* DWH = 1.57 (0.133) F = 3.83 *t-4* DWH = -2.51 (0.021) F = 3.64	*t-2* DWH = 2.91 (0.009) F = 2.58 *t-4* DWH = -3.73 (0.001) F = 3.55	*t-2* DWH = 1.79 (0.090) F = 3.21 *t-4* DWH = -2.73 (0.013) F = 3.56
Both z_1^T *and* – z_2^T	*t-2* DWH = 1.88 (0.075) F = 3.33 *t-4* DWH = -2.14 (0.046) F = 3.17	*t-2* DWH = 3.22 (0.004) F = 2.20 *t-4* DWH = -3.18 (0.005) F = 3.18	*t-2* DWH = 2.09 (0.050) F = 2.89 *t-4* DWH = -2.42 (0.026) F = 3.11

Notes: The model specification varies according to the sectoral variable:
(a): employed in training, (b): non-employed in training, (c): adults involved in lifelong learning.

Table 1.9: Endogeneity test (DWH) for the *Road Infrastructure* sector with instruments at t-2 and t-4

Instrument / Models	***(a)***	***(b)***
Openness to international trade – z_1^R	*t-2* DWH = -0.73 (0.474) F = 24.21 *t-4* DWH = 1.24 (0.230) F = 24.49	*t-2* DWH = -0.33 (0.745) F = 24.13 *t-4* DWH = 1.37 (0.187) F = 24.44
Labor productivity – z_2^R	*t-2* DWH = -0.80 (0.436) F = 24.63 *t-4* DWH = 0.02 (0.988) F = 27.55	*t-2* DWH = -0.63 (0.536) F = 24.00 *t-4* DWH = -0.10 (0.925) F = 27.13
Both z_1^R *and* z_2^R	*t-2* DWH = -0.91 (0.375) F = 18.53 *t-4* DWH = 0.09 (0.929) F = 20.57	*t-2* DWH = -0.68 (0.502) F = 18.27 *t-4* DWH = 0.06 (0.953) F = 20.32

Notes: The model specification varies according to the sectoral variable: (a): roads endowment, (b): road accidents.

Table 1.10*:* Endogeneity test (DWH) for the *Other Transport Infrastructure* sector with instruments at t-2 and t-4

Instrument / Models	***(a)***	***(b)***	***(c)***
Openness to international trade – z_1^O	*t-2* DWH = -0.04 (0.968) F = 43.49 *t-4* DWH = -0.45 (0.655) F = 43.34	*t-2* DWH = 0.08 (0.934) F = 35.13 *t-4* DWH = -0.52 (0.608) F = 34.62	*t-2* DWH = 1.30 (0.208) F = 35.58 *t-4* DWH = -0.10 (0.918) F = 35.08
Labor productivity – z_2^O	*t-2* DWH = 0.89 (0.383) F = 54.20 *t-4* DWH = 0.43 (0.674) F = 49.44	*t-2* DWH = 0.88 (0.388) F = 40.01 *t-4* DWH = 0.84 (0.413) F = 37.28	*t-2* DWH = 0.99 (0.335) F = 41.11 *t-4* DWH = 0.65 (0.525) F = 38.04
Both z_1^O *and* z_2^O	*t-2* DWH = 0.83 (0.417) F = 42.10 *t-4* DWH = 0.28 (0.781) F = 39.26	*t-2* DWH = 0.86 (0.401) F = 29.98 *t-4* DWH = 0.76 (0.459) F = 28.07	t-2 DWH = 1.08 (0.292) F = 31.02 *t-4* DWH = 0.68 (0.506) F = 28.88

Notes: The model specification varies according to the sectoral variable:
(a): railway, (b): LPT (demand), (c): LPT (supply).

1.6 The impact of cohesion policy on ordinary expenditure

We estimated model (1.1) with regional fixed effects. As known, the econometric literature (Wooldridge, 2009) states that the inclusion of the individual (regional) fixed effects is more appropriate for panel analysis when we have a limited sample size.

Individual fixed effects are robust to potential specification errors and they produce unbiased estimated coefficients also with potential omitted time-invariant characteristics since they are designed to control for regional-specific factors. The standard errors were adjusted through the Huber and White correction (robust Huber/White standard errors). The results of the model estimations are presented, for each sector, in tables 1.11-1.14.

The analysis shows that there is a strong heterogeneity in the measurement of cohesion policy additionality across sectors. In the two sectors belonging to the human capital dimension, cohesion policy seems to crowd-out ordinary policy as the estimated FE-OLS coefficient is negative and statistically significant.

In addition, from the comparison between the estimation of the different specifications inside each table, we may conclude that, in all sectors, the coefficients of the policy variable are robust to the choice of the sectoral endowment variable.

However, the difference in magnitude should be highlighted: in the *Education* sector (table 1.11) the decrease in domestic spending due to cohesion policy is more than proportional.

Table 1.11: Effects of cohesion policy on ordinary policy in *Education*

Variables / Models	***(a)***	***(b)***	***(c)***
Cohesion Policy	-2.3373*** (-4.04)	-2.3881*** (-4.13)	-2.3619*** (-3.88)
Real per capita GDP	1.6599** (2.27)	1.5744* (2.05)	1.6372** (2.18)
Students	0.0139* (1.74)		
Classes		0.2456* (1.91)	
Schools			1.4574** (2.38)
N.obs	200	200	200
R^2	0.4183	0.4250	0.4085

Notes: Robust t-test in parentheses.
***: p-value < 0.01, **: p-value < 0.05, *: p-value < 0.10.

On the contrary, in the *Training* sector (table 1.12), the FE-OLS coefficient is (in absolute value) smaller than 1. But, as stated before, for the *Training* sector, we were not able to conclude in favor of the exogeneity of the cohesion variable since the results of the endogeneity test depended on the instruments used.

Thus, to understand if the estimation method influences the results, we estimated the model also through FE-2SLS using the instruments for which cohesion policy appeared (consistently across the model specifications) to be endogenous in the results of table 1.8 (youth unemployment rate, z_2^T, alone and in combination with drop-out in training, z_1^T and z_2^T, calculated at *t-4*).

From table 1.12, we see that there are substantial differences between FE-OLS and FE-2SLS results.

By instrumenting cohesion policy, the crowding-out effect traced by the FE-OLS method does not occur in FE-2SLS and in some specifications the coefficient is also positive and significant at 5% level.

Despite the lack of solid evidence of cohesion policy exogeneity, the OLS results (attesting a crowding-out effect in this sector) are methodologically more robust, compared to the 2SLS results, since the IV estimations were performed with weak instruments.

Table 1.12: Effects of cohesion policy on ordinary policy in *Training*

Variables / Models	***(a) OLS***	***(a) 2SLS*** z_2^T	***(a) 2SLS*** $z_1^T - z_2^T$	***(b) OLS***	***(b) 2SLS*** z_2^T	***(b) 2SLS*** $z_1^T - z_2^T$	***(c) OLS***	***(c) 2SLS*** z_2^T	***(c) 2SLS*** $z_1^T - z_2^T$
Cohesion Policy	-0.7198*** (-4.67)	0.8285 (1.36)	0.7405 (1.28)	-0.5584*** (-3.95)	1.0164** (2.51)	0.9778** (2.49)	-0.6740*** (-4.19)	0.9406 (1.63)	0.8644 (1.59)
Real per capita GDP	0.4194 (1.66)	1.2016*** (3.32)	1.1571*** (3.30)	0.5937** (2.27)	1.3203*** (4.78)	1.3025*** (4.78)	0.4566* (1.74)	1.2652*** (3.62)	1.2270*** (3.64)
Employed in training	-0.0147*** (-3.47)	-0.0013 (-0.21)	-0.0021 (-0.34)						
Non-employed in training				-0.0067 (-0.69)	0.0050 (0.53)	0.0047 (0.51)			
Lifelong learning							-0.0154** (-2.72)	0.0003 (0.04)	-0.0003 (-0.05)
N.obs	200	200	200	200	200	200	200	200	200
R^2	0.3549			0.2913			0.3350		

Notes: Robust t-test in parentheses. ***: p-value < 0.01, **: p-value < 0.05, *: p-value < 0.10.

Moving to the transportation dimension, the results were more in favor of additionality. For the *Road Infrastructure* sector (table 1.13), the sign is positive but not statistically significant, attesting the neutrality of cohesion policy for the ordinary policy allocation.

Table 1.13: Effects of cohesion policy on ordinary policy in *Road Infrastructure*

Variables / Models	***(a)***	***(b)***
Cohesion Policy	4.3746 (0.94)	4.5536 (0.98)
Real per capita GDP	3.5306*** (3.16)	2.7527* (2.07)
Street endowment	0.1097** (2.45)	
Road accidents		0.1200 (1.62)
N.obs	180	180
R^2	0.2435	0.2380

Notes*:* Robust t-test in parentheses.
***: p-value < 0.01, **: p-value < 0.05, *: p-value < 0.10.

On the contrary, the cohesion funds appear to enhance ordinary policy for the *Non-Road Transportation* (table 1.14).

Table 1.14: Effects of cohesion policy on ordinary policy in *Other Transport Infrastructure* sector

Variables / Models	***(a)***	***(b)***	***(c)***
Cohesion Policy	0.9208 (1.41)	1.0590* (1.94)	1.2157* (1.90)
Real per capita GDP	1.1092* (1.73)	1.1224* (1.85)	1.0114 (1.64)
Railway index	0.1045** (2.25)		
LPT (demand)		0.0014 (1.24)	
LPT (supply)			0.1567* (1.80)
N.obs	200	200	200
R^2	0.1868	0.1436	0.1699

Notes: Robust t-test in parentheses.
***: p-value < 0.01, **: p-value < 0.05, *: p-value < 0.10.

For robustness, we performed our sectoral models by applying the Generalized Method of Moments developed by Arellano and Bond (Arellano and Bond (1991), GMM-AB) including the one-period lag of the dependent variable.

Table 1.15 shows the coefficient of cohesion policy in the GMM-AB estimation for each sector. The findings confirm the crowding-out effect in the *Education* and *Training* (which validates the OLS results compared to the 2SLS ones) sectors, the neutrality of cohesion policy in the *Road Infrastructure* sector and its additional effect in the *Other Transport Infrastructure* sector.

Table 1.15: Sectoral coefficients of cohesion policy - GMM-AB estimation

Sectors/ Models	***(a)***	***(b)***	***(c)***
Education	-1.2420*** (-5.82)	-1.2269*** (-5.64)	-1.2527*** (-5.97)
Training	-0.3162*** (-3.87)	-0.2355*** (-2.78)	-0.2883*** (-3.66)
Road Infrastructure	1.7623 (1.17)	2.1787 (1.41)	
Other Transport Infrastructure	1.4570 (1.64)	1.6567** (2.05)	1.7404** (2.12)
N.obs	160	160	160

Notes: Robust t-test in parentheses. ***: p-value < 0.01, **: p-value < 0.05, *: p-value < 0.10. For each sector, model (eq. 1.1) changes its specification according to the sectoral control variable. They are for Education, (a): students, (b): classes, (c): schools; for Training, (a): employed involved in training, (b): non-employed involved in training, (c): adults involved in lifelong learning; for Road Infr., (a): roads endowment, (b): road accidents; for Other Transport Infr., (a): railway, (b): LPT (demand), (c): LPT (supply). The number of observations in the *Road Infrastructure* sector is 140 since its last available year is 2017.

As for the other explanatory variables, in all FE-OLS models, per capita income (selected as a proxy of the general economic condition of the regional economy) is positively related to ordinary public spending.

According to the estimates, the level of regional development affects the dimension of sectoral ordinary public expenditure in a pro-cyclical fashion. This result is consistent with the Wagner Law (Wagner, 1890) which affirms that the higher the level of economic development, the greater the level of public expenditure required.

Indeed, one of the versions of Wagner Law assumes that there is a positive relationship between public expenditure divided by GDP and the per capita GDP and that the causal link goes from per capita income to public expenditure.

As for the sectoral variables, the relation between them and ordinary investment policy should be positive since these variables capture the sectoral endowment.

In the *Education* sector, domestic spending increases following the increase any of the three sectoral variables considered since operating costs grow with size.

Instead, for the *Training* sector, the relation between the sectoral variables and ordinary expenditure is not clear negative in OLS estimates (and non-significant in 2SLS estimates).

In the *Road Infrastructures* and *Other Transport Infrastructure* sectors, all the endowment variables are consistently positive and generally statistically significant. This is because the more developed is the existing transport network, the higher will be the maintenance costs required and the related ordinary investment policy.

To summarize the most relevant finding, the influence of regional policy on ordinary one is different by sector of expenditure.

This may have a possible explanation if we look at the actual implementation of the policy.

The findings of *Human Capital* may be linked to the management of human capital policies. Indeed, these policies are mostly governed by local administrations (such as regions, provinces and municipalities) which in the past years receive major funding from EU policy[26].

Instead, it is usual, at least in Italy, that the infrastructure investments in transportation are carried out in lots. The additionality may then refer to the fact that, having obtained a European funding, for instance, for a railway track lot, the completion of the public work is later financed through specific national programs, i.e., the National Transport Plan (‘*Piano Nazionale Trasporti*’) and the Regional Transport Plans (‘*Piani Regionali Trasporti*’).

[26] We would thank one of the external evaluators for this comment.

1.7 Conclusion

This chapter tries to estimate the effect of the additionality of cohesion policy on the allocative choices of the domestic expenditure by using a regional panel framework differentiated by sector for the Italian economy.

We have considered regional specificities by adding individual fixed effects and controlling for regional and sectoral specific variables. We also have extensively dealt with the potential endogeneity and the potential reverse causality between cohesion and ordinary capital expenditure policy.

The main value added of the chapter with respect to the existing literature comes from the discovery of a strong sectoral heterogeneity in the evaluation of the additionality principle.

The impact of cohesion policy on ordinary capital expenditure turned out to be very different across the different sectors of intervention. While in the transportation infrastructure domain, additionality seems more pronounced, a crowding-out effect becomes evident dealing with human capital projects.

Therefore, ordinary capital expenditure policy seems to be not exogenously determined with respect to the cohesion one. Moreover, only in some sectors, cohesion funds appear to create a stimulus to increase ordinary spending.

This calls for greater coordination between national ordinary capital expenditure policy and cohesion policy in order to avoid that cohesion projects would act to determine a reduction of domestic spending, especially in the human capital domain.

These policy implications are very relevant in the dispute on the efficiency of public expenditure, in particular in evaluating the interactions between ordinary spending and additional resources.

The propulsive or, at least, the neutral role of cohesion funds in *Road* and *Non-Road Transport* expenditure can be regarded with favour. The crowding-out effect of cohesion funds in *Human Capital* is instead not desirable since it regards a strategic sector. In this case, despite the (ex-ante) additionality rule in force, the ordinary disbursements appear to be replaced with cohesion ones after obtaining the treatment[27].

These results led to an important rethinking of the additionality principle.

[27] A change in the specification of the policy variables (in per capita terms) confirmed the found results except for the *Education* sector for which the crowding-out effect was not evident.

In our opinion, the supervision of European Commission over EU Funds' additionality should be maintained and even more strengthened. Recipient countries should clearly demonstrate to the Commission that, in all sectors of intervention, the cohesion treatment has not reduced ordinary disbursements. The reverse situation can only be justified during an (exogenous or endogenous) economic downturn which may cause significant budget problems.

As for national cohesion policy, it could be further strengthened the specific coordination between the spending authorities of the national cohesion policy and those of ordinary investments[28].

If this is not the case, the presence of regional policies may increase territorial imbalances.

Up to now, the main limitation of this study is its country-specific character. The analysis concerning Italy should be tested on other European countries to improve its generality and facilitate a comparison across countries. Data availability for other countries is a prerequisite to perform such extension.

As it will be discussed more extensively in the concluding remarks of the thesis, some evolutions of this chapter can be the extension to the analysis to other sectors which capture other relevant dimensions of economic growth, such as, for instance, environmental and cultural sector and the investigation of the potential heterogeneity of cohesion funds' additionality among Northern and Southern regions.

[28] Ordinary interventions are not only managed by the central government but also by decentralized administrations (regions, local authorities, public enterprises).

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Chapter 2

Spatial spillovers and Cohesion Policy effectiveness: an ex-post evaluation for NUTS-3 Italian regions

Summary of the Chapter

In the implementation of investment public projects addressed to a specific territory, the spatial interdependence may produce positive spillovers when the projects' outcomes are also captured by neighbouring areas. On the contrary, they may develop displacement effects if the policy affects mainly or totally adjacent territories. The chapter deals with this issue by exploring the link between spatial spillovers and displacement effects in the European and national cohesion policy outcomes. The policies' impact in two programming periods (2007-13 and 2014-20) is estimated for the Italian NUTS-3 regional growth through a spatial Durbin model which disentangles the impacts on the treated areas (direct effects) from those captured by the neighbours (indirect spillover effects). The chapter also takes into account the possible influence of the Great Recession on cohesion funds' effectiveness and on spillover relevance and direction by considering an interaction dummy variable between the cohesion treatment and the crisis years. The data set was reconstructed from the *Opencoesione* database and deals with registered expenditures related with completed projects. Our main results show that the spatial autocorrelation pattern seems to have generated a remarkable impact on the effectiveness of European regional policy at NUTS-3 regional (provincial) level, producing, in some cases, displacement effects. On the opposite, national cohesion interventions appear positively correlated both directly and indirectly (i.e., through spillovers mechanism) with provincial growth. During the crisis years, all the positive direct and indirect policies' effects have drastically reduced, highlighting the sensitivity of the policy impact to negative exogenous shocks.

2.1 Introduction

The goal of the European cohesion policy is the mitigation of social, economic and territorial imbalances through disbursements to regions in structural deficit under defined and relevant convergence objectives.

At the beginning of the European Economic Community's project, in 1957, the first attempt was the institution of the European Social Fund (ESF) 'to promote employment opportunities and geographical mobility within the Community and professional of workers' (Treaty establishing the European Economic Community, art. 123). Under the Single European Act (1987), *economic and social cohesion* became a specific target.

The policy has acquired relevance over time due to a persistent unequal well-being distribution. Even now, with the new programming period (2021-27) just started, regional incomes are far from convergence[29].

The importance of these issues at European level also lies in the implications they may have for the society. Indeed, well-being heterogeneity is one of the possible sources of social tensions and popular discontent (Bénabou, 1996). Moreover, the European unification process needs to receive strong support. Empirical evidence demonstrated that regional policy may be seen as a channel to increase consensus to EU since the decrease in votes towards Eurosceptic parties is associated with greater cohesion investment (see, for instance, Rodriguez-Pose and Dijkstra, 2020).

The implementation mechanism advanced over time through the transition from a redistribution to a territorial development policy. Since 1984, the decision on the allocated amount is subject to the regional-specific economic performance. Previously, the Funds' shares were disbursed on a national basis regardless of territorial context indicators. Therefore, the analysis of the effectiveness of cohesion funds in reaching predetermined targets has now become more and more relevant at the regional level.

Another important step followed, with the establishment of the European Regional Development Fund (ERDF) in 1975.

[29] For instance, in 2018, the PPS regional per capita income, as a percentage of the European average, varied in a range between 30% of the French Mayotte region and 263% of Luxembourg (Eurostat 2020 data).

The policy objectives were enucleated in the 1989-93 programming period and enriched in the 2007-13 one when the distinction of resources by thematic area became a specific feature of EU regional policy.

In the recent programming periods, the Partnership Agreement is set by each State in collaboration with the European Commission and binds the national and regional Operational Programs (OPs) to reach specific measurable targets. During the European Semester, the Agreement is subject to modification if the country receives a Commission' advise to align the program with the European overall growth strategy.

Four principles (concentration, multiannual programming, partnership, and additionality) are applied and the regions are divided into groups according to their level of per capita GDP. The regions are included in the main Objective[30], if their per capita GDP is less than 75% of the European average.

The cohesion policy evolution has not only concerned the design and the implementation mechanisms, but also the allocated resources. In the 2007-13 programming period, allocations amounted to 347 billion while in the 2014-20 period they increased to 352 billion, more than one third of the EU budget.

This chapter produces new evidence on the European cohesion policy impact by focusing on a potential channel of ineffectiveness when the economic effects fall totally outside the treated areas.

In particular, we try to shed light on the capability of spatial spillovers to activate displacement effects by using a research design based on a panel spatial Durbin model which distinguishes direct impacts on treated units from indirect effects on neighbouring ones.

Our novelties with respect to the existing literature are the following. The chapter, for the first time in the literature, compares the direct and the indirect (spatial) outcome of *EU* cohesion funds to the same outcomes for national cohesion funds. We also focus on the Italian provincial growth pattern during the latest programming periods (2007-13 and 2014-20) before the current one (2021-27). The provincial (NUTS-3) level was chosen for conceptual and methodological reasons. Foremost, at this scale, we capture the potential heterogeneity within regions and we better detect the spillovers since they

[30] This objective is called 'Growth and employment' in 2014-20, whereas it took the name of 'Convergence' Objective in the 2007-13 programming period and of 'Objective 1' in the previous ones.

may be more relevant across provinces due to spatial proximity and local economic linkages.

Moreover, at this geographical level, we reduce a potential source of endogeneity of cohesion policies given that the Funds' distribution is strongly endogenous to regional (NUTS-2) economic performance while it is not directly established at NUTS-3 level. Therefore, some provinces within a (NUTS-2) region, might have outperformed the region in which they are administratively included and viceversa.

As said, the years under scrutiny were partially crossed by the 2008-crisis, known as the 'Great Recession'. Cohesion funds may have fostered resilience or, on the contrary, the crisis may have reduced policy outcomes.

We capture the policy effects during the downturn with the estimation of crisis specific coefficients by using interaction dummy variables between cohesion funds and the Great Recession period.

Third, to carry out the analysis, we used a project-based data set of fully operational projects (see Gambina and Mazzola, 2023) reconstructed from the Italian cohesion policies' database, *Opencoesione*, by excluding uncompleted or blocked interventions.

Indeed, by using aggregated accounting data (such as payments or commitments), as most studies do, we lose information on how to eliminate from the macro aggregates the payments related to blocked or ongoing projects. To avoid the occurrence of this type of bias, we exploit the detail of *Opencoesione* database by extracting only operational projects which appeared more suitable to look at the overall economic effects of the policy.

Our annually completed projects are quite exogenous to provincial growth since the policy decision is contingent to the economic conditions of previous years.

The rest of the chapter is structured as follows: the second section is devoted to the illustration of the theoretical background related to the occurrence of spatial spillovers in place-based policies; the third section contains the literature review; the fourth and fifth sections deal, respectively, with our research design and results, while the sixth section concludes with policy implications.

2.2 The influence of spatial spillovers on place-based policies' outcomes

Both public debate and empirical literature show contrasting results on the effectiveness of cohesion policy for regional economic growth and convergence.

As for the role of spatial proximity on policy effectiveness, two (opposite) strands of literature emerge. The first (see, for instance, Barro, 1990) attributes the role of 'productive expenditure' to public interventions. In this framework, transport infrastructures, communication networks and business support infrastructures, which are among the typical cohesion policies' interventions, may generate potential spatial spillover effects.

On a different ground, studies in the New Economic Geography framework on the agglomeration and dispersion forces of economic activities (Baldwin *et al.,* 2003) dispute the hypothesis that public intervention is always effective in reversing the regional growth paths.

Indeed, in a north-south equilibrium (Core-Periphery model), a condition of path-dependence could be established, thus making the policy unsuitable for fostering economic convergence. Among other things, cohesion investments, specifically aimed at adapting transport infrastructures in lagging regions, may lead to a reduction in transport costs and, by this way, may determine a concentration of productive activities that, ultimately, could favour income divergence instead of convergence.

Therefore, although cohesion policy is a channel to improve sustained growth and convergence at the European level through projects addressed to citizens, businesses, and infrastructural adjustments in the most vulnerable areas, its spatial impact may generate relevant pitfalls.

Indeed, the spatial spillover effects are inherently positive if they imply the spread of public investment gains over the territories close to the 'treated' areas.

However, spillovers may translate into displacement effects if regional policy effects are caught only (or mainly) by the neighbouring territories.

The detection of the potential causes of (ex-post) policy ineffectiveness is a leading topic in cohesion policy-making in order to adjust the strategy in the following programming periods.

2.3 A literature review on ex-post evaluation of cohesion policy

The economic literature dealing with the impacts of regional development policy is widespread but there is no unanimous agreement regarding the effectiveness of the policy.

The lack of consistency across the empirical results may be due to different factors such as: data sample choice (NUTS-2, NUTS-3, municipality-level, firm-level), response variable used (per capita GDP or, more rarely, employment rate or labour productivity), programming period under scrutiny, control variables.

Some studies adopt a cross sectional specification, others use panel data on allocations by regions and time periods.

The employed methodology may also play a significant role. Indeed, each method allows to control some specific aspects, leaving out others. The prevailing techniques in the literature are OLS, GMM, macroeconometric models (Bradley *et al.*, 2003, Varga and Veld, 2011), panel data methods and, more recently, regression discontinuity design (Becker *et al.*, 2010; Pellegrini *et al.*, 2013; Gagliardi and Percoco, 2017; Giua, 2017; Crescenzi and Giua, 2020).

The lack of coherence on the results has increased curiosity but also doubts among scholars and in the public opinion. The analyses take place in a larger context related to the evaluation of public policies' efficiency.

Following the neoclassical scholars, public intervention is not required to rebalance any redistributive gap: the competitive mechanism of the market guarantees an efficient allocation of resources (Smith, 1776) and it could ensure sustained regional growth. According to this perspective, the study by Boldrin and Canova (2001) concluded that the Structural Funds were not effective for regional convergence.

A further criticism addressed to cohesion policy is its potential trade-off between equity and efficiency because even if the policy mitigates the disparities (equity), the principle of efficient allocation of the resources may be not fulfilled. Indeed, it claims to allocate most of the funds to regions that already have advantages in terms of economic indicators (Pieńkowski and Berkowitz, 2015) following the hypothesis that these may guarantee higher spending quality.

A trade-off between equity and efficiency is traced in the works of Fratesi and Perucca, 2014 (Central and Eastern European provinces in the 2000-2006 period) and Fratesi and Perucca, 2019 (European provinces in the 2000-2006 period) who concluded that the Structural Funds' effectiveness was mediated by the favourable territorial context.

Cappelen *et al.* (2003) have already pointed out that cohesion policy was more effective in the most advanced European countries between 1980-1997.

Similarly, Ederveen *et al.* (2006), concluded that, at country-level, cohesion funds' impact was mediated, from 1960 to 1995, by favourable context factors such as commercial openness, low corruption and institutional quality.

The importance of institutional quality has been stressed also by Rodrìguez-Pose and Garcilazo (2015).

Conversely, Mohl and Hagen (2010) found that, in 124 EU regions during 1995-2005 period, the Structural Funds had a positive and significant impact only on the Objective 1 regions.

Similarly, Pinho *et al.* (2015), in their analysis on 137 regions in the 1995-2009 period, concluded that the territories more influenced by Structural Funds had low initial levels of human capital and technological development.

Few studies have yet considered the effect of the Great Recession, such as Merler (2016), Bachtrögler (2016) and Becker *et al.* (2018). Among these, the first study found a positive effect of cohesion policy even in the crisis period. No spatial spillovers were included in these analyses.

As for studies focusing on the Italian case, Percoco (2005) assessed the 1970-1994 programming period focusing on southern[31] Italian results. In his work, Puglia and Basilicata appeared to be the best performing regions benefiting from EU Funds.

Aiello and Pupo (2012) found that the impact of the Funds on southern regions was greater than on northern ones from 1996 to 2007.

Giua (2017) concluded that regional policy had an impact on the employment growth rate in southern municipalities mainly concentrated in some strategic sectors.

Coppola *et al.* (2020), instead, found that European Funds explained economic growth more than other national resources in the 1994-2013 period.

[31] Except Abruzzo and Sicily due to data availability.

On a different ground, the analyses capturing the impact of spatial effects did not reach unanimous results.

Some of these studies take into account the spatial structure of the data to increase the estimation precision. Others provide policy implications about the disbursements' impact on the treated areas and on the neighbouring ones through the spatial pattern. The studies deal with spatial effects inside different methodological frameworks.

Ramajo *et al.* (2008) assessed, through an exploratory spatial data analysis (ESDA) approach, the presence of spatial patterns by discriminating the NUTS-2 regions belonging to the 'convergence countries' (Ireland, Greece, Portugal, and Spain) from the others. They concluded that the best performing regions were part of the convergence sample.

Pérez *et al.* (2009) used an interregional input-output model for Spanish regions in the 1995-1999. They found an interregional positive spillover effect and a specific EU Funds effect on lagging regions' employment.

Crescenzi and Giua (2020) employed the spatial regression discontinuity design method with a threshold of policy-change-boundary between NUTS-3 Objective 1 regions (treated) and others (non-treated) and showed that cohesion policy had a pronounced impact in Germany and the United Kingdom. In Italy, no positive effect emerged after the crisis period.

Moving to spatial econometric models, Dall'Erba and Le Gallo (2008) considered the spatial effects by implementing a spatial lag model for the European NUTS-2 regions in the 1989-1999 period. They found the presence of a positive spatial autocorrelation, and that the Structural Funds did not contribute to the convergence of the per capita GDP.

Falk and Sinabell (2008) included the spatial effects implementing a cross-sectional spatial lag and a cross-sectional spatial error model for the per capita income growth. The sample was composed of 1.084 NUTS-3 European regions over the 1995-2004 period. In this analysis, the cohesion variable was captured by a dummy for the treated areas. They found a significant role for both the spatial effects and the treatment effectiveness.

De Castris and Pellegrini (2012) evaluated the spatial spillover effects of the regional policies implemented in the South of Italy in the period 1996-2001. By employing a spatial autoregressive model, the authors detected some spatial displacement

effect in terms of employment attraction by treated regions from neighbouring areas.

Hruza *et. al* (2019) estimated a SAR model for the per capita GDP growth of Czech Republic regions in the 2004-2015 period, showing strong spillover effects between areas and positive cohesion policy effectiveness.

Fiaschi *et al.* (2018) assessed the impact of regional policy for enhancing the labour productivity in 175 NUTS-2 regions during 1991-2008 period with an SDM. The Funds addressed to the Objective 1 regions were relevant for the productivity growth of the same areas, but also had significant indirect spillover effects.

Breidenbach *et al.* (2019) used a spatial Durbin model (SDM) to analyse the per capita GDP growth of 127 European regions in the 1997-2007 period displaying a negative effect of Funds on growth due to spatial spillovers (displacement effects).

Antunes *et al.* (2020) used an SDM for the per capita income growth of 95 European regions in the 1995-2009 period showing no direct or indirect cohesion fund's effectiveness.

In synthesis, from the international literature, it emerges that spatial spillover effects are not negligible but the evidence toward strong displacement effects is not clear.

The analyses concentrating on the Italian case have rarely considered spatial effects explicitly.

Our spatial analysis in the following sections deals with some gaps that we found in the previous literature.

One of the main novelties of our analysis compared to the existing literature is the use of data referring to completed projects. Commitments or payments data are useful to trace the progress of a public program. However, they may generate biases in the policy assessment since they may include information related to blocked or incomplete projects. Thus, we tried to overcome this data pitfall by using actual project data and eliminating uncompleted projects.

We extracted the sub-sample of completed cohesion interventions from the *Opencoesione* database.

In addition, we contrast the European regional policy effectiveness (implemented through the European Regional Development Fund and the European Social Fund) with the impact of an alternative investment policy, the national cohesion policy (implemented

through the *Fondo di sviluppo e Coesione* and the *Piano di azione e coesione*) by investigating the relative role of spatial spillovers in the two contexts.

In the Italian case, the employment of *Opencoesione* allows this comparison.

Indeed, there are no current empirical evidence on the role of spatial spillovers on EU cohesion policy outcome in contrast with the national cohesion policy impact by adopting a NUTS-3 level perspective.

Another advantage from *Opencoesione* was the possibility of including the national co-financing to EU Funds. In fact, the data on national co-financing are difficult to be obtained from European Commission data, even more at the provincial level.

The inclusion of national co-financing to the EU Funds is very relevant to their assessment since these resources complement those coming from European cohesion funds.

In the Italian empirical literature, there are other works using a project-based data source. Ciani and de Blasio (2015) used *Opencoesione* to analyse the Fund's impact on local labour markets (LLM) in southern Italy by aggregating payments of European cohesion projects.

Similarly, Albanese *et al.* (2021) used the same aggregated projects payments on southern Italian LLM to evaluate the ERDF effectiveness through different methodologies (panel fixed effects, LASSO operator and spatial RDD).

Giua *et al.* (2022) extracted from *Opencoesione* a sub-sample of 'immigrant-related' projects implemented in Italian municipalities to test their impact on immigrants' economic integration.

Other contributions employed the same data base (*Opencoesione*) to evaluate some Funds' management features. Arbolino and Boffardi (2017) and Arbolino *et al.* (2019), for instance, calculated some indices, such as the 'commitment index' (funds that the regions declared to invest on the total allocations), or the 'financial realization index' (funds spent at the end of programming period over total funds) and the 'management efficiency index' (total payments divided by total available EU funding).

Lastly, Boffardi *et al.* (2022) compared the expected and effective dates of projects conclusion to produce an index describing the stage of projects' implementation during the 2007-13 programming period at regional level. This last analysis also pointed

out the relevance of the projects timing as completion dates and the actual use of the allocated funds.

However, none of these studies have used the *Opencoesione* data to evaluate the effect of spillovers on regional and provincial growth. We also investigate the differential effects of a severe global crises (the Great Recession) on Structural and Investment Funds' impact of spillovers.

2.4 Empirical framework

2.4.1 The Italian NUTS-3 economies: some descriptive statistics

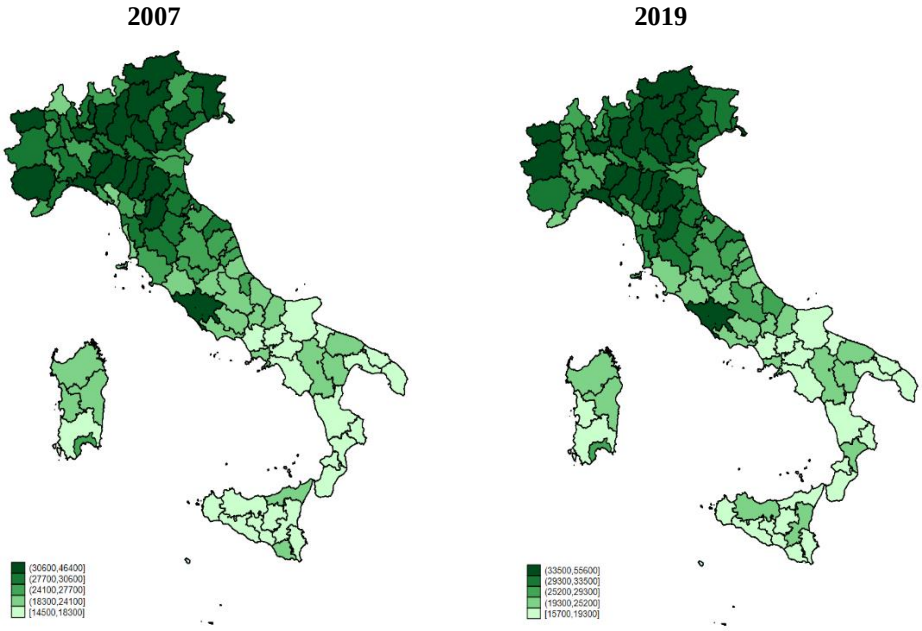
Our analysis focuses on the growth of Italian provinces during 2007-2020 time span. Table A1 in the Appendix presents some per capita GDP descriptive statistics (mean, standard deviation, minimum and maximum values) of the 107 Italian provinces.

Income per capita decreases moving from North to South and it emerges a certain level of inequality within the regions (with income mainly concentrated in the province of the regional capitals).

Figure 2.1 shows the distribution of income per capita across Italian regions. The economic gap favouring the North is substantially unchanged at NUTS-3 level in the scrutinized period.

The high heterogeneity of income per capita has also required a national cohesion policy in addition to the European one. This is an Italian peculiarity since not all European countries invest in domestic cohesion interventions.

Figure 2.1: Quantile of per capita income levels: years 2007 and 2019, respectively



Source: Authors' elaborations.

2.4.2 Data

The panel database was reconstructed starting from the information contained in *Opencoesione*, the Italian cohesion policies database managed by the Italian Cohesion Policy Department (*Dipartimento per le politiche di coesione)*, in collaboration with the Territorial Cohesion Agency (*Agenzia per la coesione territoriale)* and the State General Accounting Office (*Ragioneria generale dello Stato)*. The main purpose of this database is to increase the spending accountability by including the detailed information related to each project. The database is also useful for potential beneficiaries of European support as it describes all funding opportunities.

We have chosen this data source since a project-based data can be more representative than financial allocations data (such as commitments or payments) to capture the impact of cohesion resources. As mentioned above, accounting data may introduce bias and misleading result in policy evaluation when referred to ongoing or blocked projects which are not fully able of generating economic effects.

Therefore, we considered only data related to completed projects which have been imputed to the year of completion.

The information on completed projects ranges from 2008 to 2017. This information has been calculated for a sample of 103 Italian provinces[32].

We considered all the projects financed through cohesion policies by making a distinction between European and national interventions. For the first, the resources of the ERDF and the ESF were considered. The focus on Italy, and the use of the *Opencoesione* information, allowed us to include in the European policy also the national co-financing[33] (by *Fondo di rotazione per l'attuazione delle politiche comunitarie*). Indeed, data on government co-financing to EU Funds is not available for all countries, especially if disaggregated at NUTS-3 level.

National cohesion interventions were instead implemented by specific Funds (*Fondo di Sviluppo e Coesione* or FSC, former *Fondo Aree Sottoutilizzate* or FAS and *Piano di Azione e Coesione*[34] or PAC).

The two regional policies follow different management rules and projects selection criteria. The empirical assessment of both policies at the provincial level is not easy due to lack of data. By using *Opencoesione* information we reconstructed a NUTS-3 level database specific to the European cohesion projects and another homogeneous data set for national cohesion projects.

The two cohesion variables were expressed in per capita terms following most of the existing literature (see, for instance, Coppola *et al.*, 2020; Rodrìguez-Pose and Novak, 2013; Rodriguez-Pose and Garcilazo, 2015).

Our dependent variable is the logarithmic growth of the provincial per capita GDP expressed in constant terms. We used the three-year average of these values to control for short-run cyclical variations.

All the aggregates in the explanatory variable set were calculated in the initial year of the three-year period to reduce the endogeneity problem. In addition to the initial level of per capita GDP (to test for beta convergence), this set includes three types of variables.

[32] In the Italian statistical analyses, Italy is currently divided into 107 NUTS-3 units. However, in this work we have excluded the provinces which have been modified or established during our considered period. These are Monza and Brianza, Fermo and Barletta-Andria-Trani, established in 2004 but made operational from 2009 and, finally, South Sardinia, established in 2016.

[33] As Coppola *et al.* (2020) referring to the Italian NUTS-2 regions and Ciani and de Blasio (2015) relating to Italian Local Labor Markets.

[34] Operative since 2012.

The first group is composed of policy variables, namely the European cohesion policy (ECP) variable, which includes the national co-financing, and the national cohesion policy one (NCP).

The second group includes relevant variables which may act as control variables since they take into account the specific features of the local economy. In detail, this set includes:

1) Population density (attractiveness index). This variable is potentially suitable for solving the problem of omitted-variable bias since it is a proxy of urbanization. If an area is more crowded, it offers a greater availability of good facilities and infrastructures such as schools, hospitals, local transport and so on, by acting, at the same time, as a relevant workplace. We expect a positive role for this variable (Becker *et al.,* 1999 and Glaeser, 1999). Data came from the Italian national statistical institute (*Istituto nazionale di statistica*, ISTAT).

2-3) Public specialization (labour market resilience index) and agricultural specialization (index of vulnerability to exogenous shock). Specialization in public and in agricultural sectors was taken into account in order to capture the production structure of local economies. We have selected specifically these indicators as more sensitive in a period of economic crisis. Indeed, a higher specialization in the public sector should improve resilience in terms of jobs. We, therefore, expect a positive sign for the coefficient related to this variable. Conversely, the agriculture sector is very vulnerable to exogenous shocks such as climate change, the introduction of sustainable process innovations, international trade (Urruty *et al.,* 2016) and so on. We expect a negative sign for the coefficient related to this variable. Both indicators were calculated using the ISTAT provincial employment series.

4) Trade openness (competitiveness index). Openness to international trade (calculated by trade balance as a percentage of the provincial value added using the ISTAT series) is a proxy for provincial competitiveness. There is an agreement in the literature on the propulsive role of internationalization for economic growth (see for instance, Romer, 1990; Harrison, 1996; Frankel and Romer, 1999 and Wacziarg, 1999).

5) Graduates (human capital index). The accumulation of human capital, defined as tertiary education rate (30-34-year range) in our analyses, is one of the main

determinants of economic development (Mincer, 1981). Data came from ISTAT database.

The third set of variables includes elements of a composite indicator developed in the literature known as 'territorial capital' (Camagni, 2008 and Camagni, 2009). These elements describe additional local economy characteristics with strong territorial content such as infrastructural, natural, relational and social capital. In detail, this set includes:

6) Infrastructural capital. The role of public infrastructure in stimulating economic growth has been much debated and explored among economists (i.e., see Aschauer, 1989; Munnel, 1990a, 1990b and 1992). In our work, given the heterogeneity of Italian provinces, we considered the road endowment index calculated by *Istituto Tagliacarne* (as in Mazzola *et al.*, 2018 and Lo Cascio *et al.*, 2019).

7-9) Natural, relational and social capital. As proxies for natural, relational and social capital, we examined the available indicators among those proposed for Italy by Nifo and Vecchione (2014). For natural capital, we considered the availability of urban green space per inhabitant. Relational capital was proxied by the ratio of cooperative firm employment on total employees. Finally, for social capital, we selected a crime indicator (denounced crimes per 100.000 inhabitants). All data were available in the ISTAT database. Ex-ante we expect a positive coefficient for natural and relational capital and a negative coefficient for social capital.

Table 2.1 shows the descriptive statistics of the dependent variable, the policy variables and the controls.

Table 2.1: Variables' descriptive statistics

Variable	***Mean***	***Std. Dev***	***Min***	***Max***
Per capita income growth (%)	1.59	4.97	-21.88	26.35
EU Cohesion Policy (per capita euro)	43.87	51.02	0	416.74
National Cohesion Policy (per capita euro)	6.94	15.39	0	157.16
Population density (log)	5.18	0.76	3.66	7.89
Public specialization (% of total employment)	19.65	4.09	11.13	30.77
Agricultural specialization (% of total employment)	5.30	4.14	0.33	19.90
Trade openness (% of added value)	3.15	16.07	-74.10	51.48
Tertiary education rate (% of 30-34-years)	20.19	4.87	3.70	37.4
Street quality (index)	104.88	50.01	29.61	263.03
Urban green space (m^2 per inhabitants)	50.49	112.76	2.8	1008.10
Cooperative firms (% of total employment)	4.21	1.43	1.45	11.34
Denounced crimes (per 100000 inhabitants)	16.77	4.90	7.70	49.40

Source: Our elaborations.

To take into account the potential impact of the Great Recession on cohesion policies' effectiveness, we inserted two dummy variables capturing the interaction between the crisis years and the cohesion policy variables[35]. The impact of the Great Recession is difficult to establish a priori since Structural Funds may have acted positively in favouring the resilience of some local economies. Instead, in case of negative sign, the occurrence of a severe global downturn would be associated with a slowdown in Funds' effectiveness.

2.4.3 Econometric strategy

Relaxing the classical hypothesis of spatial independence between spatial units, the variation of an independent variable of the *j*-th unit will have a potentially non-zero effect on the dependent of the *i*-th unit: $\partial y_i/\partial x_{jk} = S_k(W)_{ij}$.

The derivative of y_i with respect to x_{ik} is not simply β_k since the explanatory variable *k* in unit *i* influences the dependent variable in unit *i* (direct effect), but also the dependent variable of unit *j* (indirect effect or spillover) and there may be a feedback effect towards the *i*-th area (LeSage and Pace, 2009) such as $\partial y_i/\partial x_{ik} = S_k(W)_{ii}$.

The explanatory power of the model estimation increases by controlling for spatial autocorrelation bias. For policy evaluation purposes, the employment of specific spatial models allows us to discriminate the direct and indirect policy impact through the analysis of the spillovers mechanism.

In this work we modelled the spatial dependence through a spatial Durbin model (SDM) in a panel approach (equation 2.1). The model encompasses both spatial autoregressive (SAR) and spatial error (SEM) models. The two nested model specifications are described in equation (2.2) and (2.3) respectively.

$$Y_{it} = \alpha + \sum_{(k=1)}^{K} x_{itk}\beta_k + \rho\sum_{(j=1)}^{N} w_{ij}y_{jt} + \sum_{(k=1)}^{K}\sum_{(j=1)}^{N} w_{ij}x_{jtk}\gamma_k + \mu_i + \lambda_t + \varepsilon_{it} \qquad (2.1)$$
$$i = 1,\ldots,N \qquad t = 1,\ldots,T$$

$$Y_{it} = \alpha + \sum_{(k=1)}^{K} x_{itk}\beta_k + \rho\sum_{(j=1)}^{N} w_{ij}y_{jt} + \mu_i + \lambda_t + \varepsilon_{it} \qquad (2.2)$$
$$i = 1,\ldots,N \qquad t = 1,\ldots,T$$

[35] The first dummy is the interaction between European Funds and the crisis years (2008-2009-2010-2011-2012), the other is the interaction between national cohesion funds and the same years.

$$Y_{it} = \alpha + \sum_{(k=1)}^{K} x_{itk}\beta_k + \mu_i + \lambda_t + v_{it} \qquad (2.3)$$
$$v_{it} = \delta W v_{it} + \varepsilon_{it}$$
$$i = 1,\ldots,N \qquad t = 1,\ldots,T$$

where ρ is the scalar parameter displaying the degree of spatial dependence between the various Y_{ij}. β and γ are the vectors of fixed and unknown coefficients, μ_i are the individual fixed effects to control for (time invariant) territorial-specific features, λ_t are the time fixed effects to control for global time-specific shocks, ε_{it} are the error components.

The coefficients w_{ij} are part of the W spatial matrix of the distances. We used a NxN non-negative and non-stochastic binary queen-contiguity matrix such as:

$$\mathrm{W} = \begin{cases} w_{i,j} = 1 \ if \, d_{i,j} = 0 \\ w_{i,j} = 0 \ otherwise \end{cases} \qquad (2.4)$$

The spatial weights were normalized to have the sum of each row equal to one (normalization method per row), namely:

$$\sum_{j=1}^{n} w_{i,j} = 1 \qquad (2.5)$$
$$i = 1,\ldots,n$$

The SAR specification assumes that the dependent variable of the *i*-unit is directly spatially associated with the dependent variable of other units. The SEM model considers the spatial data structure only in the disturbance term due to unobserved characteristics. This makes the SEM estimation not very different from the non-spatial OLS approach.

The spatial Durbin model degenerates into SAR when H_0: $\gamma = 0$ is accepted and it reduces to SEM when H_0: $\gamma + \rho\beta = 0$. The rejection of both hypotheses implies that the specification that fits best the data is SDM. The advantages in the explanatory power of SDM compared to SAR and SEM are several.

First, it better detects the spillover effects. SDM assumes not only that the dependent variable of the *i*-th unit is associated with the dependent variable of the *j*-th unit (i.e., the third term in equation (2.1)), but also that y_i depends on the explanatory variables of the neighbouring economies (fourth term).

Second, neglecting the spatial dependence in the dependent or in the explanatory variables has a consequence on the estimation accuracy since the omission from a regression of relevant independent variables produces biased and inconsistent estimation of the coefficients of all the included variables (Greene, 2005; Elhorst, 2012).

Third, SDM estimates unbiased and efficient coefficients even if the data generating process can be modelled through one of the two nested SAR and SEM models (LeSage and Pace, 2009).

The three models estimate the direct (diagonal elements of the effects matrix) and indirect (off-diagonal elements of the effects matrix) coefficients according to table 2.2.

The direct impacts are the average effects of a variation in x_i on y_i, the spillover impacts measure the average effects of a change in x_i on all neighbouring spatial units y_j.

Table 2.2: Direct and indirect impacts according to model specification (Halleck Vega and Elhorst, 2015)

Model	***Direct effects***	***Indirect effects***	***Spillovers type***
SDM	$\{(\mathbf{I} - \rho\mathbf{W})^{-1} \times (\beta_k\mathbf{I} + \gamma_k\mathbf{W})\}^{d*}$	$\{(\mathbf{I} - \rho\mathbf{W})^{-1} \times (\beta_k\mathbf{I} + \gamma_k\mathbf{W})\}^{rsum**}$	global
SAR	$\{(\mathbf{I} - \rho\mathbf{W})^{-1} \times (\beta_k\mathbf{I})\}^{d*}$	$\{(\mathbf{I} - \rho\mathbf{W})^{-1} \times (\beta_k\mathbf{I})\}^{rsum**}$	global
SEM	β_k	0	None

Notes: * The operator that calculates the mean diagonal element of a matrix.
** rsum is the operator that calculates the mean row sum of the nondiagonal elements.

The direct effects comprise feedback effects, i.e., the effect of x_i on j that come back on i. In the SDM specification, this is partly due to the coefficient of the spatially lagged dependent variable and partly due to the coefficient of the spatially lagged explanatory X_i (Elhorst, 2010). In the SAR approach, feedback effect goes only through spatially lagged Y_j.

The inclusion of feedback loops in the direct effects makes these effects different from the impact effects captured by βs.

In a non-spatial strategy, the total effects are underestimated, since the computation of β_k by OLS does not comprise feedback loops, partially omitting the comprehensive effects of x_{ik} on y_i (Gibbons and Overman, 2012; Gibbons *et al.*, 2015).

Moving from SEM to SAR and to SDM, the estimations improve accuracy and, for our policy evaluation purposes, the relevance of the inclusion of **X** and **Y** spatial delays (SDM) lies in a better estimation of total policy effects.

As for the comparison between the three models, and in particular between SAR and SDM, we better detect the spillover influence on policy outcomes, since the two specifications differ solely by the inclusion, in SDM, of spatially lagged coefficients of explanatory variables and especially of our two policy variables (EU and national cohesion policy).

For a correct estimation procedure, LeSage and Pace (2009) and Elhorst (2010) warn that the spatial analysis should start by specifying the spatial Durbin model and subsequently tests for the two exclusion restrictions to eventually choose one of the two nested models. Moreover, model selection should also be based on strong economic theoretical grounds (Cook *et al.,* 2015) depending on the case study.

Fixed effects (FE) were added following the consolidated literature (see, for instance, Wooldridge, 2009) which asserts that the FEs are better to control for territorial-specific factors, mitigating the omitted-variable bias, in particular, when the regional sample covers the total national population, as in our case. We also computed the Hausman test to check explicitly for restrictions.

2.5 Results

2.5.1 The impact of European cohesion policy on provincial growth

Table 2.3 shows the results of SDM estimation with only the first and second sets of explanatory variables focusing on EU policy impacts. For robustness check we replicated the analysis with the addition of the third set of variables (table 2.4).

Both SAR and SEM restrictions were rejected, thus the full SDM model fits better the data. The Hausman test selected the fixed effect model over the random ones.

The spatial lag of the dependent variable turns out to be positive and strongly significant. This empirically highlights, also for the Italian case, that spatial interactions lead to the association between neighbouring areas' growth (Anselin and Bera, 1988).

The EU cohesion projects seem to have exerted strong positive spatial spillovers on provinces near to the 'treated' ones.

The spatial spillover effects activated by the EU cohesion policy on neighbouring areas may have been due to the inter-regional (inter-provincial) trade and economic linkages following the benefits from the EU Funds[36].

On the contrary, the impact on recipients is not statistically significant and the direct effect is less significant than the indirect one.

Comparing all these effects, the positive direct effect is, in our case, totally due to the feedback effect since the impact coefficient is not statistically significant. Therefore, the policy appears to have not affected the treated units directly but only in a mediated way through their spatial interactions.

Since the indirect effects dominate, both in magnitude and in significance, the direct effect, there is evidence that the European cohesion policy projects generate some displacement effects that reduce the effectiveness of the overall policy.

Hence, there is evidence of the non-neutrality of spatial spillovers in the European territorial development policy.

The sign of the dummy variable coefficients capturing the effect of the crisis, shows that spillovers effects have drastically reduced during crisis period.

As for the other explanatory variables, Italian local economies seem to exploit the proximity of provinces with high population density. The two specialization variables confirm the initial assumptions: the stability of public employment is a strong resilience factor, while the vulnerability of the agricultural sector slows down provincial growth. The trade openness of the *i*-th province is positively related to the growth of the same province but less for neighbouring areas.

Economies with high levels of human capital tend to cluster since the tertiary education rate is positive both in terms of direct effects and in terms of indirect effects.

Moving to the additional control variables, the infrastructural endowment exerts a stronger role indirectly rather than directly. This result confirms how the Italian territories are linked by strong social and economic relations. A high crime rate is harmful to economic growth, while, on the opposite, natural capital is beneficial. The territories exploit positively the proximity of other economies with a marked attitude towards associationism and cooperation.

[36] We would thank one of the external evaluators for this observation.

Table 2.3: Estimations results of SDM-FE model (2008-2017) – European cohesion policy effectiveness

Variables	***Impact effects***	***Direct effects***	***Indirect effects***	***Total effects***	***Variables***	***Spatial effects***
Wy	0.26369*** (6.55)					
GDPpc	-82.7145*** (-27.84)	-84.5781*** (-28.62)	-34.7069*** (-7.56)	-119.2851*** (-24.33)	*W*GDPpc*	-5.3200 (-0.91)
EU Cohesion Policy (ECP)	0.0031 (1.22)	0.0047* (1.95)	0.0307*** (6.49)	0.0355*** (6.61)	*W*ECP*	0.0230*** (5.88)
*Crisis years*ECP (GRxECP)*	-0.0028 (-0.63)	-0.0051 (-1.29)	-0.0533*** (-7.72)	-0.0587*** (-7.89)	*W*GRxECP*	-0.0040*** (-6.34)
Population Density (Attractiveness)	1.4064 (0.20)	4.1257 (0.61)	49.9793*** (4.02)	54.1051*** (4.11)	*W*Attr*	38.1358*** (3.90)
Public Specialization (Resilience)	0.4055** (2.10)	0.4993** (2.50)	1.5775*** (3.33)	2.0769*** (3.65)	*W*Resil*	1.1467*** (3.00)
Agricultural Specialization (Vulnerability)	-0.6401*** (-3.35)	-0.6817*** (-3.50)	-0.9343** (-2.01)	-1.6160*** (-2.99)	*W*Vuln*	-0.5770 (-1.58)
Trade Openness (Competitiveness)	0.0368** (2.10)	0.0344* (1.82)	-0.0408 (-0.94)	-0.0064 (-0.12)	*W*Comp*	-0.0395 (-1.17)
Human Capital	0.0859** (2.37)	0.0913*** (2.61)	0.1117 (1.52)	0.2030** (2.48)	*W*HK*	0.0638 (1.07)
N.obs	824					
R^2	0.7599					
Hausman test	199.42					
SAR Restriction	126.49***					
SEM Restriction	204.87***					

Notes: Robust t-test in parentheses. ***: p-value < 0.01, **: p-value < 0.05, *: p-value < 0.10.

Table 2.4: Estimations results of SDM-FE (2008-2017) – Extended model – European cohesion policy effectiveness

Variables	***Impact effects***	***Direct effects***	***Indirect effects***	***Total effects***	***Variables***	***Spatial effects***
Wy	0.1625*** (3.71)					
GDPpc	-82.5704*** (-28.48)	-83.4325*** (-28.57)	-27.1931*** (-6.18)	-110.6257*** (-23.45)	*W*GDPpc*	-10.4808* (-1.75)
EU Cohesion Policy (ECP)	0.0026 (1.04)	0.0033 (1.38)	0.0231*** (5.38)	0.0265*** (5.46)	*W*ECP*	0.0197*** (5.07)
*Crisis years*ECP (GRxECP)*	-0.0013 (-0.30)	-0.0023 (-0.56)	-0.0412*** (-6.25)	-0.0436*** (-6.64)	*W*GRxECP*	-0.0354*** (-5.55)
Population Density (Attractiveness)	0.8797 (0.12)	1.5553 (0.23)	23.0067** (2.06)	24.5620** (2.14)	*W*Attr*	19.7791** (1.97)
Public Specialization (Resilience)	0.3844** (2.00)	0.4218** (2.16)	0.9179** (2.04)	1.3397*** (2.59)	*W*Resil*	0.7149* (1.85)
Agricultural Specialization (Vulnerability)	-0.6743*** (-3.58)	-0.6964*** (-3.70)	-0.9311** (-2.18)	-1.6275*** (-3.37)	*W*Vuln*	-0.6967* (-1.92)
Trade Openness (Competitiveness)	0.0500*** (2.93)	0.0504*** (2.79)	0.0136 (0.35)	0.0640 (1.37)	*W*Comp*	0.0038 (0.11)
Human Capital	0.1042*** (2.91)	0.1092*** (3.19)	0.1689** (2.39)	0.2782*** (3.66)	*W*HK*	0.1340** (2.24)
Infrastructural Capital	0.0378 (1.44)	0.0445* (1.73)	0.1249** (2.31)	0.1695*** (2.69)	*W*IK*	0.1048** (2.16)
Natural Capital	0.2431*** (3.19)	0.2425*** (2.99)	-0.1328 (-0.64)	0.1097 (0.45)	*W*NK*	-0.1567 (-0.86)
Relational Capital	0.4049 (1.42)	0.4997* (1.76)	2.1985*** (3.81)	2.6981*** (4.06)	*W*RK*	1.8708*** (3.42)
Social Capital	-0.2271*** (-3.99)	-0.2472*** (-4.52)	-0.5003*** (-4.48)	-0.7475*** (-5.73)	*W*SK*	-0.4048*** (-3.99)
N.obs	824					
R^2	0.7817					
Hausman test	222.81					
SAR Restriction	148.94***					
SEM Restriction	227.49***					

Notes: Robust t-test in parentheses. ***: p-value < 0.01, **: p-value < 0.05, *: p-value < 0.10.

Tables 2.5 and 2.6 replicate the analysis in tables 2.3 and 2.4 with the use of a SAR model. Comparing SDM with SAR specifications, we can see that the models draw different conclusions about EU policy direct and indirect effectiveness.

Indeed, the impact effect is positive and statistically significant in the SAR specification.

Similarly in the SEM specification (table 2.7), with the caveat that this model does not accurately account for the spatial structure of the data, not differentiating the global policy effect.

Conversely, as previously said, in the spatial Durbin model, the policy impact coefficient loses significance.

Given the greater power of SDM to disentangle the total policy effect into direct and indirect effects, and the rejection of both restrictions, we can conclude that the spatial spillovers have influenced the effectiveness of the European regional policy in the Italian provinces during the considered period since neighbouring territories were possibly more able to capture the gains of completed projects.

Table 2.5: Estimations results of SAR-FE model (2008-2017) – European cohesion policy effectiveness

Variables	***Impact effects***	***Direct effects***	***Indirect effects***	***Total effects***
Wy	0.4126***			
	(16.81)			
GDPpc	-73.6929***	-77.4488***	-48.0846***	-125.5335***
	(-25.45)	(-26.35)	(-11.56)	(-23.03)
EU Cohesion Policy	0.0124***	0.0130***	0.0080***	0.0210***
(ECP)	(5.30)	(5.45)	(5.29)	(5.54)
*Crisis years*ECP*	-0.0185***	-0.0191***	-0.0118***	-0.0309***
(GRxECP)	(-4.76)	(-4.91)	(-4.84)	(-5.01)
Population Density	20.9755***	21.9440***	13.6094***	35.5535***
(Attractiveness)	(3.37)	(3.45)	(3.35)	(3.45)
Public Specialization	1.0862**	1.1502***	0.7154***	1.8657***
(Resilience)	(5.80)	(5.88)	(5.02)	(5.68)
Agricultural Specialization	-0.2743	-0.2753	-0.1695	-0.4449
(Vulnerability)	(-1.39)	(-1.32)	(-1.32)	(-1.32)
Trade Openness	0.0718***	0.0756***	0.0469***	0.1226***
(Competitiveness)	(4.00)	(3.87)	(3.72)	(3.87)
Human Capital	0.1837***	0.1929***	0.1195***	0.3124***
	(5.24)	(5.26)	(5.05)	(5.31)
N.obs	824			
R^2	0.6746			
Hausman test	236.90			

Notes: Robust t-test in parentheses. ***: p-value < 0.01, **: p-value < 0.05, *: p-value < 0.10.

Table 2.6: Estimations results of SAR-FE (2008-2017) – Extended model – European cohesion policy effectiveness

Variables	***Impact effects***	***Direct effects***	***Indirect effects***	***Total effects***
Wy	0.3768***			
	(14.84)			
GDPpc	-74.8514***	-77.8812***	-41.8482***	-119.7295***
	(-26.25)	(-26.99)	(-10.64)	(-23.30)
EU Cohesion Policy (ECP)	0.0119***	0.0123***	0.0066***	0.0190***
	(5.19)	(5.31)	(4.93)	(5.33)
*Crisis years*ECP (GRxECP)*	-0.0176***	-0.0179***	-0.0096***	-0.0276***
	(-4.57)	(-4.69)	(-4.49)	(-4.73)
Population Density (Attractiveness)	15.7137***	16.2102***	8.7178***	24.9280***
	(2.48)	(2.53)	(2.44)	(2.52)
Public Specialization (Resilience)	1.0271***	1.0770***	0.5800***	1.6570***
	(5.53)	(5.60)	(4.73)	(5.41)
Agricultural Specialization (Vulnerability)	-0.3217	-0.3218	-0.1707	-0.4926
	(-1.64)	(-1.56)	(-1.56)	(-1.57)
Trade Openness (Competitiveness)	0.0768***	0.0802***	0.0430***	0.1233***
	(4.37)	(4.23)	(4.02)	(4.23)
Human Capital	0.2044***	0.2125***	0.1139***	0.3264***
	(5.89)	(5.93)	(5.64)	(6.06)
Infrastructural Capital	0.0471*	0.0516*	0.0276*	0.0793*
	(1.76)	(1.89)	(1.87)	(1.89)
Natural Capital	0.2621***	0.2748***	0.1477***	0.4226***
	(3.29)	(3.30)	(3.15)	(3.28)
Relational Capital	0.3327	0.3460	0.1843	0.5304
	(1.13)	(1.15)	(1.12)	(1.14)
Social Capital	-0.3212***	-0.3317***	-0.1772***	-0.5090***
	(-5.49)	(-5.36)	(-5.66)	(-5.64)
N.obs	824			
R^2	0.7046			
Hausman test	215.62			

Notes: Robust t-test in parentheses. ***: p-value < 0.01, **: p-value < 0.05, *: p-value < 0.10.

Table 2.7*:* Estimations results of SEM-FE model (2008-2017) – European cohesion policy effectiveness

Variables	***Total effects (a)***	***Total effects (b)***
GDPpc	-88.4757*** (-27.56)	-89.3453*** (-27.56)
European Cohesion Policy (ECP)	0.0197*** (5.88)	0.0202*** (6.21)
*Crisis years*ECP (GRxECP)*	-0.0151*** (-2.56)	-0.0157*** (-2.71)
Population Density (Attractiveness)	-0.2152 (-0.03)	2.3081 (0.28)
Public Specialization (Resilience)	0.4601** (2.44)	0.4622** (2.46)
Agricultural Specialization (Vulnerability)	-0.5868*** (-2.83)	-0.6133*** (-2.99)
Trade Openness (Competitiveness)	0.0433** (2.54)	0.0416** (2.46)
Human Capital	0.1040*** (2.89)	0.1172*** (3.22)
Infrastructural Capital		0.0328 (1.01)
Natural Capital		0.3342*** (4.51)
Relational Capital		-0.0905 (-0.32)
Social Capital		-0.2313*** (-3.95)
N.obs	824	824
R^2	0.5833	0.6144
Hausman test	231.89	277.20

Notes: Robust t-test in parentheses. ***: p-value < 0.01, **: p-value < 0.05, *: p-value < 0.10.

2.5.2 The impact of national cohesion policy on provincial growth

In table 2.8 and 2.9 we perform the same analysis of tables 2.3 and 2.4 by looking at national cohesion policy only.

Differently from the European policy outcomes, national interventions exert strong direct and indirect effects in both the treated and neighboring provinces without generating any displacement effect. Moreover, the magnitude of indirect effects for the national cohesion policy is greater than for the European cohesion one.

This evidence shows the relevance of the national cohesion interventions for Italy and prompts the domestic policy maker to not discard them especially during economic downturn.

Looking at the national policy outcome, the magnitude of the indirect effect coefficient is greater than the one of the direct effects.

The role of spatial spillovers in national policy outcome seems to be propulsive for two reasons. The spatial effects strengthen the action of direct effects since the share of the total effect due to the indirect effect is greater than the share due to the direct effect. Moreover, national policy is not sensitive to the addition of the spatial delay of the explanatory variables (the SDM results are similar to the SAR and SEM results, see tables 2.10-2.12).

The impacts on the growth of the other explanatory variables and their spillover effects remain as discussed in section 2.5.1, for both the restricted and the extended models.

In summary, the assessment of completed cohesion interventions reveals some interesting policy implications by disentangling the direct effect on the treated areas from the indirect effect on the neighboring ones.

In the Italian provinces, during the period under examination, the role of spillovers effects seemed to produce opposite results in the two regional policies. European cohesion policy projects appear to have been more effective in the provinces close to the treated ones. Therefore, the European policy maker should be concerned with displacement effects since they may be relevant at the provincial level.

Instead, spatial spillovers appear to have complemented direct effects for the national cohesion policy[37].

Table 2.8: Estimations results of SDM-FE model (2008-2017) – National cohesion policy effectiveness

Variables	***Impact effects***	***Direct effects***	***Indirect effects***	***Total effects***	***Variables***	***Spatial effects***
Wy	0.3220*** (8.31)					
GDPpc	-80.8386*** (-26.37)	-82.7613*** (-27.14)	-30.4797*** (-6.22)	-113.2411*** (-21.55)	*W*GDPpc*	3.8700 (0.68)
National Cohesion Policy (NCP)	0.0230*** (2.76)	0.0291*** (3.57)	0.0948*** (4.55)	0.1239*** (5.20)	*W*NCP*	0.0609*** (3.91)
*Crisis years*NCP (GRxNCP)*	-0.0161 (-1.36)	-0.0271** (-2.32)	-0.1834*** (-6.89)	-0.2106*** (-6.58)	*W*GRxNCP*	-0.1274*** (-6.39)
Population Density (Attractiveness)	-0.6942 (-0.10)	1.7933 (0.26)	38.2363*** (2.88)	40.0297*** (2.81)	*W*Attr*	27.5407*** (2.79)
Public Specialization (Resilience)	0.5189*** (2.66)	0.6728*** (3.33)	2.2363*** (4.42)	2.9092*** (4.79)	*W*Resil*	1.4754*** (3.86)
Agricultural Specialization (Vulnerability)	-0.5546*** (-2.87)	-0.6079*** (-3.04)	-0.9980** (-1.96)	-1.6060*** (-2.70)	*W*Vuln*	-0.5624 (-1.52)
Trade Openness (Competitiveness)	0.0534*** (3.03)	0.0546*** (2.83)	0.0207 (0.45)	0.0754 (1.34)	*W*Comp*	0.0001 (0.01)
Human Capital	0.0987*** (2.70)	0.1129*** (3.19)	0.2312*** (2.93)	0.3441*** (3.90)	*W*HK*	0.1351** (2.24)
N.obs	824					
R^2	0.7459					
Hausman test	204.88					
SAR Restriction	108.22***					
SEM Restriction	177.91***					

Notes: Robust t-test in parentheses. ***: p-value < 0.01, **: p-value < 0.05, *: p-value < 0.10.

[37] For robustness check, we employed the inverse-distance spatial matrix. The results confirmed the strong spatial spillover effects exerted by European cohesion policy; however, the direct and spillover effect of national cohesion intervention was weakened.

Table 2.9: Estimations results of SDM-FE (2008-2017) – Extended model – National cohesion policy effectiveness

Variables	***Impact effects***	***Direct effects***	***Indirect effects***	***Total effects***	***Variables***	***Spatial effects***
Wy	0.2087*** (4.86)					
GDPpc	-80.9473*** (-27.12)	-81.8435*** (-27.25)	-22.4070*** (-4.99)	-104.2506*** (-21.75)	*W*GDPpc*	-1.8933 (-0.33)
National Cohesion Policy (NCP)	0.0195** (2.41)	0.0222*** (2.85)	0.0680*** (3.78)	0.0903*** (4.38)	*W*NCP*	0.0522*** (3.43)
*Crisis years*NCP (GRxNCP)*	-0.0085** (2.41)	-0.0129 (-1.15)	-0.1250*** (-5.61)	-0.1379*** (-5.29)	*W*GRxNCP*	-0.1018*** (-5.06)
Population Density (Attractiveness)	-2.5678 (-0.35)	-2.1831 (-0.32)	10.5185 (0.91)	8.3353 (0.70)	*W*Attr*	9.1818 (0.91)
Public Specialization (Resilience)	0.4822** (2.49)	0.5462*** (2.79)	1.3153*** (2.85)	1.8615*** (3.48)	*W*Resil*	0.9700** (2.52)
Agricultural Specialization (Vulnerability)	-0.5937*** (-3.12)	-0.6274*** (-3.27)	-1.0433** (-2.30)	-1.6707*** (-3.23)	*W*Vuln*	-0.7367** (-2.00)
Trade Openness (Competitiveness)	0.0653*** (3.82)	0.0680*** (3.75)	0.0634 (1.60)	0.1315*** (2.74)	*W*Comp*	0.0394 (1.20)
Human Capital	0.1169*** (3.26)	0.1270*** (3.71)	0.2519*** (3.44)	0.3789*** (4.80)	*W*HK*	0.1883*** (3.16)
Infrastructural Capital	0.0331 (1.25)	0.0406 (1.54)	0.1180** (2.05)	0.1586** (2.34)	*W*IK*	0.0928* (1.88)
Natural Capital	0.2174*** (2.83)	0.2073** (2.49)	-0.3304 (-1.50)	-0.1230 (-0.48)	*W*NK*	-0.3212* (-1.75)
Relational Capital	0.4495 (1.56)	0.5635* (1.94)	2.1283*** (3.45)	2.6917*** (3.75)	*W*RK*	1.6947*** (3.03)
Social Capital	-0.2613*** (-4.56)	-0.2905*** (-5.24)	-0.6075*** (-5.32)	-0.8980*** (-6.71)	*W*SK*	-0.4561*** (-4.48)
N.obs	824					
R^2	0.7738					
Hausman test	308.63					
SAR Restriction	136.98***					
SEM Restriction	215.61***					

Notes: Robust t-test in parentheses. ***: p-value < 0.01, **: p-value < 0.05, *: p-value < 0.10.

Table 2.10: Estimations results of SAR-FE model (2008-2017) – National cohesion policy effectiveness

Variables	***Impact effects***	***Direct effects***	***Indirect effects***	***Total effects***
Wy	0.4498*** (19.21)			
GDPpc	-69.2200*** (-24.45)	-73.5642*** (-25.19)	-52.2510*** (-11.94)	-125.8153*** (-21.55)
National Cohesion Policy (NCP)	0.04322*** (5.31)	0.0456*** (5.50)	0.0323*** (5.24)	0.0780*** (5.52)
*Crisis years*NCP (GRxNCP)*	-0.0423*** (-3.62)	-0.0436*** (-3.66)	-0.0309*** (-3.59)	-0.0746*** (-3.68)
Population Density (Attractiveness)	18.5054*** (2.96)	19.5994*** (3.02)	13.9051*** (2.97)	33.5045*** (3.02)
Public Specialization (Resilience)	1.2035*** (6.44)	1.2864*** (6.59)	0.9145*** (5.67)	2.2009*** (6.38)
Agricultural Specialization (Vulnerability)	-0.1750 (-0.89)	-0.1716 (-0.82)	-0.1206 (-0.81)	-0.2923 (-0.81)
Trade Openness (Competitiveness)	0.0787*** (4.36)	0.0837*** (4.23)	0.0594*** (4.09)	0.1432*** (4.24)
Human Capital	0.1947*** (5.50)	0.2062*** (5.50)	0.1461*** (5.34)	0.3524*** (5.57)
N.obs	824			
R^2	0.6611			
Hausman test	165.52			

Notes: Robust t-test in parentheses. ***: p-value < 0.01, **: p-value < 0.05, *: p-value < 0.10.

Table 2.11: Estimations results of SAR-FE (2008-2017) – Extended model – National cohesion policy effectiveness

Variables	***Impact effects***	***Direct effects***	***Indirect effects***	***Total effects***
Wy	0.4080***			
	(16.59)			
GDPpc	-70.5169***	-73.9602***	-44.6959***	-118.6562***
	(-25.28)	(-25.89)	(-10.93)	(-21.81)
National Cohesion Policy (NCP)	0.0408***	0.0425***	0.0257***	0.0683***
	(5.13)	(5.29)	(4.85)	(5.25)
*Crisis years*NCP (GRxNCP)*	-0.0382***	-0.0388***	-0.0234***	-0.0623***
	(-3.32)	(-3.34)	(-3.21)	(-3.33)
Population Density (Attractiveness)	11.9106*	12.3972*	7.5019*	19.8991*
	(1.88)	(1.91)	(1.87)	(1.90)
Public Specialization (Resilience)	1.1339***	1.1965***	0.7241***	1.9207***
	(6.11)	(6.25)	(5.28)	(6.03)
Agricultural Specialization (Vulnerability)	-0.2178	-0.2140	-0.1271	-0.3412
	(-1.11)	(-1.03)	(-1.02)	(-1.03)
Trade Openness (Competitiveness)	0.0839***	0.0881***	0.0531***	0.1413***
	(4.74)	(4.60)	(4.38)	(4.61)
Human Capital	0.2167***	0.2266***	0.1366***	0.3633***
	(6.20)	(6.20)	(5.95)	(6.35)
Infrastructural Capital	0.0558**	0.0610**	0.0368**	0.0978**
	(2.06)	2.20)	(2.17)	(2.20)
Natural Capital	0.2104***	0.2235***	0.1352***	0.3587***
	(2.63)	(2.66)	(2.58)	(2.65)
Relational Capital	0.4834	0.5071*	0.3042	0.8113*
	(1.62)	(1.65)	(1.63)	(1.65)
Social Capital	-0.3426***	-0.3564***	-0.2142***	-0.5707***
	(-5.83)	(-5.66)	(-6.00)	(-5.99)
N.obs	824			
R^2	0.6969			
Hausman test	208.43			

Notes: Robust t-test in parentheses. ***: p-value < 0.01, **: p-value < 0.05, *: p-value < 0.10.

Table 2.12: Estimations results of SEM-FE model (2008-2017) – National cohesion policy effectiveness

Variables	***Total effect (a)***	***Total effect (b)***
GDPpc	-84.8457*** (-26.17)	-85.6354*** (-26.74)
National Cohesion Policy (NCP)	0.0253*** (2.90)	0.0252*** (2.92)
*Crisis years*NCP (GRxNCP)*	-0.0036 (-0.25)	-0.0042 (-0.30)
Population Density (Attractiveness)	-1.0240 (-0.12)	1.2061 (0.15)
Public Specialization (Resilience)	0.4073** (2.15)	0.4110** (2.17)
Agricultural Specialization (Vulnerability)	-0.4642** (-2.22)	-0.4779** (-2.31)
Trade Openness (Competitiveness)	0.0393** (2.31)	0.0372** (2.21)
Human Capital	0.0782** (2.16)	0.0911** (2.49)
Infrastructural Capital		0.0242 (0.73)
Natural Capital		0.3174*** (4.30)
Relational Capital		-0.0369 (-0.13)
Social Capital		-0.2185 (-3.75)
N.obs	824	824
R^2	0.5032	0.5358
Hausman test	237.15***	276.33***

Notes: Robust t-test in parentheses. ***: p-value < 0.01, **: p-value < 0.05, *: p-value < 0.10.

2.6 Conclusion

This work has shown that spatial autocorrelation patterns influenced regional policies' effectiveness in the Italian provinces during two recent programming periods. Both European and national completed projects exerted strong spatial spillover effects.

According to our estimations, the indirect spillovers of EU cohesion policy may have displaced somehow the direct impact on treated since the prevailing policy's outcome has been captured more by the areas close to the recipient ones.

This result has a relevant policy implication: during the policy design, the European policy maker cannot overlook the possibility that spillover effects may make the policy less effective on the treated areas.

Neighbouring areas may be able to keep the gains of public investment if they are more endowed of favourable structural conditions. In this case, the EU policy may also generate a negative effect on inequality across provinces.

A different result has been found for domestic cohesion policy since, in this case, the positive effect is significant in both treated and in the untreated neighbouring areas.

This stresses the importance of integrating cohesion policies coming from both national and supra-national institutions to obtain greater effectiveness in the lagging areas, especially during severe downturns.

The possible motivations of the substantial differences in the results between the two policies may be attributed to the nature of the projects and to the programming procedure. As for the first point, the completed national cohesion projects, refer mainly to infrastructures, while European Funds have financed, in a relevant quantity, incentives for businesses and citizens. As for the second, the different selection criteria of the projects may also matter. The national cohesion policy decisions are more centralized at national level while the EU disbursements are more dependent on the ability of each region to manage the funding opportunities. However, the causes of the heterogeneity in the impact of European and national cohesion policy should be further investigated[38] with more specific analysis. Such analysis could take into account explicitly the differences in the implemented projects according to the spending typologies (infrastructural vs. incentive for business and citizens) for each spending thematic objective.

[38] We would thank one of the external evaluators for this suggestion.

Finally, because of the reduction in the spillover effects during the crisis, the impact of cohesion funds appears to have somewhat reduced during the Great Recession years.

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Chapter 3

An empirical evaluation on the effects of re-programming EU Cohesion Funds on regional growth in Italy

Summary of the Chapter

The main purpose of the European cohesion policy is the achievement of balanced and sustained (long-run) growth. But what are the repercussions of the EU Funds' diversion towards short-run objectives if an unforeseen event, such as an economic crisis or a natural disaster, occurs? This chapter empirically evaluates the relative impacts on regional (NUTS-2) Italian growth when a re-programming of Structural Funds is put in place to face severe economic downturns. The re-programming in the considered time span (2007-13 and 2014-20) was mainly due to the redirection of allocated amounts towards recovery from crisis during the Great Recession or natural disasters. The assessment is carried out through the computation of an impulse response functions estimated through the Jordà local projections method. The main results show a statistically significant and robust negative effect of re-programming on long-run growth starting three years after the planned shock. This work contributes to the debate on the effectiveness of the European regional policy by evaluating, for the first time in the literature, the specific issue of Funds' diversion, detecting the distortion related to a use different from their original goals.

3.1 Introduction

The main goal of European cohesion funds is the structural adjustment of NUTS-2 territories characterized by a gap in their relevant economic indicators. The Funds finance investment projects potentially aimed at fostering regional convergence and sustained long-term growth. The idea of a European cohesion policy was launched from the beginning in the Treaty of Rome (1957) which stated the 'Community's commitment of mitigating social and economic imbalances between European territories' since the drafting of the first version of the European Social Fund (ESF).

In 1975, the creation of the European Regional Development Fund (ERDF) was a second step in the European regional policy evolution and, in that circumstance, it was decided to allocate the provisions mainly to less well-off regions.

The final scope of the European regional policy is to contribute to the development of economic activities and employment in lagging regions as well as to the reduction of inequalities of all kinds and the enhancement of infrastructural quality (European Commission, 1999).

In the 1980s, the enlargement to some Mediterranean countries (Greece, Spain and Portugal) required a substantial revision in the policy. Indeed, regional economies were increasingly facing significant challenges, such as globalization, openness to international trade and disruptive technological changes. The Reform of 1988 established four rules governing the allocation of EU Funds to enhance their effectiveness.

The first principle (*additionality*) states that cohesion funds must be purely *additional* resources and not a way to replace the 'ordinary' regionalized investments of each Member State. The second principle (*partnership*) highlights the relevance of the involvement of State, regional, local authorities and of any other stakeholder during the policy design and implementation. The third principle (*concentration*) pertains to the regional eligibility rules and thematic areas and leads to concentrate the Funds on a restricted number of objectives and of (lagging) areas. Finally, the *programming* principle affirms that the policy design should be based on an accurate short-run (conjunctural) analysis in a multi-annual framework.

The multi-annual programming and the concentration of resources aim at preventing that the Structural Funds were distracted towards objectives contrasting with regional policy aims.

Indeed, the main objectives, the distribution of the allocated amounts to the spending areas and the implementation procedures are established in the Regional (National) Operational Programme (ROP), which fully determines the official policy framework. The Programme is subject to a prior scrutiny by the European Commission and it binds the regional (national) authorities to the European goals and rules of intervention.

Although the allocations and purposes are *ex-ante* determined, the potential change of economic conditions, during a long (seven years) time span of implementation, often forces the review of the Operational Programmes (OPs).

The focus of this chapter is to evaluate the effects of re-programming through annual changes of the financial plans. The analysis is carried out for the ERDF and the Italian ROPs by adopting both aggregate and sectoral approaches. These variations are carried out either to contrast spending problems within the OP or as a consequence of economic downturn and natural disasters which may push to re-orient the funds towards short-term needs, in order to contrast a negative shock.

The key role is played by the national or regional policy maker which must identify regional needs with accuracy and link them with the re-programming decisions. However, it is not obvious that the modification of a regional financial plan would have a positive economic impact on regional growth. First of all, whereas the original versions of OP were in line with the (long-term) structural growth objectives of a region, the decision to re-programming may determine a distortion of the funds from their objectives. Second, the allocated amounts should be determined after a (regional) context analysis updated after the shock, a procedure which is never put in place. Third, the regional sectoral/regional allocation decision activates expectation mechanisms by economic agents which may be strongly unfulfilled after the re-programming.

Comparing to the existing literature, this chapter is the first attempt to investigate a research topic that could give interesting policy implications. Our main question is the investigation of the impact of modifying a cohesion program after its approval by diverting the Funds toward short-run aims. The EU Funds, and in particular the ERDF, are based upon a feasible analysis strategy since the programming phase is well defined starting from the current regional economic conditions. Therefore, any program modification should follow standardized rules.

This chapter highlights the effects on the economic growth of the ERDF re-programming, occurred during the policy implementation phase (2007-13 and 2014-20 programming periods). We estimate the impulse response functions of regional per capita GDP after the deviation (shock) from the aggregate (and sectoral) planned amount with a time horizon of five years after the shock. Our computation dwells on the Jordà local projection method (Jordà, 2005).

We also check the potential re-programming endogeneity by classifying the motivations of the Funds' diversion.

The chapter is organized as follows. The second section synthesizes the objectives and the evolution of EU cohesion policy with a particular emphasis on the (re)programming phase. Section 3.3 traces some links with the literature and section 3.4 presents our empirical strategy from both a conceptual and an econometric point of view. The fifth section shows the results of our main analysis and the policy implications, while section 3.6 extends the evaluation by dealing with sectoral re-programming. Finally, section 3.7 concludes.

3.2 The Structural Funds and the programming procedures

The cohesion policy is the European place-based economic policy aiming at reducing social, economic and territorial inequalities. To this purpose, it is allocated one third of the European budget, approximately 347 billion for the period 2007-13, 352 billion for the 2014-20 and 391 billion for the 2021-27 programming period.

The European cohesion policy is mainly implemented through the ERDF, whose objective is to enhance regional competitiveness to improve infrastructural and technological endowments. The second Fund by importance is the ESF which promotes social inclusion, quality of education and jobs opportunities.

The allocations to the regions are decided as a result of a careful programming procedure which identifies the areas to be strengthened. The programming concerns several levels: at national level, the National Strategic Reference Framework (NSRF) was the reference document of the 2007-2013 European programming period setting its policy aims. The NSRF was developed by the Member States in cooperation with the European Commission. It contained the socio-economic analysis at national level and highlighted potential national and regional weaknesses, taking into account the European and the

global macroeconomic outlooks. It also specified the provisions of each regional OP.

The OP was submitted to the Commission approval for the judgement of consistency with the general strategy of European Union and with the NSRF.

Indeed, the Commission's resolution on the NSRF preceded the decision on OPs. The Program included the regional strengths and weaknesses, the spending objectives by sector, the financing plan, the details of implementation (by the managing, auditing and certifying authorities) and a list of 'major (mainly infrastructural) projects[39]' (European Council, 2006).

One of the main features of the 2007-2013 and 2014-2020 programming periods was that each OP was financed by only one Structural Fund ('*single-fund*'). Other Programs were thematic and managed by central administrations (National Operational Programs or NOPs).

The Regional Operational Programs (ROPs) were multi-sectoral[40], referred to a specific region and managed by the regional authorities.

As for the programming phase, the 2014-20 period was not much dissimilar from the 2007-13 one. However, the general framework was the so-called *Partnership Agreement* which oriented the OPs.

The ERDF-ROP structure[41] was set by the European Commission and compiled by regional authorities. The standardized scheme allowed for a comparison of the regions by stressing the heterogeneity of socio-economic conditions, objectives and allocations.

In particular, the OP's first section was the *context analysis* focusing on general themes (demography, labour market, entrepreneurship, mobility, environment, energy and technological development) and highlighting the most relevant sectors of interventions. The outcome of the socio-economic analyses was the identification of the prevailing vulnerabilities.

The other OP's sections dealt with the coherence to the NSRF (2007-13) or the Partnership Agreement (2014-20), the description of the investment typology related to each thematic area, the definition of the authorities responsible for implementation and

[39] Projects having a cost more than 25 million for environmental and 50 million for the other sectors. They deserve a special consideration due to their cost and potential impacts.
[40] The resources considered in the OP were divided into thematic areas.
[41] With non-substantial differences between the 2007-2013 and 2014-2020 programming periods.

monitoring and, finally, the financial plan with the allocation breakdown by thematic areas.

However, the OP might be subjected to any adjustment during the seven years if significant spending problems were identified or as a consequence of relevant changes in socio-economic conditions due to the occurrence of economic crises or natural disasters.

During the years covered by this chapter, the Italian regions faced various crises and environmental damages caused by exogenous events. As known, some of the most notable events were the Great Recession, which worsened public debt vulnerabilities leading Italy towards the so-called 'sovereign debt' crisis, the Covid-19 recession (due to the Coronavirus pandemic) and various earthquakes.

In principle, the Structural Funds should not be employed to counter-cyclical needs since their main function is to stimulate long-run growth and contrast economic divergence. However, in the middle of a crisis, the European Commission could authorize their use to deal with unfavourable macroeconomic conditions.

The Commission's response to the 2008-global financial crisis was the European Economic Recovery Plan with an overall allocation of 230 billions aiming at stimulating demand in the short-run, to improve the conditions of the labour market and to suggest to the Member States the use of any possible leverage (fiscal policy, structural reforms) in coordination among them to avoid negative spillover effects (European Commission, 2008a).

In this context, cohesion policy owned a primary role as anti-cyclical action. For instance, the administrative rules were relaxed, pre-financing was increased and the national co-financing rate was reduced. The Funds' *re-prioritisation* among thematic areas was also allowed, 'with a view to accelerate the spending in the areas with more growth potential. This could include more focus on energy efficiency measures, on housing and greater support for small and medium enterprises, which are considered the main engine for growth in the European economy' (European Commission, 2008b).

After the Covid outbreak, in April 2020, the European Commission launched the Coronavirus Response Investment Initiative (CRII) and the Coronavirus Response Investment Initiative Plus (CRII+) allowing the use of Structural Funds to deal with the

consequences of the pandemic. In synthesis, these measures allowed the redirection of the resources not yet spent mainly towards the health care system and job subsidies.

The changes concerned not only the Funds' shift across thematic areas but also across regions.

On May 2020, the REACT-EU plan was established, with totally additional resources. This became part of the cohesion policy programs, used for specific interventions against the pandemic as well as for investments on green, digital and resilient recovery.

Italy changed almost all ROPs by reallocating more than €4.5 billion to strengthen the health care system, to increase SMEs' support and income subsidies to fight unemployment.

An interesting empirical investigation concerns the possible responses of regional growth after the change in the planned amount which are unforeseen during the programming phase but occurred during the implementation of the Programmes. This chapter addresses this issue empirically by considering the year-by-year variation of the amounts allocated to each Italian ROP in the re-programming exercise, evaluating its impact on the future trend of regional economic growth through the estimation of impulse response functions.

3.3 Related literature

To our knowledge, our study is the first attempt in the literature dealing with the quantification of economic effects of EU Funds' re-programming during a sufficiently large time span (covering, in our case, the 2007-13 and the 2014-20 programming periods).

The first studies concerning the topic of displacement of long-term objectives through short-run adjustments appeared only a few years ago.

Though no studies in the literature analyse directly the role played by the change in the financial plan of the ROPs, some related international literature has addressed the issue of the impacts of recent crises on cohesion policy effectiveness.

Merler (2016), through the estimation of a convergence model on 200 European regions in the period 2000-14, concluded that the 2008-crisis had no impact on regional

policy effectiveness. By contrast, the cohesion funds have conferred resilience to regional economies.

On the other hand, Bachtrögler (2016) found a negative role for the crisis in investigating the policy impact in an analysis of 250 European regions in the period 2007-13.

The discrepancy between the results of the two studies can be due to the different estimation method used: a regional convergence model in the first case, the regression discontinuity design, in the second.

The results may be influenced by the methods, but also by the way in which the effect of the crisis is considered. In the two previous papers, the crisis is included in the model through the interaction term between funds and the crisis years. Becker *et al.* (2018), instead, concluded that the crisis has diminished the Funds' impact by accounting for the crisis through an interaction between Funds and spreads between government bonds.

More recently, Di Caro and Fratesi (2023) investigated the short-term impact of cohesion policy during economic shocks spanning from 1980-2015, by finding, in a study covering 255 European regions, a positive impact of cohesion funds on regional resilience. However, each crisis produced different effects on regional labor markets.

In the Italian case, De Blasio and Ciani (2015) analysed the impact of European Structural Funds on employment, population and house prices for Local Labor Markets (LLM) in the South based on a national dataset (*Opencoesione*) for the period 2007-20 by employing a *diff-in-diffs* methodology. They found that a 10% increase in per capita cumulative payments is associated with a 0.027% decrease in employment concluding that this result could be due to the diversion of resources towards the sectors most affected by the 2008-Great Recession.

Arbolino and Di Caro (2020) also focused on the effects of the Great Recession on the Structural Funds' effectiveness, trying to understand if these effects can anticipate the impacts of the 2020-pandemic crisis. They calculated the impacts of the EU Funds on regional Italian employment during the Great Recession by designing two employment scenarios. The first scenario considered the elasticity of the EU Funds absorption (annual payments divided by commitments) and the second combined the elasticity of the first scenario with the elasticity of EU Funds' total allocation in each region. Comparing the

effective employment losses during the first months of Covid-19 with the employment losses resulting from scenario 1 and scenario 2, they found that both the absorption and the allocation of cohesion policy could have had a positive effect on regional employment reducing net employment losses.

The measurement of the impact of crises on EU Funds' effectiveness is a topic related to our analysis.

Indeed, we consider all the re-allocations in the last two European programming periods as occurred in response to crises, but also to ROPs management problems, or as a consequence of natural disasters.

The practice of the EU Funds' re-prioritisation (or distraction) is a leading (as well as recurrent) policy issue during the various programming periods.

To mention only a recent case (May 2023), a debate emerged on the increase in European military spending (especially to support industrial projects and munitions production). The proposal of the European Commission, addressed through the Regulations of the European Parliament and of the European Council on establishing the Act in Support of Ammunition Production (ASAP) would allow Member States to mobilise cohesion funds (and the Recovery Fund) to finance these projects (European Commission, 2023a; European Commission, 2023b).

In this case, the Structural Funds, which should be mostly *endogenous* to economic conditions, would be used for almost totally exogenous reasons.

During a downturn, a *trade-off* may arise regarding *how* cohesion funds are spent. In principle, they should be kept in line with their original objectives.

On the other hand, the economic downturn could complicate the implementation of (anti-cyclical) fiscal policies, exacerbating the crisis effects. Summing up, economic crises often require the deployment of all available resources, including EU Funds, to accelerate the recovery.

For example, during 2007-13 programming, cohesion policy was the main public investment policy for many EU countries facing the Great Recession and accounted for 57% of government capital investment (Prota *et al.,* 2020).

The innovation of this chapter, comparing to the existing literature, is to empirically shed light on the possible consequences on economic growth of the Cohesion Funds' re-orientation. We focus on 2007-13 and 2014-20 programming periods. Our

empirical strategy is based on the estimation of an impulse response function of the regional per capita GDP following the planned shocks. Two extensions of the analysis are devoted to evaluate the potential endogeneity of re-programming and to investigate the effects of sectoral re-programmings.

3.4 A methodology to assess the economic effects of ERDF re-programming

To evaluate the impact of ERDF re-programming on regional growth we first considered all the modifications of the financial plan (sections 3.4 and 3.5) and, in a further phase, we assessed their sector-by-sector effects (section 3.6).

Given the peculiarities of the analysis, our research design cannot be based on a static econometric perspective since the change in the financial plan may influence the future evolution of regional economic growth. An approach that fits our framework is the estimation of the dynamic multipliers from impulse response functions (IRFs).

3.4.1 The impulse response functions by local projections

An impulse response function analyses the evolution of the endogenous variable of interest until a specified time horizon starting from a shock introduced into the system. The most common method used by macroeconomists to estimate IRFs is the setup of a Vector Autoregressive Model (VAR). The specification of the VAR itself is not relevant in this case since the focus is the effect of the exogenous shock over time.

In detail, a VAR shows the trend of a vector of k endogenous and interrelated variables, set as a linear function of the previous values defining the specific dynamic structure of the variables.

As known, one of the main problems estimating the IRFs by VAR is the specification of the (unknown) true multivariate dynamic system (Jordà, 2005). Indeed, it cannot be assumed deterministically that the true data generating process can be modelled through a VAR. Also, the choice of the maximum number of lags to insert is not neglectable since the inference depends on the lag order (Hacker and Hatemi, 2008; Hatemi and Hacker, 2009).

An estimation method that overcomes these significant problems is the local projection method proposed by Jordà (2005). Local projections can be estimated through simple least squares. In this case, the inference does not require asymptotic delta-method approximations or numerical techniques, non-linearities are admitted and, as said before, the procedure remains robust to potential data generating process (DGP) misspecification. Local projections are based on sequential regressions of the endogenous variable shifted several steps ahead (Jordà, 2005).

The VAR computes them recursively, in a way that subsequent observations depend on past values. However, the basic challenge, is the identification of the real DGP.

Instead, to estimate local projections, Jordà calculates multi-step forecasts through their direct estimation for each (local) time horizon. Namely:

$$\mathbf{y}_{t+k} = \boldsymbol{\alpha}^{k} + \mathbf{B}_1^{k+1}\,\mathbf{y}_{t-1} + \mathbf{B}_2^{k+1}\,\mathbf{y}_{t-2} + \ldots + \mathbf{B}_p^{k+1}\mathbf{y}_{t-p} + \mathbf{u}_{t+k}^{k} \quad \text{with } k = 0, 1, 2, \ldots, h \tag{3.1}$$

where $\boldsymbol{\alpha}^{k}$ is a *nx1* vector of constants and $\mathbf{B}_i$ are the matrices of coefficients for each lag *i* and time horizon *k+1*. Local projections are the *h* regressions in the vector $\mathbf{y}_{t+k}$.

An impulse response function is defined as the difference between two predictions (Hamilton, 1994; Koop *et al.*, 1996):

$$IR(t, k, \mathbf{d}_i) = E(\mathbf{y}_{t+k} \mid \mathbf{v}_t = \mathbf{d}_i; \mathbf{X}_t) - E(\mathbf{y}_{t+k} \mid \mathbf{v}_t = \mathbf{0}; \mathbf{X}_t) \quad \text{with } k = 0, 1, 2, 3, \ldots, \tag{3.2}$$

where the operator E(.) is the best, mean squared error predictor; $\mathbf{y}_{t+k}$ is the *nx1* vector of endogenous variable; $\mathbf{X}_t = (y_{t-1}, y_{t-2}, \ldots)'$; $\mathbf{0}$ is a *nx1* vector; $\mathbf{v}_t$ is the *nx1* vector of reduced-form disturbances; and $\mathbf{d}_i$ are the relevant shocks. The result of IRFs estimations is the best, mean-squared, multi-step projection.

In the case of the Jordà method, the impulse response functions are:

$$IR(t, k, \mathbf{d}_i) = \mathbf{B}_1^{k}\mathbf{d}_i \quad \text{with } k = 0, 1, 2, \ldots, h \tag{3.3}$$

where $\mathbf{B}_1^{0} = \mathrm{I}$ and $\mathbf{d}_i$ the relevant shocks.

This method has been applied in the recent literature to study many macroeconomic issues. In particular, it has been used to analyse the future trend of a variable in response

to an exogenous shock in the system avoiding that the estimation quality would depend on the accuracy of the chosen lag order, as in the VAR or in the SVAR approach.

It has also been exploited to estimate the effects of public policies in a state-contingent framework (Jordà and Taylor, 2015) by estimating an IRF for each unit taking into account the potential asymmetric policy effects.

For instance, in the case of fiscal policy, Ramey and Zubairy (2014) studied the role of slack (as measured by unemployment rate) and interest rates on fiscal multipliers in US states with quarterly data.

On a different ground, Furceri *et al.* (2019) analyse the potential asymmetric effects of monetary policy shocks on US states' per capita income growth, using quarterly data. The monetary policy shock is common to all US states and the analysis identifies the differential response of each State.

These two last papers estimate a unit-specific response to the shock employing long historical series.

Our case study is slightly dissimilar. Above all, the re-programming time of each Operational Programme might not be simultaneous across the Italian regions. Secondly, long historical data are not available. As will be explained later, the analysis is based on the last two programming periods before the current one (2007-2013 and 2014-2020) due to data accessibility. Indeed, prior programming phases (2000-06 and previous ones) are not perfectly comparable with the last two in terms of rules and re-programming strategies. To enlarge the number of observations, we, therefore, adopt a panel framework.

In the literature, there are several empirical applications of the Jordà method to panel data. Jordà *et al.* (2015) evaluated the response of house prices to interest rate and credit shocks within an unbalanced panel while Teulings and Zubanov (2014) estimated the IRFs of country's GDP to banking crises shocks with annual data. The countries considered have experienced banking crises at different times and with different frequency[42].

The next sections are focused on our application. Section 3.4.2 details our shock identification strategy following the relevant reference literature and section 3.4.3

[42] This is similar to our case, where the regions have reprogrammed at different points and with different frequency.

explains the econometric model of our main analysis. The results of the estimations are reported in section 3.5.

3.4.2 Identification strategy

The computation of the IFRs by local projections is preceded by the presentation of the shock identification strategy to avoid endogeneity and, specifically, reverse causality.

Some of the shock identification strategies developed in the previous works are based on the estimation of an auxiliary regression in which the shock variable is regressed on its potential determinants and the residuals of this regression are orthogonal to the response variable of the main regression (see Furceri *et al.*, 2019). Other applications assume shock exogeneity (Teulings and Zubanov, 2014) or instrument the shock variable (Jordà *et al.* 2015) or even classify the motivations into endogenous or exogenous (Romer and Romer, 2010).

However, to the best of our knowledge, there are no benchmark studies in the literature dealing with quantifying the economic impact of the modification of a public investment program during its implementation such as the case of Structural Funds' reprogramming. Thus, it is not viable a comparison between different shock identification strategies, given the specificity of our analysis.

Our model assumes (eq. 3.4) that the ROPs shock (in planned allocation (ΔP)), does not respond to changes in the regional per capita GDP ($\Delta GDPpc$) that occurred in the same year.

$$\Delta P_{it} \rightarrow \Delta GDPpc_{it} \qquad \text{with } i = 1, 2, \ldots, n;\ t=0, 1, \ldots, T \qquad (3.4)$$

This identification strategy mimics the Cholesky decomposition by assuming that the changes on planned amount do not respond to contemporary shocks to Y and that they are orthogonal to future expectations about the economy.

The first hypothesis assumes that the regions do not change the planned amount following the change of economic conditions occurred in the same year.

Following Romer and Romer strategy (2010)[43], we have classified the different motivations for the ERDF re-programming.

A careful scrutiny of these motivations (detailed in table A2 of the Appendix) allows us to conclude that the hypothesis of exogeneity is plausible for the modifications of ROPs which derive from:

- Spending problems;
- Earthquakes and others environmental disasters[44];
- Great Recession crisis[45];
- Changes in the Operational Program due to plans introduced by national authorities and not by regional ones (such as the '*Piano di azione e Coesione (PAC)*' introduced in Italy in the *Barca Plan* framework. The management of some ERDF resources, starting from 2012, were re-centralized at national level to finance recovery-oriented interventions after the economic crisis).

The second hypothesis is valid if the regions are unlikely to change the ERDF program during a specific year in view of potential future negative economic conditions (as in monetary policy shocks). By contrary, the revisions put in place by each region as a result of the Covid-19 pandemic were decided to deal with its economic consequences. Therefore, they should not be considered as exogenous. In this case, it is appropriate to check if the potential endogeneity of the 2020 would not have influenced the results. Therefore, we eliminated the 2020 year from the sample and re-estimated the IRFs (section 3.5.2).

[43] Romer and Romer (2010), in evaluating the effect of tax change on economic growth, classify the motivation for the tax change into endogenous and exogenous to the economic conditions and identify the exogenous ones as fiscal policy shocks.

[44] Natural disasters may also produce negative economic consequences. However, the re-programmings in the regions in which natural disasters are occurred, were subsequent to the events. Moreover, the re-programmings due to the 'solidarity' transfers among regions (*Contributo di solidarietà*) were addressed to the recovery of regions affected by environmental disasters.

[45] The Funds' diversion to fight the economic and social consequences of the global financial crisis is conceptually clearly endogenous since the re-programming has been undertaken because of the crisis. However, we have treated it as exogenous for a methodological reason. Indeed, the re-programming carried out in response to the Great Recession are subsequent (2013) with respect to the significant crisis years (2008-2011). Thus, we are confident that this does not affect the accuracy of our results.

3.4.3 The IRFs of regional per-capita GDP to financial plan re-programming

The model evaluating the impact of ERDF re-programming on per capita GDP at regional level is specified in equation (3.5). The period extends from 2007 to 2020. For the final years of 2007-13 programming and the initial years of 2014-20 we considered the sum of planned amounts of both periods. This procedure allowed us to consider both programming periods by neutralizing the breakdown between the two periods.

The regional sample includes the Italian NUTS-2 level territories[46] for which all the Annual Implementation Reports (*Rapporti Annuali di Attuazione*) were available.

$$\Delta GDPpc_{it} = \alpha_i + \lambda_t + \Delta P_{it} + \Delta \boldsymbol{X}_{it} + \varepsilon_{it} \qquad (3.5)$$
$$i = 1, 2, \ldots, n; \qquad t = 0, 1, \ldots, T$$

where: $\Delta GDPpc_{it}$ is the yearly percentage change of real per capita GDP in region i and time t, α_i are individual fixed effects to control for unobservable region-specific and time-invariant characteristics which may affect changes in real per capita income; λ_t are time fixed effects to control for global time-specific shocks and ΔP_{it} is the yearly percentage change on planned amount in region i and time t. Lastly, $\Delta \boldsymbol{X}_{it}$ is a vector including two lags of the shock[47] and several lags of the dependent variable to control for short-term factors which may affect the GDP fluctuations and may be correlated with the planned shock. The inclusion of past changes of the dependent variable are, indeed, part of our shock identification strategy.

From an econometric point of view, the choice of the number of lags is not crucial for the estimation quality (Jordà, 2005). We opted for both third and fourth order[48] to better control for serial correlation[49].

[46] The regions considered are: Lombardia, Liguria, Trento, Bolzano, Veneto, Friuli-Venezia Giulia, Emilia-Romagna, Toscana, Marche, Umbria, Abruzzo, Apulia, Basilicata, Sicily and Sardinia. We included separately Trento and Bolzano which are NUTS-3 areas but administratively treated as regions ('autonomous provinces').

[47] The estimation efficiency may increase when the number of lags of the shock increases. But out data cover only the last two planning periods. Therefore, the inclusion of a further lag would strongly reduce the sample size, in any case lowering the statistical efficiency.

[48] Both reported for robustness check.

[49] Three- and four-years lags appeared as a reasonable number of lags to avoid short-term disturbances.

To check for the robustness of the results, we estimated equation (3.5), augmented by the vector $\Delta \boldsymbol{C}_{it-1}$ which includes control variables aimed at reducing the omitted variable bias (eq. 3.6).

$$\Delta GDPpc_{it} = \alpha_i + \lambda_t + \Delta P_{it} + \Delta \boldsymbol{X}_{it} + \Delta \boldsymbol{C}_{it-1} + \varepsilon_{it} \qquad (3.6)$$
$$i = 1, 2, \ldots, n; \qquad t = 0, 1, \ldots, T$$

The accurate selection of control variables is not a negligible issue to reduce the potential bias on the coefficient estimation of our shock variable. The extensive set of explanatory variables concerned, in percentage change, regional production features (specialization) and the degree of urbanization (attractiveness), measured by population density (inhabitants per km^2, calculated from the National Statistical Institute, ISTAT).

As for specialization, given the macroeconomic downturn on our sample years, we opted for the employment share of agriculture or public sector[50] over the total (data were calculated from ISTAT). Population density and specializations indicators have been delayed of one period in order to reduce reverse causality (Jordà *et al.*, 2015).

3.5 Results

3.5.1 Main results

Figures 3.1-3.4 show the impulse response functions on the whole sample (2008-2020) estimated by the Jordà local projection method using region-based cluster-robust standard errors. The results indicate a persistent negative effect starting three years after the planned shock which remains stable by varying the number of lags of the dependent variable (from 3 to 4) and of the planned shock (from 1 to 2), or by adding the **C** vector of the regional specific controls. The negative effect of re-programming is also significant starting three years after the planned shock and remains persistent up to the fourth year. The negative effect is significant up to five years ahead only if we calculate the local projections with two lags of the shock (see Figg. 3.1b, 3.2b, 3.3b, 3.4b).

[50] The choice was done for apposite reasons. Agriculture is one of the most vulnerable sectors to exogenous shocks. Conversely, the public sector is one of the most resilient ones due to a higher share of stable (long-term) employment.

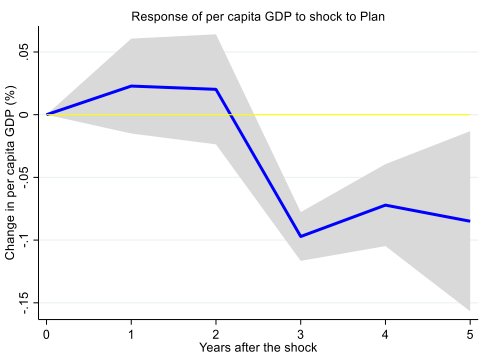
As a robustness check, we specified the dependent variable in levels, in place of yearly percentage change. The results, not reported for brevity, were confirmed.

What we have found can be considered a specific source of ineffectiveness of EU cohesion policy which may be added to the ones already debated in the literature.

Such ineffectiveness concerns the distraction of the EU funds from their long-term objectives following short-run adjustments[51]. In ex-post policy evaluation, the effect of re-programming for short-term needs results to be not negligible and may influence the policy outcomes considerably. Therefore, to avoid policy ineffectiveness, the feasibility of cohesion funds' re-prioritization should be accurately assessed when short-run emergencies arise.

Figure 3.1: estimation of IRFs of regional per capita GDP to planned shock, with three lags of the dependent variable – Without control variables – One and two lags of the planned shock

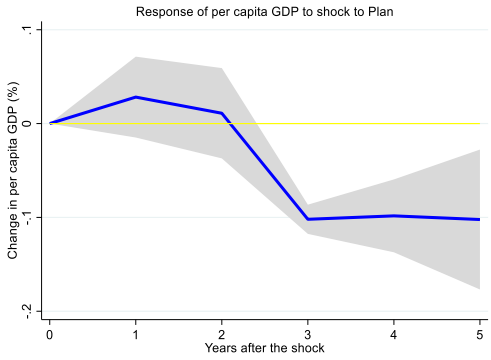
(a)



k = 1	k = 2	k = 3	k = 4	k = 5
0.0228	0.0202	-0.0971***	-0.0721***	-0.0850
(0.0230)	(0.0267)	(0.0119)	(0.0199)	(0.0437)
N = 180	N = 165	N = 150	N = 135	N = 120

Notes: 1 lag of the planned shock.
Region-based cluster-robust standard errors in parenthesis.
*: p-value < 0.05, **: p-value < 0.01, ***: p-value < 0.001.

(b)



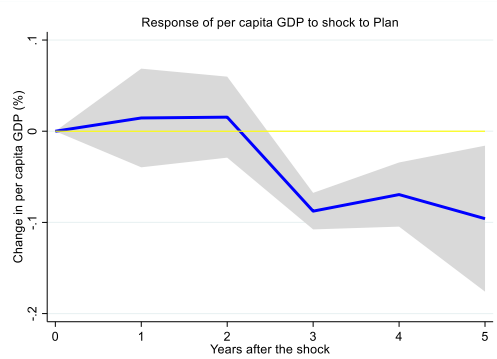
k = 1	k = 2	k = 3	k = 4	k = 5
0.0282	0.0110	-0.102***	-0.0983***	-0.102*
(0.0262)	(0.0292)	(0.00945)	(0.0236)	(0.0453)
N = 165	N = 150	N = 135	N = 120	N = 105

Notes: 2 lags of the planned shock.
Region-based cluster-robust standard errors in parenthesis.
*: p-value < 0.05, **: p-value < 0.01, ***: p-value < 0.001.

[51] Specifically, in the last two programming periods, European regions had to recovery from economic crises and natural disasters (see table A2 of the Appendix).

Figure 3.2: estimation of IRFs of regional per capita GDP to planned shock, with three lags of the dependent variable – With control variables – One and two lags of the planned shock

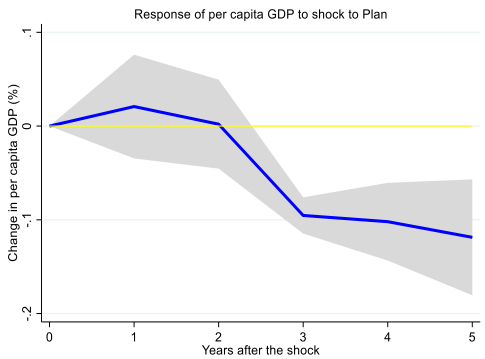
(a)



k = 1	k = 2	k = 3	k = 4	k = 5
0.0145	0.0154	-0.0876***	-0.0695**	-0.0959
(0.0329)	(0.0270)	(0.0122)	(0.0214)	(0.0486)
N = 180	N = 165	N = 150	N = 135	N = 120

Notes: 1 lag of the planned shock.
Region-based cluster-robust standard errors in parenthesis.
*: p-value < 0.05, **: p-value < 0.01, ***: p-value < 0.001.

(b)

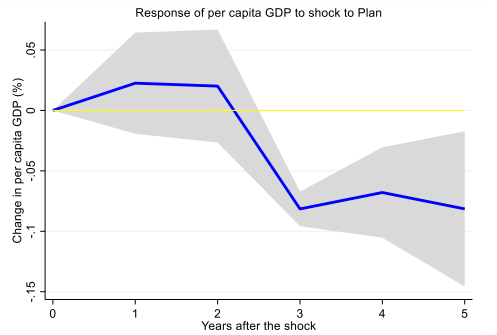


k = 1	k = 2	k = 3	k = 4	k = 5
0.0208	0.0020	-0.0954***	-0.102**	-0.119**
(0.0336)	(0.0288)	(0.0117)	(0.0252)	(0.0376)
N = 165	N = 150	N = 135	N = 120	N = 105

Notes: 2 lags of the planned shock.
Region-based cluster-robust standard errors parenthesis.
*: p-value < 0.05, **: p-value < 0.01, ***: p-value < 0.001.

Figure 3.3: estimation of IRFs of regional per capita GDP to planned shock, with four lags of the dependent variable – Without control variables – One and two lags of the planned shock

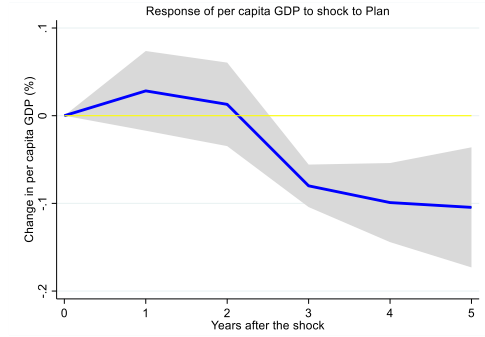
(a)



k = 1	k = 2	k = 3	k = 4	k = 5
0.0226	0.0202	-0.0815***	-0.0679**	-0.0815
(0.0254)	(0.0284)	(0.00868)	(0.0227)	(0.0390)
N = 180	N = 165	N = 150	N = 135	N = 120

Notes: 1 lag of the planned shock.
Region-based cluster-robust standard errors in parenthesis.
*: p-value < 0.05, **: p-value < 0.01, ***: p-value < 0.001.

(b)

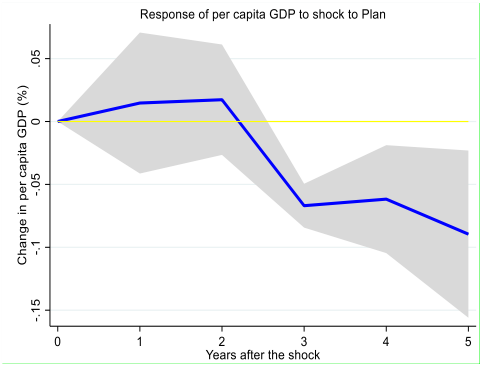


k = 1	k = 2	k = 3	k = 4	k = 5
0.0283	0.0129	-0.0800***	-0.0991**	-0.105*
(0.0276)	(0.0289)	(0.0147)	(0.0274)	(0.0416)
N = 165	N = 150	N = 135	N = 120	N = 105

Notes: 2 lags of the planned shock.
Region-based cluster-robust standard errors in parenthesis.
*: p-value < 0.05, **: p-value < 0.01, ***: p-value < 0.001.

Figure 3.4: estimation of IRFs of regional per capita GDP to planned shock, with four lags of the dependent variable – With control variables – One and two lags of the planned shock

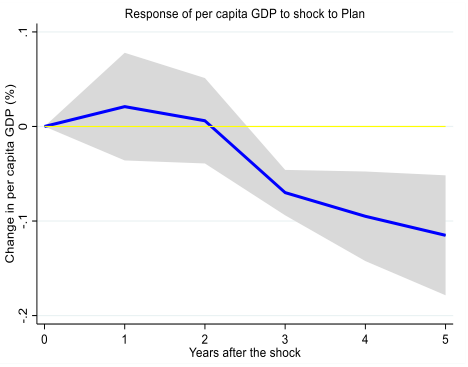
(a)



k = 1	k = 2	k = 3	k = 4	k = 5
0.0147	0.0173	-0.0669***	-0.0617*	-0.0895*
(0.0341)	(0.0267)	(0.0106)	(0.0261)	(0.0404)
N = 180	N = 165	N = 150	N = 135	N = 120

Notes: 1 lag of the planned shock.
Region-based cluster-robust standard errors in parenthesis.
*: p-value < 0.05, **: p-value < 0.01, ***: p-value < 0.001.

(b)



k = 1	k = 2	k = 3	k = 4	k = 5
0.0210	0.00604	-0.0699***	-0.0950**	-0.115**
(0.0346)	(0.0274)	(0.0146)	(0.0288)	(0.0685)
N = 165	N = 150	N = 135	N = 120	N = 105

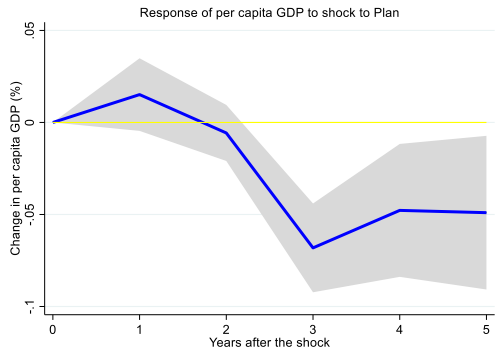
Notes: 2 lags of the planned shock.
Region-based cluster-robust standard errors in parenthesis.
*: p-value < 0.05, **: p-value < 0.01, ***: p-value < 0.001.

3.5.2 Robustness checks

As previously said, most of the considered re-programming are exogenous, but the 2020 revision, dealing with the health and economic consequences of the Covid-19 pandemic, is quite endogenous. Therefore, following Romer and Romer (2010) classifications, we excluded this revision and recalculated the IRFs without the year 2020. The results (figures 3.5-3.8) are substantially unchanged showing a significant negative effect starting from three years after the planned shock. Marginal differences with the previous analysis concern the statistical non-significance of the fifth year effect after the shock. This may be attributed to the decrease in the sample size occurring when we exclude the 2020-year from observations.

Figure 3.5: estimation of IRFs of regional per capita GDP to planned shock (excluding 2020 revision), with three lags of the dependent variable – Without control variables – One and two lags of the planned shock

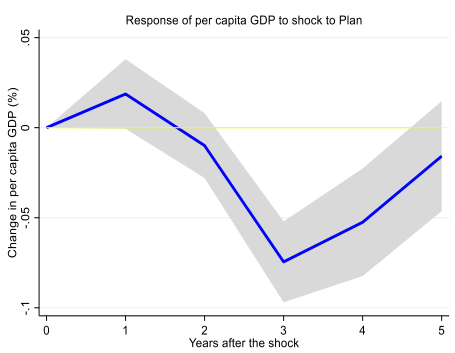
(a)



k = 1	k = 2	k = 3	k = 4	k = 5
0.0151	-0.0057	-0.0681***	-0.0478*	-0.0490
(0.0120)	(0.0092)	(0.0147)	(0.0220)	(0.0254)
N = 165	N = 150	N = 135	N = 120	N = 105

Notes: 1 lag of the planned shock.
Region-based cluster-robust standard errors in parenthesis.
*: p-value < 0.05, **: p-value < 0.01, ***: p-value < 0.001.

(b)

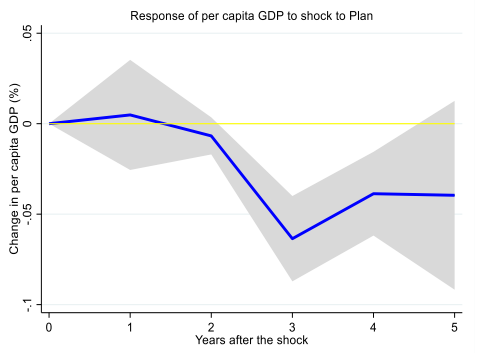


k = 1	k = 2	k = 3	k = 4	k = 5
0.0187	-0.0099	-0.0745***	-0.0525*	-0.0158
(0.0118)	(0.0109)	(0.0137)	(0.0181)	(0.0186)
N = 150	N = 135	N = 120	N = 105	N = 90

Notes: 2 lags of the planned shock.
Region-based cluster-robust standard errors in parenthesis.
*: p-value < 0.05, **: p-value < 0.01, ***: p-value < 0.001.

Figure 3.6: estimation of IRFs of regional per capita GDP to planned shock (excluding 2020 revision), with three lags of the dependent variable – With control variables – One and two lags of the planned shock

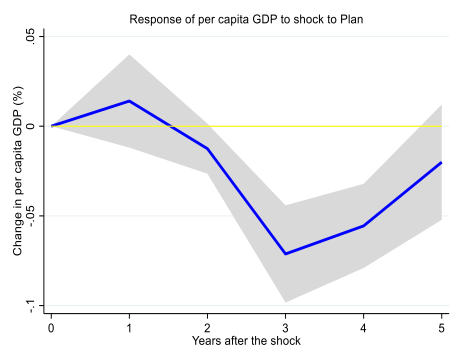
(a)



k = 1	k = 2	k = 3	k = 4	k = 5
0.0048	-0.0067	-0.0636***	-0.0387*	-0.0396
(0.0185)	(0.0062)	(0.0143)	(0.0141)	(0.0317)
N = 165	N = 150	N = 135	N = 120	N = 105

Notes: 1 lag of the planned shock.
Region-based cluster-robust standard errors in parenthesis.
*: p-value < 0.05, **: p-value < 0.01, ***: p-value < 0.001.

(b)

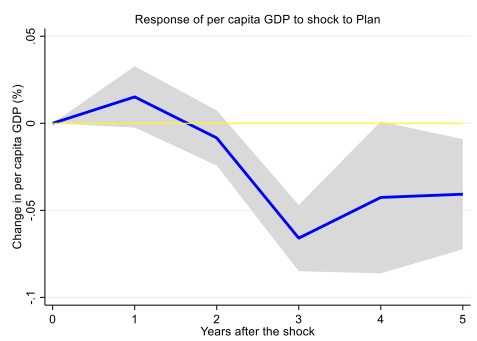


k = 1	k = 2	k = 3	k = 4	k = 5
0.0140	-0.0125	-0.0712***	-0.0556**	-0.0200
(0.0158)	(0.0084)	(0.0165)	(0.0143)	(0.0195)
N = 150	N = 135	N = 120	N = 105	N = 90

Notes: 2 lags of the planned shock.
Region-based cluster-robust standard errors in parenthesis.
*: p-value < 0.05, **: p-value < 0.01, ***: p-value < 0.001

Figure 3.7: estimation of IRFs of regional per capita GDP to planned shock (excluding 2020 revision), with four lags of the dependent variable – Without control variables – One and two lags of the planned shock

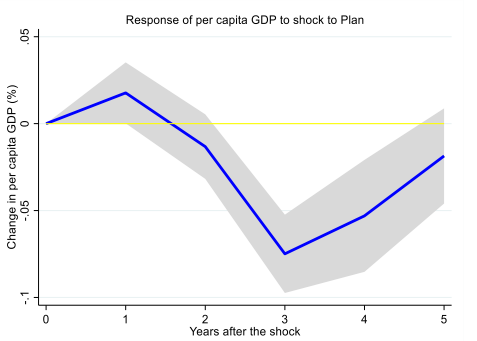
(a)



k = 1	k = 2	k = 3	k = 4	k = 5
0.0152	-0.0084	-0.0660***	-0.0426	-0.0407
(0.0107)	(0.0096)	(0.0116)	(0.0265)	(0.0192)
N = 165	N = 150	N = 135	N = 120	N = 105

Notes: 1 lag of the planned shock.
Region-based cluster-robust standard errors in parenthesis.
*: p-value < 0.05, **: p-value < 0.01, ***: p-value < 0.001.

(b)

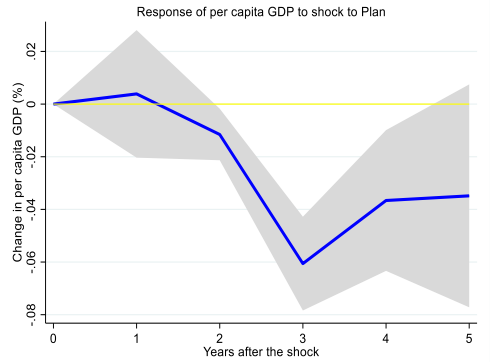


k = 1	k = 2	k = 3	k = 4	k = 5
0.0177	-0.0132	-0.0749***	-0.0531*	-0.0186
(0.0107)	(0.0113)	(0.0137)	(0.0196)	(0.0166)
N = 150	N = 135	N = 120	N = 105	N = 90

Notes: 2 lags of the planned shock.
Region-based cluster-robust standard errors in parenthesis.
*: p-value < 0.05, **: p-value < 0.01, ***: p-value < 0.001.

Figure 3.8: estimation of IRFs of regional per capita GDP to planned shock (excluding 2020 revision), with four lags of the dependent variable – With control variables – One and two lags of the planned shock

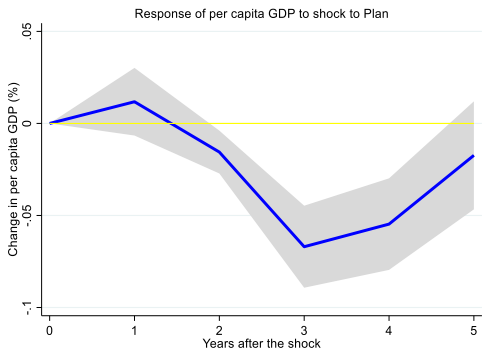
(a)



k = 1	k = 2	k = 3	k = 4	k = 5
0.0038	-0.0115	-0.0606***	-0.0366*	-0.0349
(0.0147)	(0.0059)	(0.0108)	(0.0162)	(0.0257)
N = 165	N = 150	N = 135	N = 120	N = 105

Notes: 1 lag of the planned shock.
Region-based cluster-robust standard errors in parenthesis.
*: p-value < 0.05, **: p-value < 0.01, ***: p-value < 0.001.

(b)



k = 1	k = 2	k = 3	k = 4	k = 5
0.0118	-0.0156*	-0.0670***	-0.0547**	-0.0173
(0.0112)	(0.0070)	(0.0135)	(0.0151)	(0.0178)
N = 150	N = 135	N = 120	N = 105	N = 90

Notes: 2 lags of the planned shock.
Region-based cluster-robust standard errors in parenthesis.
*: p-value < 0.05, **: p-value < 0.01, ***: p-value < 0.001.

3.6 The impact of sectoral re-programmings

To disentangle the effects of the revisions for the different sectors of intervention we have developed an extension of our investigation dealing with the variations of the financial plans by sector.

After an accurate analysis of each single regional investment plan, contained in Table A3 of the Appendix, we have grouped the spending areas of interventions into 4 sectors, labeled 'Competitiveness', 'Tourism', 'Environment and Energy' and 'Transport'. In particular, *Competitiveness* includes business incentives for innovation, research and development and ICT. The *Tourism* sector includes both the interventions aimed at protecting and enhancing natural and cultural heritage and the incentives for the tourism sector devoted to increase the tourist attractiveness of the region. The *Environment/Energy* sector looks at environmental sustainability and energy efficiency. Finally, investments in the latter sector (*Transport*) are all those addressed to upgrade transport infrastructures.

Biases are very likely in assessing the effect of re-programming on a sector-specific dimension such as sectoral labor productivity. Though we have tried this specific exercise, we have not obtained any relevant results. Therefore, to reduce the imprecision linked to the use of sector-specific dependent variables, we analysed the impact of sectoral re-programming on aggregate regional per capita GDP (figures 3.9-3.12) following equations (3.7) and (3.8).

$$\Delta GDPpc_{it} = \alpha_i + \lambda_t + \Delta P_{it,s} + \Delta \boldsymbol{X}_{it} + \varepsilon_{it} \qquad (3.7)$$
$$i = 1, 2, \ldots, n; \quad t = 0, 1, \ldots, T; \quad s = 1, \ldots, 4$$

$$\Delta GDPpc_{it} = \alpha_i + \lambda_t + \Delta P_{it,s} + \Delta \boldsymbol{X}_{it} + \Delta \boldsymbol{C}_{it-1} + \varepsilon_{it} \qquad (3.8)$$
$$i = 1, 2, \ldots, n; \quad t = 0, 1, \ldots, T; \quad s = 1, \ldots, 4$$

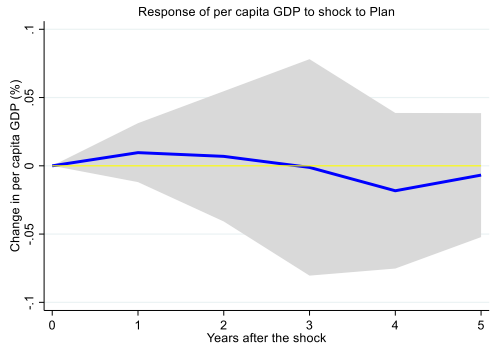
where: $\Delta GDPpc_{it}$ is the yearly percentage change of real per capita GDP in region i at time t, α_i are individual fixed effects, λ_t are time fixed effects, $\Delta P_{it,s}$ is the yearly percentage change on planned amount in region i, at time t, for sector s, $\Delta \mathbf{X}_{it}$ is a vector

which includes two lags of the shock and fourth lags of the dependent variable[52] and the vector $\Delta \mathbf{C}_{it-1}$ introduces the same control variables of the previous analysis[53].

The results of the sectoral analysis are presented in figures 3.9-3.12.

Figure 3.9: estimation of IRFs of regional per capita GDP to planned shock on *Competitiveness* sector

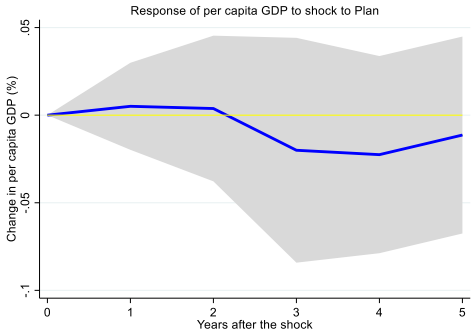
(a)



k = 1	k = 2	k = 3	k = 4	k = 5
0.0096	0.0069	-0.0011	-0.0183	-0.0068
(0.0131)	(0.0290)	(0.0482)	(0.0346)	(0.0276)
N = 165	N = 150	N = 135	N = 120	N = 105

Notes: ***without specific control variables (eq. 7).***
Four year lags of the dependent variable.
Two year lags of the planned shock.
Region-based cluster-robust standard errors in parenthesis.
*: p-value < 0.05, **: p-value < 0.01, ***: p-value < 0.001.

(b)



k = 1	k = 2	k = 3	k = 4	k = 5
0.0050	0.0037	-0.0200	-0.0225	-0.0113
(0.0151)	(0.0253)	(0.0390)	(0.0342)	(0.0342)
N = 165	N = 150	N = 135	N = 120	N = 105

Notes: ***with specific control variables (eq. 8).***
Four year lags of the dependent variable.
Two year lags of the planned shock.
Region-based cluster-robust standard errors in parenthesis.
*: p-value < 0.05, **: p-value < 0.01, ***: p-value < 0.001.

Overall, the negative effect of the ERDF re-programmings is persistent starting from the third year for all sectors[54], though the medium-run impact on per capita GDP is less significant than in the main analysis. Consequently, the negative impact of changes in the financial plan is stronger when we consider the revision as a whole (aggregate analysis). Indeed, the effects of re-programming on *Competitiveness* and *Tourism* (figures 3.9 and 3.10) are marginal. Thus, following the latter results, the negative aggregate effect (see section 3.5) might be mainly explained by the re-programming of the infrastructural interventions, namely in the *Transport* and *Environment/Energy* sectors (figures 3.11 and 3.12). The re-programmings in the *Transport* and the *Environment/Energy* sectors might

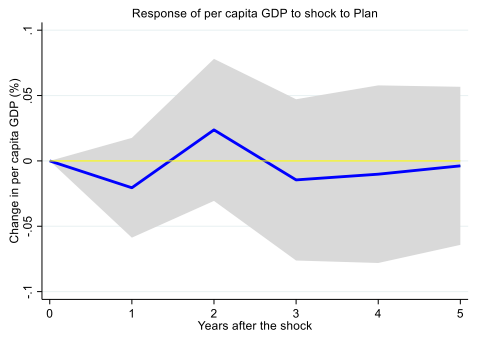
[52] For robustness, we estimated the IRFs also with three lags of the dependent variable and one lag of the shock, as in the previous analysis (section 3.5). The results, not reported for redundancy, are extensible.
[53] Namely, population density and specialization on public and agricultural sector.
[54] The second year for the *Environment/Energy* sector, figure 3.11.

have had more negative impacts than those in the other sectors since ex-ante programming is more relevant for infrastructural sectors.

Finally, we estimated the sectoral models by excluding the re-programmings resulting from shifts of resources among spending axes. The results, not reported for brevity, were confirmed for each sector. In addition, they revealed a positive and significant effect in the *Competitiveness* sector one year after the shock. The short-term positive impact of the competitiveness re-programming may be due to the massive intervention addressed to the firms particularly in the re-programming linked to the 2008-crisis and to the Covid-19 pandemic.

Figure 3.10: estimation of IRF impulse response functions[55] of regional per capita GDP to planned shock on *Tourism* sector

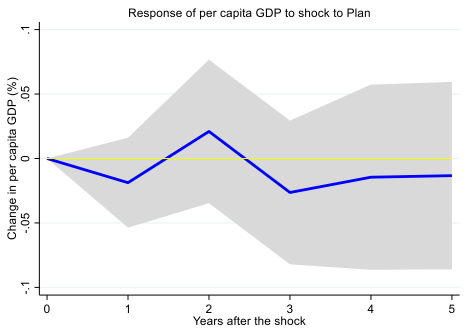
(a)



k = 1	k = 2	k = 3	k = 4	k = 5
-0.0206	0.0237	-0.0145	-0.0102	-0.0037
(0.0232)	(0.0330)	(0.0375)	(0.0413)	(0.0368)
N = 154	N = 140	N = 126	N = 112	N = 98

Notes: ***without specific control variables (eq. 7).***
Four year lags of the dependent variable.
Two year lags of the planned shock.
Region-based cluster-robust standard errors in parenthesis.
*: p-value < 0.05, **: p-value < 0.01, ***: p-value < 0.001.

(b)



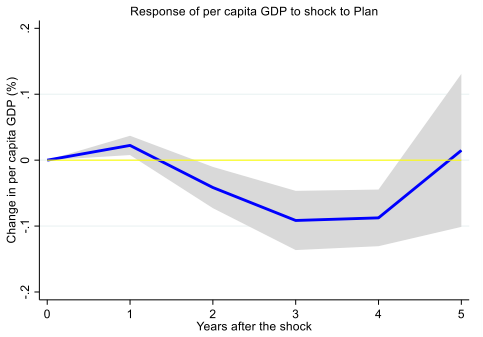
k = 1	k = 2	k = 3	k = 4	k = 5
-0.0188	0.0210	-0.0264	-0.0145	-0.0133
(0.0212)	(0.0338)	(0.0339)	(0.0437)	(0.0442)
N = 154	N = 140	N = 126	N = 112	N = 98

Notes: ***with specific control variables (eq. 8).***
Four year lags of the dependent variable.
Two year lags of the planned shock.
Region-based cluster-robust standard errors in parenthesis.
*: p-value < 0.05, **: p-value < 0.01, ***: p-value < 0.001.

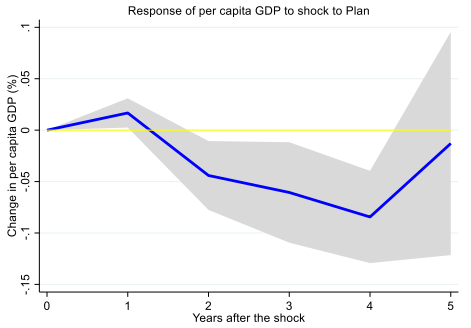
[55] The estimation of *Tourism* re-programming excludes the Bolzano region from the sample due to a difficult identification of tourism interventions across the different thematic areas.

Figure 3.11: estimation of IRFs impulse response functions of regional per capita GDP to planned shock on *Environment/Energy* sector

(a)



(b)



k = 1	k = 2	k = 3	k = 4	k = 5
0.0223*	-0.0415*	-0.0915**	-0.0876**	0.0148
(0.0088)	(0.0190)	(0.0273)	(0.0261)	(0.0705)
N = 165	N = 150	N = 135	N = 120	N = 105

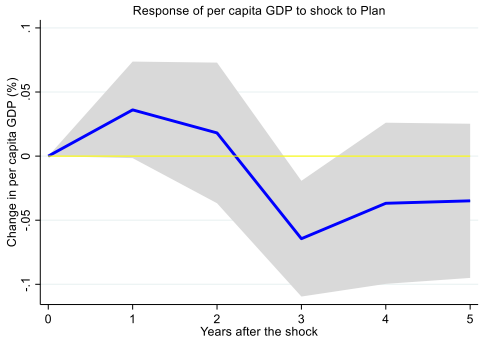
Notes: ***without specific control variables (eq. 7).***
Four year lags of the dependent variable.
Two year lags of the planned shock.
Region-based cluster-robust standard errors in parenthesis.
*: p-value < 0.05, **: p-value < 0.01, ***: p-value < 0.001.

k = 1	k = 2	k = 3	k = 4	k = 5
0.0167	-0.0441*	-0.0606	-0.0844**	-0.0130
(0.0086)	(0.0204)	(0.0297)	(0.0273)	(0.0660)
N = 165	N = 150	N = 135	N = 120	N = 105

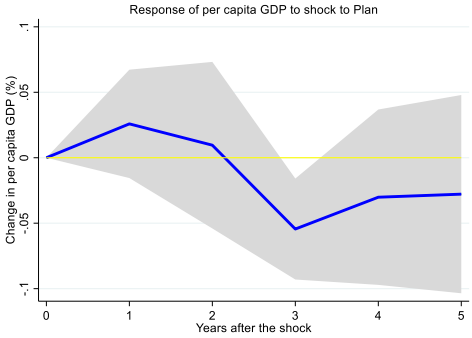
Notes: ***with specific control variables (eq. 8).***
Four year lags of the dependent variable.
Two year lags of the planned shock.
Region-based cluster-robust standard errors in parenthesis.
*: p-value < 0.05, **: p-value < 0.01, ***: p-value < 0.001.

Figure 3.12: estimation of IRFs impulse response functions of regional per capita GDP to planned shock on *Transport* sector

(a)



(b)



k = 1	k = 2	k = 3	k = 4	k = 5
0.0361	0.0181	-0.0644*	-0.0368	-0.0349
(0.0229)	(0.0333)	(0.0274)	(0.0382)	(0.0365)
N = 165	N = 150	N = 135	N = 120	N = 105

Notes: ***without specific control variables (eq. 7).***
Four year lags of the dependent variable.
Two year lags of the planned shock.
Region-based cluster-robust standard errors in parenthesis.
*: p-value < 0.05, **: p-value < 0.01, ***: p-value < 0.001.

k = 1	k = 2	k = 3	k = 4	k = 5
0.0259	0.0095	-0.0545*	-0.0301	-0.0278
(0.0252)	(0.0387)	(0.0234)	(0.0407)	(0.0460)
N = 165	N = 150	N = 135	N = 120	N = 105

Notes: ***with specific control variables (eq. 8).***
Four year lags of the dependent variable.
Two year lags of the planned shock.
Region-based cluster-robust standard errors in parenthesis.
*: p-value < 0.05, **: p-value < 0.01, ***: p-value < 0.001.

3.7 Conclusion

The European cohesion policy implementation is preceded by an accurate regional context analysis highlighting regional vulnerabilities. It establishes the ground for identifying the projects potentially suitable for fostering a balanced and sustained economic growth. However, the occurrence of significant (and unexpected) events such as economic crises or natural disasters during policy implementation often forces the policy maker to reallocate EU resources to fight unexpected economic and social consequences. The question at stake is then whether it is appropriate or not to distract cohesion funds from their long-term growth objectives to face short-run needs.

After an analysis of the motivations for the re-programming of Regional Operational Programs, this chapter evaluates its effects on the economic growth of Italian regions by estimating an impulse response function through local projections. We found an overall and quite persistent negative and significant effect of the shock caused by re-programming. As for the sector-by-sector scrutiny, the negative effect is more pronounced in the infrastructural sectors namely *Transport* and *Environment/Energy*.

This work was a first attempt to address, through an empirical analysis, the issue of the adjustment of Structural Funds' allocations aims during the policy implementation phase. The topic is particularly relevant also in a forward-looking perspective given the start of the 2021-27 programming.

From the analysis, we can conclude that the objectives of the EU cohesion policy remain substantially not in line with short-term needs.

Therefore, after an economic crisis, or an environmental disaster, a *trade-off* arises on the use of European Structural Funds.

On the one hand, the Structural Funds should be related to the ex-ante goals of the policy discouraging continuous adjustments in the Regional Operational Programs.

On the other hand, the policy makers are often forced to deploy all available resources, including European Funds to recovery quickly from downturns.

In our opinion, in light of the results found in our analysis, it would be more appropriate to evaluate ex-ante all potential effects of the reprioritization perhaps by using counterfactual methods.

In some sense, the use of Next Generation EU (and the Recovery Plan in Italy) may be potentially exposed to the same problem. Although established as a consequence

of (recovery from) the pandemic crisis, investments are mainly directed to projects potentially suitable to promote sustained long-term growth, such as ‘green transition’, digital improvement, smart and inclusive growth. Therefore, a distraction of the funds to cover short-run emergencies should not be encouraged.

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This thesis has analyzed, both conceptually and empirically, three potential sources of displacement effects related to the implementation of cohesion policy in the Italian economy. We found several interesting results that allow potential policy implications.

The first Chapter depicted a strong sectoral heterogeneity in the evaluation of the impact of cohesion policy on ordinary capital expenditure. According to the main results, in the transportation infrastructure domain, additionality seems more pronounced, while a crowding-out (substitution) effect is more evident dealing with human capital projects. The complementary role of cohesion treatment with respect to ordinary policy, in transport investments, might be due to the completion of some lots with the ordinary policy in addition to the ones realized with the cohesion policy according to a multiannual integrated programming plan of infrastructures in this domain.

These results call for greater coordination between the national ordinary capital expenditure policy and the cohesion one and suggest a strengthening of the supervision of the European Commission over EU Funds' additionality. Apart from the concern at the supranational level, national policy makers should be much more careful in fulfilling regional policy's additionality since if the treatment causes a reduction of ordinary spending, there would be an increase of regional inequality.

The estimates presented in the second Chapter show that both European and national finalized projects produce strong spatial spillover effects. The indirect effects of EU policy may have displaced somehow the direct impact of the policy since the prevailing policy's outcome appears to occur, at subnational level, more in areas close to the recipient ones. In a policy-making perspective, during the programming phase, each financed project should be considered as a potential catalyst of spatial externalities. Neighboring areas might be able to keep the gains of public investment if they were more endowed of favorable structural conditions. Also in this case, the EU policy may therefore generate negative effects on inequality across provinces.

By contrast, domestic cohesion policy appears to be equally effective in both treated and neighboring areas. This stresses the importance of integrating cohesion policies coming from both national and supra-national institutions, especially during economic downturns.

The possible motivations of the substantial differences in the results between the two policies may be attributed to the nature of the projects and to the programming procedures. The completed national cohesion projects refer mainly to infrastructures, while European Funds are also addressed, in a relevant quantity, to finance incentives for businesses and citizens. Moreover, the national cohesion policy decisions are more centralized at a national level while the EU disbursements are more dependent on the ability of each region to manage the funding opportunities.

Finally, the Great Recession exerted a negative role on both the direct and the indirect (spillover) effects of European and national cohesion funds, therefore reducing their impact on local economic growth.

According to the results of the third Chapter, the aggregate effect of a re-programming shock is persistently negative and statistically significant.

The results are robust to variation of the number of lags of the shock and of the dependent variable and to the addition of control variables. Performing a sector-by-sector scrutiny, the negative effect is more pronounced in the infrastructural sectors. These findings do not recommend strong Funds' diversions from long-term objectives to face short-run emergencies. These should be covered by ordinary fiscal policy or by additional resources specifically allocated to short-run needs.

A potential advancement of the first Chapter would be the extension to further spending sectors pertaining to other relevant components of regional development strategy. Expenditures oriented to environmental protection and sustainability and to cultural heritage promotion may be the first in the list.

Another evolution can be the investigation of the potential heterogeneity of cohesion funds' additionality between regional typologies in terms of specialization and level of development (such as Northern and Southern regions).

As for the second Chapter, the analysis on completed cohesion projects at NUTS-3 level can be complemented by an evaluation that includes also ongoing projects (to monitor the role of spatial externalities produced in progress) and by a consideration for the relevance of spatial spillover across spending typologies (infrastructural vs. incentive for business and citizens) or across spending sectors. This study could reveal the sources of the heterogeneous impact of the two cohesion policies.

Another complementary analysis can be a regional level assessment because spillovers between regions should be less relevant than those between provinces.

However, this analysis must be made preliminarily feasible by the implementation of strategies that tackle the endogeneity of the cohesion variable since the treatment, at a regional level, is strongly dependent on regional economic context.

A possible extension for the third Chapter can be to develop different model specifications which would consider employment rate as dependent variable, to perform the occurrence of the re-programmings in a different fashion (i.e., dichotomous) and evaluate the effect of the re-programmings over a longer-run period. Preliminary analyses have confirmed the results of the third chapter.

Finally, a more general limitation of this thesis is its country-specific character. Indeed, an evolution of the first and third chapters, subject to data availability, would be the enlargement of the analyses to additional EU countries, highlighting possible country differences in evaluating the effects of cohesion policy additionality and re-programming impact. Particularly for the third Chapter, the reprogramming of Regional Operational Programs can be influenced by differences in regional administrative capacity and a study of the reprogramming effects for other EU regions could make evident this potential institutional heterogeneity[56].

[56] We would thank one of the external evaluators for this suggestion.

Table A1: Descriptive statistics of Italian per capita income (euro), by provinces (NUTS-3) across 2007-2020 period

Province	*Mean*	*Std*	*Min*	*Max*
Torino	30807	1555	28600	33700
Alessandria	27129	1127	25800	29400
Asti	24357	1268	21600	26500
Biella	26071	1022	24700	27900
Cuneo	30857	1369	29000	33500
Novara	28143	1645	25800	31300
Verbano-Cusio-Ossola	23364	996	21500	25300
Vercelli	26893	1176	24800	29300
Aosta	37107	1008	35700	38800
Genova	33179	1708	31200	36800
Imperia	23679	1542	20900	26700
La Spezia	28586	1610	25700	31000
Savona	27629	1070	26100	29700
Milano	51800	2573	46400	55800
Bergamo	32071	1359	30200	34800
Brescia	32093	1694	29900	35200
Como	27893	1115	26400	29900
Cremona	29736	1821	26900	32800
Lecco	29607	1509	27500	32200
Lodi	26436	1074	25100	28900
Mantova	29593	1749	26900	32600
Monza e Brianza	29464	1191	27700	31700
Pavia	24179	1116	22700	26500
Sondrio	28829	1079	27200	31200
Varese	29257	931	27600	30700
Bolzano	42807	3101	38600	48400
Trento	36300	1335	34500	39400
Venezia	29771	1406	28000	32800
Belluno	29950	2640	25900	35400
Padova	31771	1764	28600	34900
Rovigo	24729	986	23100	26600
Treviso	31079	1645	28900	33700
Verona	32136	1404	30800	34800
Vicenza	31721	2019	28800	35400
Trieste	31971	2.302	29000	35800
Gorizia	26129	1599	23400	29400
Pordenone	29250	1613	25700	32000
Udine	29693	1262	27900	32200
Bologna	38086	2231	34300	42300
Ferrara	25643	1230	23800	27300
Forlì - Cesena	30643	1448	28600	33300
Modena	35786	2015	33300	39000
Parma	35850	1600	33700	39000
Piacenza	31171	1.871	27600	34000
Ravenna	30721	1176	28700	32500
Reggio-Emilia	34064	1840	31900	37200
Rimini	28671	1216	26800	31000
Firenze	36250	2310	34400	42900
Arezzo	27086	1216	25300	29700
Grosseto	23907	641	23000	24900
Livorno	25636	966	23300	27000
Lucca	27143	1001	26000	29200
Massa-Carrara	23179	1385	20900	25500
Pisa	29993	1410	28400	32900
Pistoia	24821	1043	22900	26500
Prato	30093	1775	28100	33100

Continue from **Table A1**

Provinces	***Mean***	***Std***	***Min***	***Max***
Siena	29843	1466	27700	32100
Perugia	25664	917	24400	27100
Terni	23500	1159	21700	25300
Ancona	29036	962	27600	31000
Ascoli Piceno	24621	1144	23100	26800
Fermo	24207	920	22200	25900
Macerata	24879	1162	23700	27100
Pesaro-Urbino	25786	1100	24300	28100
Roma	38086	1262	36200	39700
Frosinone	21700	913	20500	23600
Latina	22329	803	21300	24100
Rieti	19300	898	18100	21300
Viterbo	21064	564	20100	22200
L'Aquila	24107	1210	21200	26100
Chieti	24364	1329	22100	26500
Pescara	24621	570	23300	25600
Teramo	22957	673	22100	24300
Campobasso	21064	967	19400	22700
Isernia	20007	776	18500	21000
Napoli	18914	662	17900	20300
Avellino	17814	679	16800	19100
Benevento	16764	475	16100	17600
Caserta	16400	701	15600	17800
Salerno	17864	732	16800	19300
Bari	20643	972	19500	22700
Barletta-Andria-Trani	15236	674	14300	16500
Brindisi	17336	964	15600	18800
Foggia	17071	855	16100	18700
Lecce	15964	719	15200	17500
Taranto	17650	626	16700	18600
Potenza	22143	1880	19600	25500
Matera	18600	1048	17400	20600
Reggio Calabria	17257	480	16600	18100
Catanzaro	19229	929	17100	20400
Cosenza	15586	452	14800	16400
Crotone	17293	655	16400	18400
Vibo Valenzia	15214	584	14500	16500
Palermo	18579	471	17900	19400
Agrigento	14864	445	14400	15700
Caltanissetta	15879	753	15100	17800
Catania	18257	483	17700	19400
Enna	15471	458	14800	16400
Messina	17764	551	16800	18700
Ragusa	18407	880	17300	20100
Siracusa	17979	1000	15000	19300
Trapani	15993	501	15300	17000
Cagliari	27093	1348	25200	29400
Nuoro	18093	679	16800	19500
Oristano	17657	800	16300	18900
Sassari	20393	570	19600	21600
Sud Sardegna	14764	569	13900	16000

Notes: The distinction between the NUTS-2 regions is marked in bold. **Source:** Our elaborations.

Table A2 – ERDF re-programming of Italian regions implemented by '*Autorità di Gestione*', taken from 'Annual Implementation Reports'

Region	***Programming period***	***Year of modification to financial plan and Motivation***
Lombardia	2007-13	2013 - Reallocation of resources from 'Mobility' to 'Innovation' to finance a relevant 'Broadband' project.
Liguria	2007-13	2012 - Diversion of funds from 'Innovation and competitiveness' to the 'Contributo di solidarietà' addressed to Emilia Romagna, Lombardia and Veneto for the earthquakes (May 2012). After this event, the Italian Minister of economic development approved this contribution financed by each regional ERDF-ROP.
Trento	2007-13	2013 - Diversion of resources from 'ICT' and 'Sustainable urban development' addressed to the 'Contributo di solidarietà' for the seismic events of 2012 (see Liguria above).
	2014-20	2020 - Diversion of expenditure to finance health care costs and jobs subsidies after the COVID-19 pandemic outbreak.
Bolzano	2007-13	2013 - Diversion of funds from 'Environmental Sustainability' and Technical Assistance, addressed to 'Contributo di solidarietà' after earthquakes (see Liguria above).
	2014-20	2020 - Increase of the financial plan to finance intervention of mitigation of the hydrogeological risk and houses' energy efficiency.
Veneto	2007-13	2013 - Diversion of resources from energy and transport to finance the recovery after the seismic events.
Friuli-Venezia Giulia	2007-13	2013 - Reallocation of 23% of the total planned mostly due to expenditure acceleration, and to avoid the so-called automatic decommitment of resources, and partly due to seismic events.
Emilia-Romagna	2007-13	2013 - Reallocation of resources from 'Energy', due to the reduction of the number of 'Aree produttive ecologicamente attrezzate', to research, productive environment, tourism and technical assistance. The region also received the 'Contributo di solidarietà' addressed to recovery after the earthquake.
Toscana	2007-13	2013 - The re-programming of the financial plan was implemented as a result of the 2008 crisis and mainly concerned diversion of funds from transportation to productive environment.
	2014-20	2020 - The 2020 re-programming was implemented as a result of the economic crisis due to the pandemic outbreak and mainly concerned the diversion of resources from ecological transition and environment to health sector and subsidies to SMEs.
Marche	2007-13	2013 - The re-programming was a consequence of spending issues in particular in innovation, territorial development and technical assistance.
	2014-20	2017 - Substantial increase of resources addressed to the recovery after the earthquake.
Umbria	2007-13	2013 and 2014 - Diversion of funds from transport to recovery interventions after the 2008 crisis.

	2014-20	2018 - Increasing of financial plan due to the recovery after the earthquake.
	2014-20	2020 - Re-programming after pandemic with diversion of resources from research, and energy to healthcare system, SMEs subsidies and job subsidies to tourism sector.
Abruzzo	2007-13	2009 and 2010 - Substantial change of objectives due to the re-programming after the earthquake.
	2007-13	2013 - Re-programming due to the 2008 crisis for interventions to support SMEs especially given their difficulties in accessing credit. The budget addressed to the recovery after the earthquake has been again increased.
	2014-20	2018 and 2019 - Increase of resources addressed to seismic risk prevention and to the protection of geologically more fragile areas.
	2014-20	2020 - Changes to the financial plan due to the COVID 19 pandemic, with a diversion of resources from research to firm's support.
Apulia	2007-13	2012 - Re-programming due to the *Piano Azione and Coesione (PAC)*, in detail, part of ERDF resources, starting from 2012, were managed at national level in the *PAC* framework to finance short-term interventions due to the economic crisis.
	2007-13	2014 - Change due to spending acceleration.
	2014-20	2020 - Diversion of resources to job subsidies, SMEs support (including agricultural sector) and subsidies against poverty, after COVID-19 outbreak.
Basilicata	2014-20	2020 - Diversion of resources toward health, childcare, education and subsidies to SMEs in response of pandemic.
Sicily	2007-13	2012 and 2013 - Re-programming due to the economic crisis, mainly aimed at supporting SMEs. Sicily was also involved in *PAC* diverting resources toward social inclusion objectives (income support and '*Cassa integrazione guadagni'*).
	2014-20	2017 and 2018 - Re-programming due to the inclusion of some infrastructural 'Major projects' started during the previous programming periods but not completed yet (such as the 'Agrigento Caltanissetta' project).
Sardinia	2007-13	2012 - The PAC led to a reduction in ERDF (see Apulia above).

Source: Our systematization.

Table A3 – Regional thematic areas of ERDF

Region	***Programming period 2007-13: Spending thematic areas***	***Programming period 2014-20: Spending thematic areas***
Lombardia	Innovation Energy Mobility Cultural and natural resources Technical assistance	Research and innovation ICT Competitiveness Environmental protection Sustainable urban development Tourism Technical assistance
Liguria	Innovation and competitiveness Energy Urban development Cultural and natural resources Technical assistance	Research and innovation ICT SMEs competitiveness Energy Environmental protection Cities Technical assistance
Trento	Environment and Energy ICT Productive environment Sustainable urban development Technical assistance	Research and innovation SMEs competitiveness Energy Climate change adaptation ICT Technical assistance
Bolzano	Productive environment Environmental sustainability Climate risk prevention Technical assistance	Research and innovation ICT Sustainable environment Climate risk prevention Technical assistance
Veneto	Research and innovation Energy Environmental protection Transport infrastructures Cooperation projects Technical assistance	Research and development ICT Productive environment Energy and environment Seismic risk Sustainable urban development Technical assistance
Friuli-Venezia Giulia	Research and innovation Sustainable environment Transport infrastructures Territorial development Energy Technical assistance	Research and innovation SMEs competitiveness ecological transition Urban development Technical assistance
Emilia-Romagna	Industrial research Firm competitiveness Energy and environmental Cultural and natural resources Technical assistance	Research and innovation ICT firm competitiveness Low emission economy Cultural and natural resources Cities Technical assistance
Toscana	Research and innovation Sustainable environment Energy Transport infrastructures Sustainable territorial development Technical assistance	Research and innovation ICT SMEs competitiveness Ecological transition Environment Cities Technical assistance
Marche	Research and innovation ICT Energy Transport infrastructures	Research and development ICT SMEs competitiveness Low emission economy

	Territorial development Technical assistance	Adaptation to climate change Environment Seismic prevention Technical assistance
Umbria	Research and innovation Environment Energy Transport infrastructures Recovery after the earthquake Technical assistance	Research and innovation ICT SMEs competitiveness Energy Cultural and natural resources Recovery after the earthquake Technical assistance
Abruzzo	Research and innovation Energy ICT Territorial development Recovery after the earthquake Technical assistance	Research and innovation ICT Productive environment low emission economy Hydrogeological risk Cultural and natural resources Seismic risk Technical assistance
Apulia	Research and innovation Energy and environment Social inclusion Cultural and natural resources Transport infrastructures Employment policies Cities Governance Technical assistance	Research and innovation ICT SMEs competitiveness Energy Adaptation to climate change Cultural and natural resources Transport infrastructures Employment policies Social inclusion Education and training Governance Urban development Technical assistance
Basilicata	Transport infrastructures ICT Productive environment Cultural and natural resources Urbanization Social inclusion Energy Technical assistance	Research and innovation ICT Productive environment Energy Environment Transport infrastructures Social inclusion Education Technical assistance
Sicily	Transport infrastructures Natural resources Tourism Research and innovation Productive environment Governance Urban development Transport infrastructures Social inclusion Education and training Technical assistance	Research and innovation ICT SMEs competitiveness Energy Adaptation to climate change Environmental protection Transport infrastructures Social inclusion Education and training Technical assistance
Sardinia	ICT Social inclusion and education Energy Cultural and natural resources Urban development Productive environment Technical assistance	Research and innovation ICT Productive environment Energy Environment Cultural and natural resources Social inclusion Technical assistance

Source: Regional Operational Programs.