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ESSAYS IN REGIONAL ECONOMICS ASSESSING COHESION POLICY EFFECTIVENESS AND MEASURING WELL-BEING FOR EUROPEAN REGIONS

Settore Scientifico Disciplinare SECS-P06 ECONOMIA APPLICATA

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TABLE OF CONTENTS

ESSAY 2

ESSAY 3

INTRODUCTION[§]

This thesis is composed of three essays in regional economics. The three papers study European regions' economic and social progress from two different perspectives. The first analyses the impact of EU Cohesion Policy in improving specific areas of European regions' economies. The second ground of analysis is the measurement and dynamics of well-being at the NUTS 2 level. Both issues –the effectiveness of Cohesion Policy and the measurement of well-being – are high on the agendas of policy makers, international institutions and academic debate. In line with the recent debate, in each essay economic and social progress are assessed considering not only the productive sphere, but also a wider range of factors, which, indeed, are found to affect regional development.

Cohesion Policy is the European Regional Policy whose aims are defined by Article 174 of the Treaty on the Functioning of the European Union: "In order to promote its overall harmonious development, the Union shall develop and pursue its actions leading to the strengthening of its economic, social and territorial cohesion." The European Union supports the economic and social development of regions through Cohesion Policy with the ultimate goal of improving citizens' well-being especially in the least developed areas (Barca, 2009). The new policy concept is defined around a place-based development approach; the OECD calls this the "new paradigm of regional policy". Its objective is to reduce persistent *inefficiency* (underutilisation of resources resulting in income below potential in both the short and long run) and persistent *social exclusion* (primarily, an excessive number of people below a given standard in terms of income and other features of well-being).

The effectiveness of Cohesion Policy remains one of the most significant and highly debated aspects of EU policy. This is due to the lack of tangible results, especially in the current context of crisis and austerity. Despite the increasingly large numbers of empirical studies on the impact of EU Regional Policy, no unanimous results have been reached. One of the most controversial issues is the measurement of policy impact uniquely in terms of the growth of per-capita GDP. Some recent and widely cited publications maintain that regional per-capita income convergence does not adequately capture the aim of Cohesion Policy (Barca 2009; Barca and McCann 2011). Per-capita income convergence is neither a necessary nor a sufficient condition for achieving the efficiency and social inclusion objectives of Cohesion Policy and should not be used as a policy target. The reduction of the capacity underutilisation of a region can take place while the income gap with other regions increases or vice versa. Analogously, in terms of the social inclusion objective, a reduction in the income gap in a region compared to others is compatible with a rise in social exclusion as measured by the number of people with low incomes (Barca 2009). Consequently, changes in the income dimension say little about what is happening to other aspects of well-being.

[§] I wish to thank Prof. Rosanna Nisticò and Prof. Philip McCann for their helpful comments on an earlier draft of the work.
Some of the thesis results were discussed and presented in occasion of the following conferences: RSAI British & Irish Section-43rd Annual Conference - Aberystwyth, Wales - 19th to 21st August, 2014; 54th ERSA Congress " Regional development & globalisation: Best practices" -Saint Petersburg- 26th to 29th August 2014; XXXV Conferenza scientifica annuale AISRe "Uscire dalla crisi. Città, Comunità e Specializzazione Intelligenti" Padova, 11-13 September 2014; 55th RSA Trento- Società Italiana degli Economisti- 23-25 Ottobre 2014.

Thus, differing from the existing literature (Becker 2010, 2012; Hagen and Mohl 2009; Pellegrini *et al.* 2013), in Essay 1 we try to assess the effectiveness of Cohesion Policy considering, other than the growth of per-capita GDP, the following specific fields of intervention: Research, Technological Development and Innovation, and Transport Infrastructure.

We use the *sharp* Regression Discontinuity Design, a non-experimental technique that allows us to create a counterfactual scenario for policy evaluation (Thistlethwaite and Campbell 1960). We consider specific outcome variables for each field of intervention: patent applications for Research and Innovation and potential road accessibility for Transport Infrastructure (Stelder 2014). The sample refers to the NUTS 2 regions of the EU with 15 member states. The data used comes from an original dataset with comparable information at the European regional level, including also the certified expenditure for specific interventions. Our methodology consists of estimation of the effects both with a parametric (polynomial regression estimated with OLS) and non-parametric approach (local linear regression) and testing the results obtained through a variety of robustness checks suggested by the literature. In addition, and differently from the standard checks, we also carry out a robustness control related to different sample compositions and different time intervals. In particular, we consider per-capita GDP over a period of fifteen years (from 1995 to 2010) and over two sub-periods (1995-2003 and 2003-2010), and test the sample for the effect of possible outliers. We then consider the impact of transfers in RTDI and Technical Assistance on the growth rate in patent applications per million inhabitants. The whole period studied for the outcome variable is 1999-2010, but we look also at three sub-periods: 1999-2007, 2002-2010 and 2002-2007, and we consider three different sample compositions. Finally, we look into the presence of discontinuity in the growth rate of potential road accessibility as an outcome of expenditure in transport infrastructures, considering two sample compositions.

Our findings differ for each of the outcome variables considered. A positive impact of the policy is found for patent applications and potential road accessibility, though it is less marked for the latter. On the other hand, no significant results were obtained when considering the per-capita GDP growth rate – with some exceptions in the long run. These findings confirm the importance of investigating the effects of policy interventions also by means of specific outcome indicators, as suggested by Barca and McCann (2011).

As for the effectiveness of European Regional Policy, the issue of the measurement of well-being has gained momentum among researchers, policy makers and international organisations. Traditionally, economists have analysed well-being by mainly focusing on production indicators. Nowadays however, it is widely accepted that the progress of countries should not be measured by looking just at growth in terms of GDP. To obtain a full picture of countries' performances, we must look at multidimensional measures of economic and social progress. This multidimensional line of research has grown in popularity also following publication of the Report by the Commission for the Measurement of Economic Performance and Social Progress (Stiglitz *et al.* 2009) and a number of initiatives promoted by prestigious international organisations. Since 1990, UNDP has published the yearly Human Development Report calculating the Human Development Index (HDI); in 2013 OECD started several initiatives for the definition of quality of life measures, and the European Union is currently organising a number of meetings and programmes named "Beyond GDP" with the aim of developing "indicators that are as clear and appealing as GDP, but more inclusive of environmental and social aspects of progress" (European Commission 2014).

Developing better measures of well-being and progress is a common international goal that involves national governments in several countries (France, Italy, the Netherlands, Ireland, Germany, the USA and Canada). There is widespread agreement that well-being is a multidimensional concept that cannot be captured by a single dimension. Income in particular represents just one of the different dimensions affecting well-being and it fails to achieve many other aspects of people's quality of life (Monfort 2009). This was underlined also by Barroso during the opening speech of the "Beyond GDP Communication" conference (2007), in which he argued that there is a strong shared need to adopt suitable indicators for measuring progress in a multidimensional framework. What has emerged from the current debate is not that GDP is a poor indicator; on the contrary, it is the best-recognised measure of economic performance, widely used in economic forecasting and allowing to make cross-country and over-time comparisons. Rather, despite its largely acknowledged informative power, GDP is not an accurate measure of well-being (Kuznets 1934; Tobin and Nordhaus 1973; Costanza *et al.* 2009; Dunford and Perrons 2012; to name some). The common goal, shared also by the Stiglitz-Sen-Fitoussi Commission is thus to flank GDP with other indicators of economic performance and social progress (GDP and beyond).
Our aim is to contribute to the empirical literature on the measurement of social and economic progress by calculating a synthetic indicator of well-being at the European regional level in Essay 2 of this thesis, and by focusing on the regions of Italy in Essay 3.

In the second essay we consider a database of 15 variables and construct six composite indicators that reflect different well-being dimensions: people's health and social conditions; education and life-long learning; household material conditions; knowledge economy; local environment attractiveness in terms of infrastructure endowments and tourist inflows; age and gender equality in labour market conditions. Sub-indicators are then combined in an overall synthetic index of well-being for 216 NUTS 2 of the European Union (27 member states). For the aggregation weights we decide to adopt the Equal Weight (EW) approach (Berloffa and Modena 2012; Marchante *et al*. 2006; OECD 2013). Besides the definition of a composite well-being indicator, our study has two further goals: the definition of a taxonomy of European regions in terms of well-being, and an analysis in terms of convergence. In other words, well-being in European regions is analysed both in a synchronic and in a diachronic perspective, covering an eleven-year period from 2000 to 2010. It is then compared with levels and trends of per-capita Gross Domestic Product (GDP). To obtain a taxonomy of European regions, we carry out a cluster analysis in terms of well-being levels. Further, we assess dispersion across regions (σ-convergence) and rank mobility (γ-convergence) over the same period both in terms of well-being index and per-capita GDP among European regions. When investigating the presence of σ-convergence, we refer to three inequality measures (coefficient of variation, Theil and Gini indices); whereas for γ-convergence, we look at intra-distributional mobility in the regional ranking by means of the Kendall index (Siegel 1956). The cluster analysis reveals that regional gaps are an issue not only between countries but also within the same country; whilst the convergence analysis highlights that although regions converge in some dimensions of well-being; this is not enough to change their relative position in the regional ranking.

The third essay of this thesis focuses on Italian regions and makes use of the data provided by a recent project carried out by the Italian National Institute of Statistics (ISTAT) in conjunction with the National Council for Economy and Labour (CNEL). This project produced a database covering 12 dimensions of "Equitable and Sustainable Well-Being" (hereafter BES) consisting of a set of 134 outcome indicators. They also provide a report in which well-being in Italy is examined from a multi-dimensional perspective following the recommendations of the "Stiglitz Commission", but without attempting the final step of aggregating the data into a synthetic measure of well-being. We select 57 variables at the regional level for the period 2004-2010, grouped in ten dimensions of well-being: Culture and Free Time, Education, Employment, Environment, Essential Public Services, Health, Material Living Conditions, Personal Security, Research and Innovation, Social Relations. Afterwards, these sub-indicators are synthesised in the Regional Well-Being Index (RWBI) and this is then compared with per-capita GDP. The construction of all partial indicators as well as of the overall well-being index required the implementation of 77 principal component analyses. In the second part of the work, we investigate well-being dispersion across regions and the regional rank mobility over the period 2004-2010 by using two non-parametric techniques (σ-convergence and γ-convergence), applied to both the partial and overall indicators previously calculated. We also compare the dynamics of regional well-being with those of the traditional indicator of economic performance: per-capita GDP.

The contribution of our work is both conceptual and methodological. First, it expands the spectrum of domains and variables through which much of the empirical literature has measured well-being in Italian regions so far. Second, by selecting the relevant dimensions of well-being on the basis of the BES project results, we minimise the arbitrariness in the choice of variables, recurrent in studies on the construction of synthetic indicators. Third, whilst the BES report did not attempt the final step of aggregating the data into a synthetic measure of well-being, this is instead a specific objective of our paper. To the best of our knowledge, this is the first study that uses a two-step principal component analysis to calculate single domain sub-indices in the first step, and the overall well-being indicator in the second step, using the sub-indices as the new variables. Finally, by analysing convergence for both single-domain indices and the overall well-being indicator, we capture the dynamics of well-being and assess changes in the quality of life domains at the regional level over time.

We find that the regional well-being divide in Italy is at least as significant as the economic divide, suggesting the importance of redirecting the focus of public policies and academic debates to quality of life-related aspects of economic and social progress.

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ESSAY 1

ASSESSING COHESION POLICY EFFECTIVENESS ON EUROPEAN NUTS 2: COUNTERFACTUAL EVALUATION ON TRANSPORT ACCESSIBILITY AND RESEARCH AND INNOVATION USING A REGRESSION DISCONTINUITY DESIGN APPROACH

[Abstract]
Traditionally, European Cohesion Policy effectiveness has been evaluated in the economic literature in terms of its impacts on the per capita growth rate of GDP. However, no unanimous results have been reached so far. In this essay, the effect of European Regional Policy are evaluated at the EU 15 NUTS 2 level by considering, alongside GDP growth, two specific fields of intervention, namely "Research, Technological Development and Innovation" (RTDI), and "Transport Infrastructure" (TI). Our econometric approach involves the use of a non-parametric Regression Discontinuity Design technique to a uniquely-disaggregated Cohesion Policy dataset broken down according to the specific objectives of each stream of funding. The analysis considers different time intervals and different regional sub-samples. The statistically significant results obtained show a positive impact of Cohesion Policy on the Objective 1 regions' progress, when the two specific fields of intervention are considered.

Keywords: EU Cohesion Policy, Regional growth, Regression Discontinuity Design, Research and Innovation, Transport Infrastructure
JEL classification: O18. O47. C21. R11

1.1 Introduction[†]

The aim of this work is to assess the effectiveness of European Cohesion Policy during the programming period 2000-2006[1] in improving both research and innovation activities and transport accessibility, alongside its impact on the growth rate of per-capita GDP.

Previous contributions to the assessment of EU Cohesion Policy were focused mainly on the growth rate of the Gross Domestic Product (Becker 2010, 2012; Hagen and Mohl 2009; Manzella and Mendez 2009, Pellegrini et al. 2013), leaving its impact on other specific fields of intervention unexplored. In recent years, however, a number of studies has stressed the importance of considering the multidimensional nature of both social progress and economic development, broadening the scope of analysis to more than just the production sphere (Acemoglu et al. 2005; CMEPSP 2009; Fitoussi 2013; Sen 1999, 2006; Stiglitz et al. 2009; Tabellini 2010; UNDP 2013). This strand of research is in line with the European Union Treaty statement that: "in order to promote its overall harmonious development, the Union shall develop and pursue its actions leading to the strengthening of its economic, social and territorial cohesion" (art. 174 of the Treaty on the functioning of the European Union, ex art. 158 TEC).

† This essay was carried out during my visiting research period at the University of Groningen-Faculty of Spatial Sciences-Department of Economic Geography.

[1] More precisely, the programming period 2000-2006 is the focus of the analysis, but we aim to account also for the time-delayed effects of the policy; thus we consider a longer time interval for the outcome variables. Moreover, in order to have a greater stability of the sample, we consider the eligibility status of the regions for both programming periods (1994-1999 and 2000-2006).

Following this view of analysis, in this study we use an original dataset with comparable information at the European regional level to investigate a wider range of impacts of European Regional Policy than those considered in the literature so far.
With this aim in mind, we apply a Regression Discontinuity Design, a non-experimental method for comparing the performance of different groups of observations. The article is structured as follows. Section 2 presents a survey of previous studies on the effects of EU Regional Policies. Section 3 briefly discusses the contents and goals of European Regional Policy. Section 4 illustrates the study's methodology and in section 5, the construction of the dataset is described. Section 6 presents the results of the analysis by comparing trends in the regions affected by the EU Regional Policy with trends in other regions. Section 7 discusses the conclusions; and lastly possible future extensions of the research are mentioned in section 8.

1.2 Theoretical framework

The effectiveness of EU Regional Policy was especially evaluated in terms of convergence in per capita growth rate of GDP amongst regions. The use of GDP as a synthetic indicator of regional performance and of policy effectiveness has the advantage of being a standard measure available for all countries, thus facilitating spatial and temporal comparisons of the results. However, GDP does not account for dimensions of social and economic progress that are not strictly related to the production activity (Fleurbaey 2009, Bleys 2012).
The Report of the Stiglitz, Sen, Fitoussi Commission (2009) emphasises the necessity of going "beyond GDP" for "measuring economic performance and social progress". Following this point of view, our work takes a multidimensional approach to the evaluation of the effects of the EU Regional Policy in the NUTS 2 regions of the European Union, looking at specific outcome variables concerning a wider range of progress dimensions than that of production.
Several studies have investigated the impact of Cohesion Policy on economic growth. However, the heterogeneity of the data, the variety of methodological approaches used and the low quality of regional data on Structural Funds have not allowed to reach unanimous results, leaving open the debate on the effectiveness of Regional Policy (Hagen and Mohl 2008). In terms of the impacts of the policy, there are now more than fifty studies analysing the effects of European regional policy on EU regions, of which between approximately two thirds and three quarters of these papers find either positive effects or positive but mixed effects on the recipient regions while the remaining quarter find either negligible or even negative effects (McCann 2015). For a summary of the main findings, see Table 1.
Following Ederveen et al. (2002), we classify these studies into three groups based on the type of evaluative approach adopted: case studies, model simulations and econometric models. We further expand the survey with a number of more recent contributions and a more detailed clustering of the econometric studies.

1.2.1 Case studies

The case studies literature evaluates single policy projects, with varying emphasis on the way in which the funds are actually spent, on their impact on local authority practices, or on their macroeconomic implications (Ederveen et al. 2002). A number of case studies assesses the impact of Cohesion Policy on the growth of gross per-capita regional production and employment. In most of the cases, they find some kind of limitation to the effectiveness of Cohesion Policy, though they do not present quantitative estimates of the policy's impact. The great majority of these studies in fact contains a detailed description of the socio-economic situation in the regions analysed as well as of the projects to be financed by Cohesion support, but the evaluation itself boils down an enumeration of the project's output (kilometres of roads constructed, number of jobs created and so on). Some studies adopt this approach focusing on single programmes and single areas. Among these, the most cited are Huggings (1998) on the Objective 2 programmes in industrial South Wales, Daucé (1998), who focused on the most depressed rural area in Burgundy, and Lolos (1998) who analysed the macroeconomic and structural policies in Greece and Portugal.

Further, many researchers argue that considering only the numeric impact of the policies is insufficient and have tried to include single projects in regional economic models in order to capture also the spillover effects (European Commission, 1999). Others have tried to get an idea of the impact of Cohesion Funds from reviewing various case studies of different projects referring to specific areas (Das Neves 1994). Bachtler and Taylor (1996) consider the evaluation of projects and the EU official surveys, though they do not estimate a quantitative impact. The practical experiences of Cohesion support are brought together in the work of Bachtler and Turok (1997) with case studies on the United Kingdom, Germany, The Netherlands, Austria, Finland and Sweden. These studies highlight the difficulty in achieving coherence in these big *ad hoc*-defined projects, even in the presence of reforms aiming to define regional plans and a common EU framework; they also stress the difficulties in evaluating policy effects which are considered by the majority of these studies presumably modest.

1.2.2 Model simulations

Model simulations complement the traditional case studies in three main ways. First, they evaluate the contribution of Cohesion Policy on a macroeconomic ground, considering the results in terms of regional productivity or employment levels. Second, they model the general equilibrium consequences of Cohesion Policy and sometimes investigate the occurrence of externalities. Third, they provide the counterfactual, analysing how regions would have fared without the Cohesion support.

The first attempts at evaluating Cohesion support through model simulations used EU macroeconomic models, and in particular the HERMES model, developed to analyse supply side shocks in the 1970s and 1980s. This model reveal a positive impact of Cohesion Policies, however, it has only been applied to Ireland (Bradley 1992; Bradley, Fitz Gerald and Kearney 1992). The HERMIN model on the other hand (Bradley, O'Donnell, Sheridan, and Whelan 1995; Bradley, Modesto, and Sosvilla-Rivero 1995; Bradley 2000), has been applied to Ireland (Bradley, Whelan, and Wright 1995), Spain (Herce and Sosvilla-Rivero 1995) and Portugal (Modesto and Neves 1994; Modesto and Neves 1995). All these studies find a positive impact of Cohesion support with a significant role in the reduction of regional disparities, which would not have been the same in the absence of the Policy. Further, the European Commission (1999a, 1999b, 2001a) reports on the results of other simulations obtained using HERMIN as well as QUEST, a model that focuses on the demand side (Röger 1996).

Another strand of research refers to model simulations other than the European Commission models. Gaspar and Pereira (1992) develop a two-sector endogenous growth model of private, public and human capital accumulation for Portugal and they find that the current structural changes have a marked impact on economic growth as they contribute to generating a convergence process.

A different modelling approach is used by Goybet and Bertoldi (1994), who consider models that range from a neo-Keynesian to a dynamic general equilibrium with endogenous growth; they conclude that Objective 1 regions on average grow faster than EU member states. Greece is the focus of analysis in the works of Lolos, Suwa-Eisenmann, and Zonzilos (1995) and Lolos and Zonzilos (1994), who use a general equilibrium model; their results are mixed in terms of both the sign and intensity of the Policy's impact. More recent studies by Pereira (1997, 1999), Gaspar and Pereira (1995) and Pereira and Gaspar (1999) use an endogenous growth model to assess the impact of the Cohesion support on the GDP growth of Greece, Ireland and Portugal for the period 1989-93. The results show a substantial impact on economic growth in these economies and a significant contribution to convergence. They also highlight the importance of continuing the transfer programme since the relative long-run position of these countries would still be far from EU standards.

The overall conclusion from the simulation exercises is that Cohesion support significantly contributes to regional growth and employment. The weakness of this approach is however, the indirect measurement of the Policy's effect, which is highly dependent on the hypotheses underlying the model used in the analysis.
In conclusion, model simulations illustrate the Policy's potential effects, which are found to be positive, but they fail to account for a number of important factors that may reduce the actual effectiveness of Cohesion support, such as crowding out effects, inefficient allocation and rent-seeking behaviour.

1.2.3 Econometric models

Among the contributions that adopt econometric methods, we can identify two different approaches: the classical regression framework, where growth equation models are estimated (Barro 1991, 1997; Barro and Sala-i-Martin 1992; Sala-i-Martin 1994), and the more recent literature based on the treatment effect technique. In both strands of research, however, no unambiguous results have been reached and it is possible to provide a further classification of these studies based on the effects they observe.

Classical regression framework

In the classical econometric regression approach, there is a controversial evidence of the policy effects. Based on the results obtained, we identify three groups of works: the first group gives an optimistic policy evaluation, finding a positive and statistically significant impact (de la Fuente *et al.* 1995; Cappellen *et al*. 2003; Rodriguez-Pose *et al.* 2004; Beugelsdijk and Eijffinger 2005; Falk and Sinabell 2008); the second group obtains mixed results, finding that policy effectiveness is dependent on the presence of specific conditions (Puigcerver-Penalver 2004; Antunes and Soukiazis 2005; Percoco 2005; Ederveen *et al*. 2006; Bäh, 2008; Esposti and Bussoletti 2008; Mohl and Hagen 2008, 2010; Bouvet 2010; Rodríguez-Pose and Novak 2013); finally, the third group includes works that have a pessimistic vision of the policy, showing either negative or redistributive effects (Fagerberg and Verspagen 1996; Boldrin and Canova 2001; Garcia-Milà and McGuire 2001; de Freitas *et al*. 2003; Dall'Erba and Le Gallo 2008; Aiello and Pupo 2012; Wostner and Šlander 2009).

Amongst the works highlighting the policy's success we find the research of de la Fuente et al. (1995), where a growth model that includes public capital and human capital is estimated. The authors show evidence that public investments in infrastructure and education have a significant impact on growth in the Spanish regions in the period 1980-1990. They thus conclude that adequate regional policies can encourage both growth and convergence. A positive and statistically significant impact of EU Regional Policy on the regional growth is found also in Cappellen et al. (2003). In addition, they show that the effects are stronger in more developed environments, calling for policy interventions to improve the competences of the receiving contexts (for example by facilitating structural changes, or by increasing the investment capacity in R&D in the poorer regions). In their empirical analysis, the authors validate the hypothesis that regional growth is the outcome of three groups of factors: the exploitation of knowledge developed elsewhere (diffusion of knowledge); the creation of new knowledge in the region (innovation) and the presence of "complementary factors" that affect the capacity for exploiting the potential of knowledge created elsewhere. This research design entails two main problems: the definition of an indicator of innovation, and the measurement of "complementary factors". As a proxy for innovation, they use the intensity of research and development (employees in R&D in firms as a percentage of the total employment); whereas among the complementary variables they consider: transport infrastructure, population density, industrial structure, long-term unemployment. The estimation results confirm that the impact of the contributions (public financing) is strictly dependent on the receptiveness of the receiving environment.

Rodriguez-Pose and Fratesi's (2004) evaluation of the effects of Regional Policies is also positive. They consider the impact of the Structural Funds on the Objective 1 regions. Their results confirm a key role of the development funds allocated to lagging regions in Europe: their positive impact on regional economies keeps regional disparities more stable, meaning that they avoid the expansion of regional gaps. However, transfers have failed to achieve their goal of reducing the gap between the European core and its periphery.

Beugelsdijk and Eijffinger (2005) deal with two main issues: first, they verify convergence across European member states over the period 1995-2001; secondly, they analyse the problems of moral hazard and substitution effect. As regards the first issue, they show that Structural Funds have a positive impact on convergence, as there is a trend of backward countries catching up with richer ones. In terms of the second issue, they consider two kinds of problems. The first one is the possibility that opportunistic behaviour may occur: since eligibility for the Funds is dependent on the presence of a certain GDP threshold, policy makers could decide to use the funds inefficiently in order to get more funds in the future (moral hazard). A crowding out effect (or substitution effect), on the other hand, might prevail if the transfers received are invested in projects for which the states have already allocated national resources: states, substitute the national resources with Structural Fund transfers with the consequence of no additional impact. To consider the moral hazard and substitution effect, the authors estimate two different convergence equations, one for "clean" countries and another one for "corrupt" countries[2]. The influence of corruption on the funds' impact on economic growth is evaluated with an interaction term. Results do not show a weaker relationship of Structural Funds to growth for the more corrupt countries.

[2] A corruption index related to perceptions of the degree of corruption as seen by business people, risk analysts and the general public and ranging from 10 (highly clean) to 0 (highly corrupt), is included in the regression equations.

In the work of Falk and Sinabell (2008), a spatial econometric approach is used to investigate the growth effects of EU Structural Funds for Objective 1 regions at the NUTS 3 level. They estimate the regional growth of per-capita GDP as a function of (a) the initial level of per-capita GDP (in PPT), (b) the share for each sector (primary or secondary), (c) Objective 1 area eligibility and (d) population density. In addition, in order to investigate the sources of the growth differential between Objective 1 and other regions, they apply the Blinder-Oaxaca decomposition, finding that the growth differential between Objective 1 regions and other regions is solely due to differences in the characteristics and not to differences in the coefficients.

Another group of studies finds evidence that the effectiveness of European Regional Policy is dependent on the specific context's features. Puigcerver-Penalver (2004) model the impact of the Objective 1 policy, adopting a "hybrid" growth model that links the growth rate of per-capita income to (a) its initial level, (b) the Structural Funds transfers, the catching-up variable and the initial level of Total Factors Productivity (TFP). The model is estimated by means of OLS using a panel data approach with fixed effects (only Objective 1 regions are considered). The results show a positive effect of the Structural Funds on the per-capita growth rate of income in Objective 1 regions. However, these results change when the two programming periods are considered separately: the impact is still positive during the first programming period but almost null in the second.

Antunes and Soukiazis (2005) aim to determine whether there are differences in the convergence process between the coastal and the inland regions of Portugal. They examine the relevance of Structural Funds as conditioning factors in the convergence process and to what extent they contribute to regional per-capita income growth. The analysis considers the NUTS 3 regions of Portugal by using a panel data approach. Results show that Structural Funds help regions to grow faster but their marginal impact is small. They have a significant positive effect only in the coastal area, helping its regions to grow faster.

Percoco's research (2005) focuses on six Italian Mezzogiorno regions and analyses the impact of the Structural Funds by means of a supply-side model, with a Cobb-Douglas function. He finds a high volatility in the level of growth rates induced by Structural Fund expenditure. The work of Endeerven et al. (2006) also belongs to this strand of research. They investigate the effectiveness of Structural Funds through a panel analysis for 13 EU countries. They demonstrate that, on average, the funds are only effective, in the countries with the "right" institutions[3]. In the conclusions, the authors stress the necessity of improving institutional quality as an essential step for triggering a catching-up process.

Bähr (2008) analyses EU Regional Policy effectiveness by focusing on the different federal structure of its member states (EU13) for seven five-year periods, from 1960-1965 to 1990-1995. A pooled cross-sectional regression econometric model is used for the estimation of the different degrees of sub-national autonomy (decentralisation) among member states on the effectiveness of Structural Funds expenditure. The results suggest that Structural Funds are more effective in promoting growth when decentralisation is higher.

[3] The authors distinguish between three broad groups of institutional quality variables. First, they consider variables related to the outcome of government policy (inflation and government savings); second there are variables that synthesise social cohesion (trust, norms of civic cooperation, the degree of ethnolinguistic fractionalisation); third, a group of indicators that measure institutional quality directly (corruption perception index or institutional quality index).

Esposti and Bussoletti (2008) investigate the impact of Objective 1 Structural Funds expenditure using a database of 206 EU 15 regions in a time interval ranging from 1989 to 2000. They assume that structural payments condition the "natural" convergence process of the poorer European regions towards the richer ones. Therefore, they estimate an augmented conditional regional convergence model to assess whether growth convergence actually occurs. Considering they consist mainly of investment expenditure, Structural Funds are included in the regional growth convergence model as a variable, affecting the investment rate. A limited but positive impact of Objective 1 Funds was found for the EU as a whole; whereas a negligible or negative effect is registered in some specific cases.

Mohl and Hagen (2008, 2010) seek to evaluate the growth effects of EU Structural funds at both the NUTS 1 and NUTS 2 levels over the period 2000-2006. They use a panel estimation controlling for endogeneity, serial and spatial correlations and heteroskedasticity. They find that the total EU aid (including Objectives 2 and 3) has no statistically significant or even negative impact on regional growth; whereas Objective 1 payments have a positive and statistically significant impact on the regional GDP growth rate. Bouvet (2009) analyses the impact of the EU Regional Policy on inequalities, as the reduction of interregional income inequalities is a leading aim of EU cohesion policy. His findings confirm the persistence of within-country inequality, calling for a reform to existing EU Regional Policies. More specifically, he concludes that structural policies should be elaborated at the regional level and not at the national level and that funds should be further concentrated onto poorer regions.

An econometric model is adopted to evaluate the effect of Structural Fund expenditure on the growth of regional per-capita GDP in Rodriguez-Pose and Novak (2013). They refer to the last programming periods for which full sets of data are available (1994-1999 and 2000-2006), using factor endowments, institutional quality and initial conditions as conditioning variables. They also take into account the learning mechanism resulting from evaluation of the policy. The results reveal an increase in policy effectiveness in successive periods.

In the third group are those studies that observe no policy impact or redistributive effects. Fagerberg and Verspagen (1996) analyse growth in 70 regions (in six EU member states) in the post-war period. Their findings show no impact of the Funds on convergence in terms of per-capita GDP, but that Europe seems to grow with at least three different speeds for dynamism, productivity and unemployment. No evidence of convergence (or divergence) was also found in the work of Boldrin and Canova (2001) on the EU15 regions between 1980 and the mid '90s. Their results do not allow to definitively assert the effects of Structural Funds on growth; however, they show the redistributive function of Regional Policies to be a consequence of political equilibria inside the European Union.

A clear negative effect is instead observed by Garcia-Milà and McGuire (2001). They evaluate the impact of EU grants on the economic performance of the Spanish regions, using a difference-in-difference model. Results highlight that the policies have not been effective in stimulating private investment or improving the overall economies of the grant-recipient (and poorer) regions. De Freitas et al. (2003) link Objective 1 status to the speed of convergence among regions in the period 1990-2001, in order to account for the effects of the 1989 Structural Funds reform. They estimate Barro equations and control for the quality of national institutions. The authors explicitly investigate whether "Objective 1" status on average improves the rate of convergence. Their findings give evidence of conditional convergence among regions, but they show that Objective 1 eligibility does not have a statistically significant role in fostering convergence. On the contrary, it emerges that region specific factors are important in explaining regional disparities.

Dall'Erba and Le Gallo (2008) evaluate the impact of Structural Funds on convergence across 145 European regions in the period 1989-1999. They estimate a neoclassical model of growth (Barro and Sala-I-Martin, 1995), accounting for location externalities and for a possible endogeneity of the funds. Fund endogeneity might occur as Objective 1 eligibility is fixed with the 75 percent rule (the region must have a per-capita GDP lower than 75% of the European average in the three years previous to the start of the programme); as a consequence, regions receive an amount that is proportional to their development gap. Their estimation results show that significant convergence does occur, but funds have no role in determining it. Cohesion Policy effectiveness is also investigated in the work of Aiello and Pupo (2012) that evaluates the impact of Structural Funds on the growth of Italian regions from 1980 to 2007. For the period 1994-2007, they consider the amount of expenditure actually spent and not only committed; moreover, they consider some institutional aspects in the definition of the fund impact. They use a convergence equation (growth model) with panel data in which the Structural Funds are an explanatory variable. The results show that, although the distribution of the funds is coherent with greater resource allocation to the lagging regions, there are different performances in the management of the funds among the Italian regions. They conclude that Structural Funds have a mainly distributive effect and do not affect the pattern of growth of Italian regions in the long-run.

Wostner and Šlander (2009) demonstrate that the Cohesion Policy increases structural expenditure of the receiving countries, but their effectiveness is also related to other conditions, such as micro-efficiency in the management of the funds and their effects on private investments.

Treatment effect framework

Over the past few years, several studies have evaluated public policies with counterfactual methods. These studies adopt non-experimental methodologies based on the idea that eligibility for a specific policy Objective can be considered as a treatment (like the treatments received by patients in medicine). It is thus possible to identify two different groups of regions with comparable characteristics - "treated" and "untreated" regions - and evaluate the causal effect of the treatment. As mentioned before, no unanimous results have been achieved. Policy success is confirmed in Becker *et al.* (2010, 2012) and Pellegrini *et al.* (2013); whereas Becker et al. (2013) and Gagliardi and Percoco (2013) observe a conditional effect. Conversely, a positive but not strongly significant effect is highlighted in Hagen and Mohl (2008) and a negative effect is observed in Accetturo *et al.* (2014).

The analysis of Becker et al. (2010) seeks to evaluate the causal effect between the Objective 1 status and the growth rate of per-capita GDP for the treated regions, using a fuzzy Regression Discontinuity Design (RDD) approach for the evaluation of the programmes. The results point to a positive effect of the funds on the per-capita GDP growth rate. However, the result is less optimistic if the employment rate is considered; this might be related to the fact that the creation of new jobs requires a longer period of time than the duration of a programming period (5-7 years). As a robustness check, they repeat the analysis at different territorial levels (NUTS 2 and 3), for three sub-periods, taking into account the possible presence of location externalities. In Becker *et al.* (2012), the analysis considers only the NUTS 3 regions in the programming periods 1994-1999 and 2000-2006 by means of a Generalised Propensity Score estimation. The authors aim to understand whether the transferred funds foster growth in the Objective 1 regions. A dose-response function is estimated; it connects the annual average per-capita GDP growth rate with the intensity of the treatment received, in order to find the optimal dose of the treatment. The results show that EU transfers sustain a more rapid growth, but in 36 percent of the regions considered the intensity of the transfers is higher than the optimal level and their reduction would not produce any loss in terms of growth. In a recent work by Pellegrini *et al.* (2013), the effects of regional policy are evaluated through a *sharp* RDD approach, using an original dataset for the period 1994-2006. The results show the presence of a weak positive impact of the European regional policy on regional growth. The robustness of the results is investigated by applying both a parametric and a non-parametric approach with different kernels.

In Becker *et al.* (2013), attention is focused on the heterogeneity between units. They consider Structural Funds transfers to Objective 1 NUTS 2 regions in three programming periods (1989-93, 1994-99 and 2000-06) and use a RDD approach with heterogeneous treatment (HLATE). Heterogeneity in the reaction to the treatment is modelled through the consideration of a different absorptive capacity of the regions, expressed as a function of the endowment of human capital (percentage of workers with at least secondary education) and/or the quality of regional government (by means of a composite indicator which synthesises public services, education, health services and respect for the laws). The results confirm that EU transfers produce a positive effect on the growth rate of per-capita GDP and on the growth rate of investments only for regions with a sufficient endowment of human capital and “good enough” institutions, that is to say, higher absorptive capacity.

Gagliardi and Percoco (2013) assess the effectiveness of EU Cohesion Policy on Objective 1 regions performance by adopting a Regression Discontinuity Design (RDD) in the context of a Local Average Treatment Effect (LATE) regression. Differing from the previous literature, they introduce spatial heterogeneity amongst the units of analysis. The results show that EU Cohesion Policy has been effective in fostering development in lagging areas in Europe. However, its effectiveness remains controversial: policy impact is strongly heterogeneous within each NUTS 2 region. Rural areas close to the main urban agglomerates are those that benefited the most; further, they have driven the positive results observed for the full sample.

In order to avoid the problem of misspecification of the functional form, Hagen and Mohl (2008) carry out an analysis using the Generalised Propensity Score (GPS). They estimate a dose-response function (Hirano and Imbens 2004) over a sample of 122 regions belonging to the NUTS 1 and 2 levels of the EU 15 in the period 1995-2005. The main assumption for the application of this method is the Stable Unit Treatment Value Assumption (SUTVA) that considers the distribution of output for each region as independent from the potential state of the treatment in another region, conditional to the observed covariates. Though this is a very strong assumption, it avoids the presence of spatial correlation. The authors cannot investigate the presence of externalities, but they adopt the “weak unconfoundedness” hypothesis, which posits a treatment for each region as independent from the potential outcome. The results show a positive but not statistically significant impact of Structural Funds transfers on the average growth rate of the regions. Therefore, the dose of payment received is not important for the determination of the policy’s effects on growth.

Accetturo *et al.* (2014) look at the impact of the transfers on local social capital endowments by using a regression discontinuity design for EU Objective 1 Structural Funds. They find evidence that transfers reduce local endowments of trust and cooperation and they conclude that it is necessary to focus more deeply on the pre-requisites for receiving the aid. In particular, the authors argue that effectiveness of local public goods has a crucial role in the right use of the transfers.

A new regression discontinuity technique has been developed recently in other fields of geographically-related research dealing with the issue of education (Black 1999), labour markets (Dell 2010), real estate markets (Dachis *et al.* 2011), firm size (Giacomelli and Menon 2012) and firm incentives (Einio and Overman 2012). These approaches are commonly known as 'spatial Regression Discontinuity Design' or 'spatial RDD', and they consider the geographical location as the key forcing variable. In these cases, the discontinuity which is to be exploited by the econometric technique is given by the administrative or geographical boundaries and the sub-samples to be examined are the spatial units on either side of the geographical boundary. In the case of EU Regional Policy evaluation, in some countries the regions falling into the Objective 1 and in the non-Objective 1 groups, respectively, can be simply identified by looking at the geographical boundaries. However, this is not true for all countries, with the consequence that the effect of the policy for the treated regions that have a good performance but are located far from the geographical boundaries may be rather underestimated.

1.3 European Regional Policy

The theoretical background of the EU Regional Policy is based on the new growth theories and the New Economic Geography. The European Regional Policy, also known as Cohesion Policy, represents one of the main axis of European integration. It covers a substantial share of the entire EU budget that is 36 percent of the Union budget – amounting to around € 347 billion in the programming period 2007-2013. These resources are primarily aimed at "reducing disparities between the levels of development of the various regions and the backwardness of the least favoured regions" (Art. 174 of the Treaty on the Functioning of the EU). European regions are still characterized by wide differences in per-capita GDP and in levels of well-being, with underutilisation of economic and human resources in the lagging regions. The sub-national gaps also produce depressive effects on the performance of individual member states.

European Cohesion Policy started out in 1975 with the European Regional Development Fund (ERDF) that supported infrastructural development and productive investment for the creation of employment, especially for firms. The importance of Cohesion Policy grew over the years, and thanks to the creation of additional funds, it came to make up one third of the Union budget.

The year 1989 was of crucial importance to the definition of Regional Policy design: the First Delors Report introduced important changes as regards both the financial side, with increased resources, and the governance aspects, with the introduction of the principles of complementarity, additionality, partnership, concentration and programming. The aims of the Policy's structural interventions were of two kinds: horizontal objectives, which involved the Union as a whole, and vertical objectives, which explicitly addressed backward areas. Before 1989, the European budget was defined on a yearly basis and Regional Policy was concentrated in the ERDF. The main beneficiaries were Italy, the United Kingdom, France and Greece. After the endorsement of the Single European Act in 1987, the Regional Policy was reorganised into multi-year programming periods -the first one covered the 1989-1993 period - and the aim of the policy became primarily the pursuit of cohesion and the reduction of wellbeing disparities across European regions. The First Delors Report pointed also to the risk that higher European economic integration could trigger a mechanism of concentration of economies of scale, productive factors specialisation, high-quality infrastructure and skilled workforce in a unique centralised area, leaving the less developed, peripheral regions outs of this process with a consequent negative impact on the integration process (Pupo, 2004).

On 1st November 1993, the European Union Treaty entered into force along with the modified Treaty of Foundation of European Community (EC Treaty). As concerns Regional Policy and Cohesion, the Treaty introduced a new instrument, the Cohesion Fund, and a new institution, the Regional Committee, as well as the principle of subsidiarity. In December 1992, the European Council defined new financial perspectives for the period 1994-99, allocating 168 billion of ECU to the Structural Funds and Cohesion Fund, an amount double the budget for the previous year and making up one third of the community budget. Aiming to reduce disparities and foster cohesion, the European Community introduced a number of new financial instruments to facilitate implementation of the new policy programmes. Amongst the most relevant instruments were: the European Social Fund (ESF), the European Agricultural Guidance and Guarantee Fund (EAGGF), the Financial Instrument for Fisheries Guidance (FIFG) and the Cohesion Fund. The European Social Fund, which along with ERDF, EAGGF and FIFG, constituted the Structural Funds, promoted improved access conditions and fostered social inclusion and human capital (education and training). The EAGGF instead concerned the financing of the Common Agricultural Policy (CAP). The FIFG contributed to reaching the objectives of the Common Fisheries Policy (CFP), supporting structural action in the fisheries sector, in the field of aquaculture and in the transformation and commercialisation of their products. In order to accelerate economic, social and territorial convergence, in 1994 the European Union established the Cohesion Fund. This fund was allocated to countries with an average per-capita GDP lower than 90% the community average. The Cohesion Fund was meant to finance infrastructural projects in the environment and transport sectors. Transfers belonging to this fund were subject to specific conditions, such as the condition that member states with a public deficit higher than 3% of GDP, could not get any new project approved until the deficit fell under that threshold.

Programming period 2000-2006 introduced new policy content and new implementation procedures. Civil society participation in EU policy governance grew, whereas programme management and evaluation became more decentralised. The reorganization of the policy entailed the reduction of the Objectives to a number of three and a greater concentration in terms of finance, geographical areas and areas of intervention. Policy priorities were defined as the Structural Funds objectives: Objective 1, Objective 2 and Objective 3. Objective 1 aimed to promote the development and structural adaptation of the lesser developed regions; it consisted of almost 70% of total allocations of Structural Funds for the period 2000-2006 (it was 68% in 1994-1999), which amounted to around € 136 billion. Recipients of this kind of aid were identified by the Commission through the “GDP criteria”: aid was devolved only to regions with a per-capita GDP lower than 75% the community average. Objective 2 addressed the economic and social reconversion of areas with structural difficulties, such as economic change, declining rural areas and depressed areas.

Objective 3 aimed to modernise systems of training and to promote employment outside the regions eligible for Objective 1. This Objective, in particular, supported the European employment strategy for active policies against unemployment and social exclusion. Structural Funds also financed community initiatives in the following sectors:

a) cross-border, transnational and interregional cooperation, that aim to promote the harmonious, balanced and sustainable development of the community (INTERREG);
b) economic and social revitalisation of the city and areas adjacent to the crises, for the promotion of urban sustainable development (URBAN);
c) rural development (LEADER);
d) transnational cooperation, to foster new forms of struggle against discrimination and inequality in the labour market (EQUAL).

In programming period 2007-2013, the classification of the Objectives changed. Objectives 1, 2, 3, respectively became Convergence, Competitiveness and Cooperation. In particular, the Convergence Objective involved the less developed member states and regions (ex Objective 1), the Competitiveness Objective concerned regions no longer included in the Convergence Objective and aimed to increase their competitiveness, attractiveness and employment, fostering social and economic change. Finally, the Cooperation Objective affected regions that have land and maritime borders and the areas of transnational cooperation; its aim was to foster activity that encourages territorial development and interregional cooperation. The number of cohesion financial instruments was reduced from six to three: two Structural Funds (ERDF, ESF) and the Cohesion Fund. The specific aids, before being included in the EAGGF and FIFG were grouped in the European Agricultural Fund for Rural Development (EAFRD) and European Fisheries Fund (EFF). The previous system of fund management was thus simplified through the introduction of a two-step process; eligibility rules were decided at the national level with greater importance given to the proportionality principle (European Commission 2008). To improve cooperation between the European Commission and the European Central Bank, three new instruments were introduced: Jaspers, Jeremie and Jessica, aimed at enhancing correct application of the funds.

The 2008 world financial economic crisis highlighted the need for EU policy to foster appropriate institutional and governance reforms. EU institutions put in place new development policies for the promotion of growth, which were more outcome oriented and built around institutional incentives and sanctions (McCann and Ortega-Argilés 2013a). An important contribution to Cohesion Policy reform after 2013 comes from the work "An agenda for a Reformed Cohesion Policy" (Barca 2009) also known as "Barca Report", that looked into the debate around the necessity of a renovation of the European budget for removing the bureaucratic inertia that characterised it. In pursuit of its territorial development strategy, the Union could adopt a place-based (and not space blind) strategy of development for the supply of public goods in order to reach social development in addition to the economic growth of the place concerned (Barca, McCann and Rodriguez-Pose 2012). The Cohesion Policy of the previous years was strongly criticised for its lack of attention to the achievement of objectives and results, highlighting the need for a set of indicators to guide results evaluation and monitoring (Barca and McCann 2011). The Report also emphasised the necessity of establishing an adequate system of incentives and penalties to transform Cohesion Policy into a tool for the promotion of the development. Another important change was the establishment of ex-ante conditionality, relating to the clarity of objectives, transparency of the policy's processes and the introduction of a penalty for the breaching of this conditionality. Compared with previous periods, greater analytical rigour and conceptual freedom were needed for the development of the new policies (Garretsen, McCann *et al.* 2013). The changes driven by the Report will be assessed in the next programming period (2014-2020), with the "Europe 2020" objectives, based on three priorities:

- Smart Growth: to create an economy based on knowledge and innovation;
- Sustainable Growth: to promote a more resource-efficient, greener and more competitive economy;
- Inclusive Growth: to foster employment and economic, social and territorial cohesion.

The Union needs to focus on the main objectives of this Smart, Sustainable and Inclusive Growth. These are interconnected and can be explained by the following five points: employment growth rate; increase in investments in R&D; greenhouse gas emission reduction; reduction of the number of early school leavers and poverty reduction (European Commission 2010).

1.4 Methodology

The empirical literature on the evaluation of Regional Policies relies on different methodologies and data, and no consensus has yet been reached (see section 1.2). In this essay, the effects of EU Regional Policy are observed by means of a technique that can isolate it from other factors that may affect the analysis' results: the Regression Discontinuity Design (Thistelthwaite and Campbell 1960; Hahn *et al.* 2001) in the *sharp* version. This methodology considers a discontinuity in the treatment related to some observations, to obtain an estimation of the Local Average Treatment Effect (LATE), by comparing units eligible for the treatment (Objective 1 regions) with other non-eligible ones (non-Objective 1 regions). The effect of the treatment estimated is located in the point of discontinuity. For the application of RDD, four basic assumption need to be respected (Lee *et al.* 2009):

- the treatment is not randomly assigned, but there is at least one observable variable (assignment variable or forcing variable);
- the assignment variable presents a discontinuity in correspondence of a threshold;
- the assignment variable cannot be manipulated (agents cannot modify it in order to move from one side to the other of the threshold);
- the other variables are regular functions (without discontinuity in correspondence of the cut-off point): the only reason that produces a jump at the threshold is discontinuity in the treatment.

The fundamental hypothesis of this method is that the units just above (or below) the threshold that do not receive the treatment, represent a good term of comparison with those just below (or above) the threshold that receive the treatment. Therefore, any discontinuity in the conditioned expected value of the outcome, in proximity of the cut-off point, may be interpreted as evidence of the causal effect of the treatment.

In our analysis, the statistical units are the NUTS 2 regions of the European Union with 15 member states (EU15)[4]. Our aim is to assess whether Objective 1 regions experienced greater growth than non-Objective 1 regions, by considering improvement in the potential road accessibility (Stelder 2014) and in research and innovation activities (patent applications). However, we will assess the presence of a discontinuity also by looking at the growth rate of per-capita GDP. Objective 1 eligibility is defined by the "75 percent rule"; as a consequence, regions with a per-capita GDP lower than 75 percent the community average are considered Objective 1. The forcing variable is the regional per-capita GDP and the cut-off point is the 75 percent threshold; the treatment is

[4] EU15 includes: Germany, France, Italy, the Netherlands, Belgium, Luxembourg (founding countries), Denmark, Ireland and the United Kingdom (1973), Greece (1981), Spain and Portugal (1986), Austria, Finland and Sweden (1995).

eligibility to the Objective 1 Fund. This situation is a good framework for the application of the RDD: consider a NUTS 2 (A) with a per-capita GDP equal to 74.99 percent the EU average and a NUTS 2 (B) with a per-capita GDP equal to 75.01 percent, the first one will be eligible for Objective 1, whereas the second will not receive the treatment. We can assume that the two regions have similar characteristic except for the treatment, therefore they are more comparable than others that are more distant from the cut-off threshold (Becker *et al.* 2010).

Considering *c* as the cut-off point and *Xi* as the forcing variable, following the work of Pellegrini *et al.* (2013), we adopt a *sharp* version of the RDD, since treatment assignment is assumed to depend only on the 75 percent rule (to support this assumption we exclude from the sample regions that receive aid for other reasons). We denote the potential outcomes of the region *i* with *Yi(0)* and *Yi(1),* where *Yi(1)* is the outcome obtained in presence of the treatment (Objective 1 regions) and *Yi(0)* is the outcome obtained by the non-treated regions (non-Objective 1). In correspondence with the discontinuity point, the conditioned expectancy of the outcome, given the covariates, underlines the causal effect of the treatment (Imbens and Lemieux, 2008):

$$\lim_{x \downarrow c} E[Y_i | X_i = x] - \lim_{x \uparrow c} E[Y_i | X_i = x] \quad (1)$$

If the average causal effect of the treatment is taken into consideration the above relation becomes:

$$\tau_{SRD} = E[Y_i(1) - Y_i(0) | X_i = c] \quad (2)$$

In order to increase result robustness, estimation will use both a parametric and non-parametric approach and the results will be verified for different samples specifications, kernels and confidence intervals. The aim is to avoid problems related to the limited number of observations in proximity with the cut-off point, which can reduce the accuracy of the estimations. Moreover, the effects of Regional Policy may be affected by other factors that enhance or prevent growth (e.g.: geographical location and externalities).

In the parametric regressions, the Ordinary Least Square (OLS) estimation with robust standard errors is applied. For the non-parametric estimation, we use the local linear regression method with standard errors obtained with bootstrap (Nichols 2001).

The equation for a generic polynomial model of *m* order is[5]:

$$Y = \alpha + \tau D + \sum_{i=1}^{m} \beta_i X^i + \sum_{i=1}^{m} \delta_i D X^i + \varepsilon$$

When a parametric approach is used, the choice of bandwidth is equivalent to the definition of the polynomial order of the regressions (Lee and Lemieux 2009). Different specifications are considered in order to analyse how the polynomial degree affects the results. The best polynomial order is chosen by looking at the Alkaike Information Criterion (AIC): the best model is the one with the lowest AIC[6].

Following Lee and Lemieux (2009), Imbens and Lemieux (2008) and Pellegrini *et al.* (2013), two additional robustness checks are added: we verify whether in the density function of *X*, for *X*=*c*, there are other discontinuities (that may show an alteration in the control variable) and we investigate the presence of other discontinuities in the outcome variable. In order to exclude any

[5] We consider *m*=3.

[6] The parametric estimation is applied only as a further robustness check of the results obtained with the non-parametric method, for this reason the usual issues related with this approach (heterogeneity, endogeneity and so on) are not considered here.

gerrymandering (Menon 2012) type of manipulation in the proximity of the threshold with respect to the continuity of the density function of the forcing variable, the McCrary test is used (McCrary 2008). In our case, the assignment to the treatment (i.e. eligibility for Objective 1 status) cannot be easily predicted. We might think that countries may behave opportunistically by maintaining their per-capita GDP below the threshold in order to attract funds; actually, this cannot happen, because the threshold is fixed at 75 percent of per-capita GDP community average, the value of which can be known only after publication of all regional data. Moreover, Eurostat applies strict controls on the procedures for estimation of regional accounts. McCrary (2008) suggests that a jump in the conditional density of the forcing variable can be considered as a test of its manipulability: when regions are sorted around the threshold, the RDD approach is not applicable.

The McCrary test (2008) estimates the density function of per-capita GDP for a confidence interval of 95 percent. In the RDD approach, the choice of the kernel is of fundamental importance: some authors consider the Epanechnikov kernel, whereas other scholars prefer the Triangle; we opt for more than one kernel specification: Epanechnikov, Gaussian, Rectangular and Triangle.

Another important element is the choice of bandwidth. There are many rules of thumb for the definition of the optimal bandwidth. Different bandwidths produce different estimations, so it is important to estimate more than one and at least three: the optimal bandwidth, its double and its half. The wider the bandwidth, the stronger the discontinuity will be, because the impact of possible erratic observations close to the threshold becomes smaller. For the choice of the optimal bandwidth, the index of Imbens and Kalyanaraman (2009) is calculated; this index determines the asymptotic optimal interval for the regression discontinuity.

It is also important to test that there are no jumps in the treatment and outcome levels and that, other covariates do not have discontinuity at the cut-off point. In order to verify the first point, the effect is estimated for different thresholds and with different kernels and bandwidths; for the second, we consider the population average, using a local linear regression with different kernels.

Our goal is to try to move attention away from the strictly economic-productive sphere towards some specific fields of policy intervention. The main challenge is the identification of possible outcome variables and the availability of data at the NUTS 2 level. With this aim in mind, we decided to take into account two different aspects of regional social and economic development in addition to per-capita GDP: transport infrastructure and research and innovation.

We use an exclusive dataset on the certified expenditure of European regions between 1999 and 2007. Thanks to this data, we know which regions received the transfers for specific fields of intervention (FOI). The importance of using this kind of data is stressed by Aiello *et al.* (2012), who argue that considering both regional-level and specific areas of intervention expenditure is one of the most critical points in the study of EU policy effectiveness.

De La Fuente (2003) points to the importance of considering the amounts effectively spent and not only those programmed or committed. Consideration of certified expenditure avoids all these inconveniences. For the evaluation of the effects of the policy, we refer to specific outcome variables for each area: for transport infrastructure, we consider potential accessibility to road networks (Stelder 2014); for research and innovation, we consider the patent applications per million inhabitants. The sample we refer to, for each of these outcome variables, is different because we analyse only regions with certified transfers in the specific FOI. To test the robustness of the results, the analysis is conducted with different specifications of the outcome variables (growth rate and difference in levels). The variables and samples used in the analysis will be described in detail in the following section. The use of the Regression Discontinuity Design allows us to eliminate the problem of the choice of a specific functional form, which usually occurs in classical growth equations.

1.5 Dataset construction

The construction of the dataset can be divided into three steps. Following Pellegrini et al. (2013), the first step aims at the definition of a sample that satisfy the hypothesis of the RDD approach and allow us to have regions included in the same group for two consecutive 'programming' periods (1994-1999 and 2000-2006). The second and the third steps are aimed to obtaining a panel structure for the dataset of the certified expenditure for the NUTS2 regions and the transformation of the outcome variables. The dataset consists of EU 15 regions at NUTS2 level with the Objective 1 recipient regions of the transfers being those NUTS2 regions with a per-capita GDP (in PPS) lower than the 75 percent of the community average. For the programming period 1994-1999, the Commission computed the eligibility threshold on the basis of data on per-capita GDP for the period 1988-1990 (per-capita GDP in PPS, ESA79 criteria)[7]. Therefore, in constructing the forcing variable, we considered the per-capita GDP for the period 1988-1990.

The initial sample included 213 regions classified as NUTS 2 (2003): 61 of these regions were Objective 1 in the programming period 1994-1999, the remaining 152 were not. In order to make the sample more homogeneous over the two programming periods, we excluded four NUTS 2 regions from the initial group of Objective 1. These are regions that experienced a level of per-capita GDP greater than 75 percent the community average in the period 1988-1990 (the reference period of the Commission for establishing eligibility to the funds) and that, however, became eligible for the funds for political reasons: Prov. Hainaut (BE), Corse (FR), Molise (IT), Lisboa (PT). The other 57 regions remained eligible for Objective 1 status also in the following programming period 2000-2006. In order to have a more comparable and stable control group we decided to exclude from our sample regions that were Objective 1 in the period 2000-2006, but not in the previous period. These were:

- five regions which were non treated in 1994-1999 but became eligible for Objective 1 in 2000-2006: Burgenland (AT), Itä-Suomi (FI), South Yorkshire (UK), Cornwall and the Isles of Scilly (UK), West Wales and the Valleys (UK);
- five non-Objective 1 regions in the period 1994-1999, that became partially eligible in 2000-2006: Länsi-Suomi (FI), Pohjois-Suomi (FI), Norra Mellansverige (SE), Mellersta Norrland (SE), Övre Norrland (SE).

Some non-Objective 1 regions also benefited from Cohesion policy transfers because they fell under other Objectives. Following Pellegrini *et al.* (2013), we took into account the per-capita intensity of financial resources among the different regions, distinguishing between *hard-financed* regions (Objective 1, treated regions) and *soft-financed* regions (non-treated regions). As many sources of financing - Structural Funds, Cohesion Fund, National co-financing, Private financing – existed in both programming periods 1994-1999 and 2000-2006, we needed to identify a threshold value of per capita transfer intensity. We fixed this at €1960, which is the minimum value of certified per-capita expenditure in Objective 1 regions (Pellegrini *et al.* 2013). The results show that nine non-Objective 1 regions had a level of per-capita expenditure higher than the fixed threshold.

[7] For a focus on PPS see Eurostat-OECD (2006).

In particular, we excluded from analysis the non-Objective 1 Spanish regions that received aids from the Cohesion Fund: Pais Vasco, Comunidad Foral de Navarra, La Rioja, Aragòn, Comunidad de Madrid, Cataluña, Illes Balears as well as the Finnish regions of Etelä-Suomi and Åland that benefited from other funds. Finally, we excluded the regions that did not receive transfers in all the FOI of certified expenditures selected (Bruxelles, Provincia di Trento, Prov. Brabant Wallon, Prov. Vlaams Brabant, Bedfordshire, Hertfordshire, East Anglia, Eastern Scotland, Usimaa-Helsinki). Thus, our sample consisted of 180 NUTS 2 regions (54 treated and 126 untreated) which remained in the same group for both programming periods considered in the analysis; further, they are homogeneous groups also in terms of the amount of per-capita transfers: soft-financed (untreated) or hard-financed (treated). Our resulting sample met the requirements for the application of the Regression Discontinuity Design in the *sharp* version.

We derived data on the certified expenditure directly from the European Commission offices (DG-Regional policy) and from the Italian Ministry for Economic Development (Department for Development and Economic Cohesion). The data did not originally have a panel structure and the Structural Funds and Cohesion Fund were reported in two different tables, so we had to transform them before carrying out the econometric analysis (see for instance tables P1 and P2 in the Appendix). The main problem in using this database was the lack of a region name or code, which would allow to easily associate each value to a specific region. We selected two specific FOI (level 2) for the Structural Funds: Research and Innovation and Transport infrastructure[8]; as regards the Cohesion Fund we chose the Technical Assistance Project and Transport Project.

The panel dataset was constructed manually, observing the following rules:

- the total amount was fully imputed to the region where the name of the region was expressly and univocally specified in the identification name of the programme;
- programme expenditure for NUTS at a lower level than NUTS 2 were imputed to the respective NUTS 2 region;
- national programme expenditure was shared between all the regions of the country, using the population at the beginning of the programming period as a distribution criteria[9];
- municipality programmes, natural regions and consortiums expenditure was imputed to the NUTS 2 involved in the group (when identifiable), using the same criteria as for the previous point[10];
- expenditure for which recipient regions could not be identified from the name of the programme was deleted;
- data about cross border and interregional cooperation was not considered.

The third step involved in the construction of the dataset is described for each variable in the following section.

1.6 The variables

After these preliminary transformations, the dataset presented a panel structure containing data regarding certified expenditure by year, fund and field of intervention for each NUTS 2 (table P3); the next step was the identification of the outcome variable for each field of intervention analysed.

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[8] In particular: 18. Research, technological development and innovation, RTDI; 31. Transport Infrastructure.

[9] Otherwise, the first available year is used.

[10] For the Association of Portuguese Municipalities, for which there is a specific website, expenditure is attributed to the NUTS 2 of the Association's Headquarters.

1.6.1 Per-capita GDP

Traditionally, the economic literature considers GDP growth as the outcome variable of public transfers in studies differing from each other for model specifications, regional levels and time intervals considered. No unambiguous results have so far been reached.

In line with this strand of literature, we started our analysis of the effectiveness of Cohesion Policy by using per-capita GDP growth rate as the outcome variable and the RDD approach. To assess the evidence of a discontinuity among Objective 1 and non-Objective 1 regions, we referred to a period of fifteen years (from 1995 to 2010) and two different sub-periods: 1995-2003 and 2003-2010. Further, we analysed the full sample and two sub-samples that excluded, first, the highest and the lowest values and then the colonial regions.

1.6.2 Patent Applications

Schwab *et al.* (2007) point out that innovation is essential for developed economies, as they need new technologies and new cutting-edge products to maintain their competitive advantage. As Cantwell (2006) underlines, this requires an environment which is conducive to creating relationships between firms and the science infrastructure, between producers and users of innovation and the inter-firm level, and between firms and the wider institutional environment. Feldman (1993) suggests that the process of introducing innovations is facilitated by a firm's location. She demonstrates that product innovations tend to be concentrated in states where innovative inputs are present, in particular specialised knowledge resources that enhance the innovation process.

In recent smart specialisation developments related to EU Cohesion reform, support instruments for innovation are more focused on socio-economic influences on technological development and usage concerning smart growth, energy and sustainable growth and entrepreneurship promotion. Consequently, innovation promotion is much more linked than in the past to questions of transparent and appropriate governance systems (McCann and Ortega-Argilès 2013b).

Patents are a means of legally protecting inventions developed by firms, institutions or individuals, and they can thus be interpreted as indicators of inventions (Annoni *et al.* 2010). Patents are aimed at ensuring property and market exclusivity on the protected invention and are released by a national patent office (OECD, 2009). We considered patent applications per million inhabitants from the OECD *Regpat* dataset as the outcome variable for the field “Research and Innovation”.

As is well known, patent indicators give information on the output of the R&D. When comparing regional performance, the OECD Patent Manual (2009) recommends the use of fractional accounting for patents, in order to: i) attribute to each region its actual contribution to invention; ii) when summed up all regions give a total of 100%. Patent data can be regionalised considering the address of either the inventor or the holder. The inventor’s address usually indicates where the invention was made. The priority year is the year of first filing for a patent; it is the closest to the actual date of invention, and should therefore be used as the reference date when compiling patent indicators aimed at reflecting technological improvements (Maraut *et al.* 2008). We considered a fractional count by inventor and priority year patent data. The *Regpat* database used includes patent applications to the European Patent Office (EPO), to the Patent Cooperation Treaty (PCT) and to the United States Patent and Trademark Office (USPTO).

Data transformations and a summary of the main steps of the analysis are listed below:

- *Missing values*: for OECD patent data, missing values are equal to zero. However, when no data was available at NUTS 2 level we used the Eurostat variable "Employment in technology and knowledge-intensive sectors by NUTS 2 regions and sex" (1994-2008, NACE Rev. 1.1) for the calculation of the weight (countries involved: Greece, Belgium, France d'Outre-Mer, Germany, Netherlands, England) which allowed us to transform national statistics into data suitable for imputation at the regional level. Only for Greece and Cumbria Eurostat data was not available: in these cases the imputed data is, respectively, the average NUTS 1 value (NUTS 1 value/nr. of NUTS 2) and the mean of the other NUTS 2.
- *Certified Expenditure*: we considered the Field of Intervention (FOI) "Research, Technological Development and Innovation (RTDI)" for Structural Funds and "Technical Assistance" (TA) for Cohesion Funds. All the regions with a positive TA were included in the RTDI sample.
- *Periods*: the whole period considered in the analysis covers the years from 1999 to 2010. However, we split the time interval of the analysis into three sub-periods: 1999-2007; 2002-2010; 2002-2007.
- *Samples*: in the first step, we considered the whole sample and the outcome variable was expressed as both growth rate and difference in levels. In a second step, we considered some restricted samples: in the first sample (R1), we excluded the regions of Martinique, Guyana, the Autonomous Region of the Azores, Melilla and Ceuta who have zero values for some years and always a negative growth rate; in the second sample (R2) we dropped also Alentejo which has the highest growth rate in the distribution in 1999-2010 and seemed to be an outlier.
- *Estimations*: we use parametric (OLS) and non-parametric estimations (local linear polynomial estimation with standard errors estimated with bootstrap method - 500 replications).

1.6.3 Potential road accessibility

As the Territorial Agenda of the European Union states: "Mobility and accessibility are key prerequisites for economic development of all regions of the EU". Consequently, transport infrastructure improvement is a key policy instrument to promote regional economic development (ESPON, 2006). Over the period 2000-2006, about 35% of Structural Funds and 50% of the Cohesion Fund were spent on infrastructure projects (Crescenzi and Rodriguez-Pose 2008). The quality of infrastructure is essential for the efficient functioning of an economy (Schwab *et al.*, 2007). Modern and efficient infrastructure endowments contribute to both economic efficiency and territorial equity as it allows for the maximization of the local economic potential and the efficient exploitation of resources (Crescenzi and Rodriguez-Pose 2008). High-quality infrastructures guarantee easy access to other regions and countries, contribute to better integration of peripheral and lagging regions, and facilitate the transport of goods, people and services. This has a strong impact on competitiveness as it increases the efficiency of regional economies (Annoni *et al.* 2013). The recent literature argues that the traditional cost-benefit analysis cannot capture the effects of infrastructures on regional development, but it is necessary to consider also the effects of the network externalities (OECD 2002). In McCann and Shefer (2004), the role of infrastructures in the regional development process is discussed. They analyse the relationship between infrastructure investment and regional development with a focus on the transportation infrastructure investment.

They conclude that the different geography-firm transactions cluster types are of crucial importance in the evaluation of the role played by transportation infrastructure on regional development. However, empirical works on the role of infrastructure in the development process highlight a lack of data, especially for the road network. The EU recently financed a project aimed at the construction of a historical database of European road networks since 1960 with a time interval of ten years. Stelder's paper (2014) presents a first analysis rested on this database. We thus chose the potential road accessibility data collected in this EU project as the outcome variable of the certified expenditure of transport infrastructures.

In Stelder's paper, the accessibility concept is expressed with the functional form based on Reilly (1931):

$$A_i = \sum_j P_j D_{ij}^{-\beta} \qquad (2)$$

with A for accessibility, P for population or any other local activity, D for distance or any other definition of transport costs, and a parameter β indicating the distance decay intensity.

In Stelder's analysis (2014), absolute accessibility A_j is scaled to relative accessibility a_j:

$$a_j = \frac{A_i}{\sum_j A_j} \qquad (3)$$

For each location, accessibility may be increasing at the same ratio, which may cause additional economic growth, but uniform in all locations, with the consequence that no one is benefiting more than others from infrastructure improvement[11].

Therefore we use the change in relative accessibility α_i is derived as:

$$\alpha_i(t) = \frac{\alpha_i(t)}{\alpha_i(t-1)} \qquad (4)$$

With this transformation, the usual geographical bias that gives central locations the highest accessibility is eliminated.

The following points summarise some crucial steps of our analysis:

- *Exclusions*: some regions were eliminated from analysis as their values were missing: South Aegean, Crete, the Autonomous City of Ceuta, the Autonomous City of Melilla, the Canaries, the Autonomous Region of the Azores, the Autonomous Region of Madeira.
- *Certified expenditure*: we consider the FOI "Transport Infrastructure" both for the Structural and Cohesion Funds. All the NUTS 2 who received the Cohesion Funds also received Structural Transport Funds.
- *Period*: for the outcome variable we cannot split the analysis into sub-periods, because data on POT is only available for some specific years (1955, 1970, 1980, 1990, 2000, and 2012). We decided to consider the growth rate for the period 2000-2012.
- *Samples*: we first considered the whole sample; then we excluded the Reunion Island that has a growth rate equal to zero.
- *Estimations*: we used parametric (OLS) and non-parametric estimation (local linear polynomial estimation with standard errors estimated with bootstrap method - 1000 replications).

Our goal was to verify whether the treated units that received (and spent) EU transfers for these specific fields of intervention experienced a greater growth in the outcome variables of these transfers. As mentioned before, the samples used were different for each specific FOI, because not all the units received transfers for both sectors of intervention.

[11] For more details on transport cost functions in NEG models, see McCann (2005).

1.7 Results

In this section, we discuss the main results of our analysis.

The first part contains a descriptive analysis of the pattern regions show in the growth rate of the outcome variable in relation to the transfers received (in both absolute and per-capita terms). The histograms give us a first impression of how regions reacted to the funds received. We consider the expenditure in logarithms and the growth rate of the outcome variable. The regions are sorted according to the value of their forcing variable (percentage of the per-capita GDP in PPS in proportion to EU average).

Figure 1 shows the histograms of the overall per-capita certified expenditure (without distinguishing the fields of intervention), given by the Structural Funds and Cohesion Funds (excluding private and national funds) for the sample considered as a whole. The vertical axis represents per-capita certified expenditure of Cohesion Policy, while the horizontal axis represents the NUTS 2 regions sorted by the forcing variable (per-capita GDP for the period 1988-1990 in PPS, ESA 79 criteria). The red line is the cut-off point. The clear division in the levels of the expenditure between the two groups supports our choice of a sharp RDD. Figure 2 shows the histogram of the logarithm of per-capita certified expenditure in Research, Technological Development and Innovation (SF) and Technical Assistance (CF) for the period 2000-2006 and the growth rate in patent applications (1999-2010), while Figure 3 shows the same variable but without considering per-capita level expenditure. In the first case, there is greater regional variability in terms of certified expenditure. In both cases, there is no clear demarcation between the two groups in terms of the transfers received.

Further, in both cases there is confirmation that Objective 1 regions exhibit a higher growth rate in patent applications despite the transfers received being almost the same for the two groups. The level of RTDI is for both groups around the average expenditure, whereas by considering per capita RTDI expenditure, non-Objective 1 regions show greater variability.

The results are quite different if the outcome variable is the growth rate of potential road accessibility. Figures 4, 5, 6 and 7 present the histograms of the logarithm of the certified expenditure in Transport (SF and CF) for the period 2000-2006 and the growth of Potential accessibility (POT) to road networks in the period 2000-2012. In Figures 4 and 6, expenditure is considered at the per-capita level. Figures 4 and 5 focus on Objective 1 regions. In this case, the sorting criteria is the POT growth rate in ascendant order. The graphs show a clear higher growth for the Portuguese and Spanish regions, although they receive transfers equal to or lower than the average. The variability in the transfers received by Objective 1 regions is emphasized when per-capita expenditure is considered. There is a dual trend in the growth rates that divides the Portuguese and Spanish NUTS 2 from the Italian, German and Greek regions. This result might be related to specific national policies and to a greater backwardness of these regions in terms of road infrastructure. When all the regions are taken into account (Figures 6 and 7), once again the variability in the certified expenditure increases if per-capita values are considered. In this case, the higher growth rate of the Objective 1 regions is less clear than for the patent applications, but it is still present. This result could be related to the fact that the variable POT considers only the road networks, whereas many of the improvements to the accessibility of European regions were probably devoted -especially in the recent years - to other kind of networks (air, maritime, railways), which are not accounted by the POT variable. This suggests that the amount of transfers regions receive is not the sole factor to determine the growth rate of the outcome: the efficient use of the funds by regions also plays an essential role. After this first graphic evidence, we now focus separately on each field of expenditure.

1.7.1 Per-capita GDP

Whole sample

The whole sample consists of 180 NUTS 2 regions: 54 are Objective 1 regions and 126 are non-Objective 1. Table 2 shows the descriptive statistics for the annual average growth rate of per-capita GDP and the overall per-capita certified expenditure. The maximum growth rate is 6.67 (Salzburg) and the minimum -0.52 (Noord-Brabant). The average value is 1.05 (standard error 1.06).

Considering the two groups of regions, the mean value of the growth rate is 1.01 for Objective 1 and 1.07 for non-Objective 1. The maximum and minimum values for the whole sample are the same as for the non-treated regions, whereas for the treated regions, the maximum value is 4.67 (Sachsen-Anhalt) and the minimum -0.32 (Norte). On the other hand, statistics on per-capita certified expenditure show wide differences between the two groups. Preliminary evidence of discontinuity can be obtained by considering a *naïve* estimation of the difference between the annual average growth rate of the treated and non-treated regions. The result is a negative coefficient (-0.05) for Objective 1 regions, but it is not statistically significant (p-value: 0.743). This first step does not reveal any significant difference in the GDP growth rate for the two groups. In the period 1995-2003, the result is still negative (-.0565) and not statistically significant, whereas for the years 2003-2010, it becomes positive (.0096) though not significant.

Representing the outcome variable in function of the forcing variables, as Lee and Lemieux (2009) suggest doing, the information given by the *naïve* estimations was confirmed. Figures 8 (1995-2010), 9 (1995-2003) and 10 (2003-2010) show that in correspondence with the threshold, the growth rate of treated regions is very similar to that of untreated regions.

The *naïve* estimation and the graphic representation do not show any significant discontinuity for the annual average growth rate of per-capita GDP in correspondence with the threshold between Objective 1 and non-Objective 1 regions.

However, a simple difference in growth rate is not enough for an evaluation of the Regional Policy. Consequently, we use a RDD approach with a local linear regression estimation and standard errors estimated with bootstrap (500 replications). Tables 3 (1995-2010), 4 (1995-2003) and 5 (2003-2010) show the results of these estimations with four different kernels (Triangle-tri, Rectangular-rect, Gaussian-gau and Epanechnikov-epa) and three bandwidths (optimal, half and double). For the whole period, there is no evidence of significant (negative or positive) discontinuity with any kernels or bandwidths, except for the rectangular kernel and the optimal bandwidth, for which a discontinuity in favour of Objective 1 regions (5.52 percentage points) is found and is statistically significant at 10 percent. Further, the Rectangular kernel is the only one in which the estimated coefficients are negative, whereas for the other kernels they are always positive though not significant.

Considering the first eight years of the period, the previous result is not confirmed; in fact, no significant coefficients are found with the Rectangular kernel, while with a half or double bandwidth and Gaussian or Epanechnikov kernels a positive and statistically significant coefficient is found. This means that there is a discontinuity in favour of non-Objective 1 regions.

Moving our focus to the last seven years of the period, no significant results were obtained. Table 6 presents the results of the parametric estimations (OLS with robust standard errors). If we choose the best model using the AIC, we should select model 6. However, the second lower AIC value is that of model 5, which presents one linear term and one quadratic term. This means we observe an advantage of 4.8 annual percentage points in the annual average per-capita GDP growth rate in favour of the Objective 1 regions (the results found for the non-parametric estimation with Rectangular kernel are here confirmed).
Figure 11 analyses the discontinuity trend relatively to different bandwidth dimensions, considering a Rectangular and a Gaussian kernel. Sections *a*, *b*, *c*, *e*, *f* confirm the absence of a discontinuity as revealed by the non-parametric estimation; conversely, figure 11 *d* displays the discontinuity found with the Rectangular kernel and the optimal bandwidth.
As a further control, we test the presence of discontinuity in the outcome variable for different threshold values. Table 7 shows the results obtained with the optimal bandwidth and the Rectangular and Gaussian kernels for the thresholds 50, 60, 80 and 90; no significant discontinuities were found. To exclude the presence of manipulations in the density function of the forcing variable at the threshold, we refer to the McCrary test (McCrary 2008). Figure 12 shows that the discontinuity around the cut-off is not statistically significant with a confidence interval of 95%.
In conclusion, when we consider this sample composition and the growth rate of per-capita GDP as an outcome variable, no stable significant discontinuity result emerges.

Restricted sample GDP 1

In this sample, we exclude the regions that appear as outliers, because they show the highest or lowest values of the outcome variable: Sachsen-Anhalt, Salzburg, Nord-Pas de Calais, Noord Holland, Essex and Inner London. The sample now consists of 174 units: 53 Objective 1 and 121 non-Objective 1. The idea is to get more stable results through the exclusion of the extreme values.
The *naïve* estimation of the difference in the outcome variable average growth rate in the period 1995-2010 is still positive (0.016) and not statistically significant (p-value= 0.901), but the value is lower than the previous sample. The result is negative (-.0116) in the period 1995-2003 and positive (.0058) in 2003-2010, and in both cases it is not significant. The graphic analysis in Figures 13 (1995-2010), 14 (1995-2003) and 15 (2003-2010) confirm that there is no clear demarcation between the two groups in the per-capita GDP growth rate. In the same sample, if we look to the local linear regression (tables 8, 9 and 10) and consider the whole period (table 8), a statistically significant discontinuity of 5.5 annual percentage points is found for the optimal bandwidth and the triangle kernel. When the sub-period 1995-2003 (Table 9) is analysed, the discontinuity with Gaussian and Epanechnikov kernels and with half and double bandwidths is also confirmed; however, like for the previous sample, the value is lower and almost equal to 0.2 annual percentage points. Over the period 2003-2010 (Table 10), there is no evidence of any significant difference between the Objective 1 and the non-Objective 1 groups of regions.
It emerges that exclusion of the extreme values does not significantly affect the results in terms of discontinuity: the results obtained are similar to those of the estimations which include them.

Restricted sample GDP 2

After exclusion of the extreme values, we decided to follow another criterion for the reduction of the sample, excluding the colonial regions - Guadalupe, Martinique, Guyana, Reunion, Ceuta and

Melilla, the Azores and Madeira - and Alentejo that still presents a different development pattern than other Portuguese NUTS 2.

The new sample consisted of 165 units, of which 44 Objective 1 and 121 non-Objective 1. The result of the *naïve* estimation was again the same as the previous step, with a negative and not statistically significant coefficient in all the three periods considered[12]. The graphic analysis (Figures 16, 17 and 18) does not reveal big differences in the growth rate of the outcome variable. However, for the period 1995-2010 (Figure 16), the left side of the graph displays a higher growth of the outcome variable than the right side.

If we instead consider the local linear regression estimation, the results are quite different. Unlike in the previous samples, there is no statistically significant discontinuity in favour of non-Objective 1 regions in the three periods analysed (Tables 11, 12 and 13); whereas an advantage (5.5) in the annual average per-capita GDP growth rate in favour of the treated regions persists when considering the whole period (Table 11), a triangle kernel and the optimal bandwidth. Nonetheless, this result is not confirmed with other kernels and using a parametric estimation (Table 14).

In conclusion, we argue that European Regional Policy seems to have a positive impact on the annual average growth rate of per-capita GDP, but its effect is observed in the long-term and not confirmed in the short term.

1.7.2 Research Technological Development and Innovation

Table 15 shows the descriptive statistics for patent applications and for RTDI expenditure for the whole sample and the two groups. The sample consists of 167 units, of which 50 regions are Objective 1 and 117 are non-Objective 1. The maximum growth rate in patent applications is 11.25 (Alentejo) and the minimum is -1 (Ceuta and Melilla). Its average value is thus 0.79 (standard deviation 1.39). If we look at each group separately, the result is rather different: the average growth rate in patent applications for treated regions is 1.55 while for untreated regions is 0.48. The maximum and minimum values of patent growth rate both refer to Objective 1 regions. Looking at expenditure, on the other hand, there is less of a difference amongst the two groups: the mean value is almost the same. The descriptive statistics confirm that diversity among the two groups is linked to the outcome variable and is not too clear from just expenditure levels.

The analysis and its robustness check were carried out with reference to two main guidelines: the first is the time interval; the second is based on the sample composition. The decision to consider the time dimension was due to the nature of the investments that may require different time intervals for their realisation. For this reason, the outcome variable was considered for the whole period (1999-2010) as well as for three sub-periods: the first (1999-2007) excludes the last three years (it considers just the years in which the transfers were devolved); the second (2002-2010) excludes the first three years, so it takes into account the possibility that some investments require time to be effective; finally, the third considers only the central years (2002-2007). Results robustness was verified also by considering the outcome variable equal to the simple difference between the first and the final year. If there is no discontinuity in the difference in level, there is evidence of a convergence process. Another important proof of robustness is the analysis of different samples. A preliminary dataset screen showed the presence of some possible outliers. We wanted to assess if the results found for the whole sample were robust to the exclusion of the

[12] Coefficients are equal to -.0188 in the whole period, -.03656 in 1995-2003, and - .0007 in 2003-2010.

outliers or if it was only due to these extreme values. With this aim, we considered a first sub-sample R1 excluding Martinique, Guyana, the Autonomous Region of the Azores, the Autonomous City of Melilla and the Autonomous City of Ceuta, all with some missing values and a negative growth rate. In the second sub-sample R2, we excluded also Alentejo that seemed to be an outlier in the whole period because it had the highest growth rate, though it had a clear increasing trend. It was eliminated to give more stability to the results obtained.

As we will see below, the results were strongly robust to the sample restrictions and they also gained advantages in terms of stability, so we decided to refer to this last sample for the other common robustness checks.

First, we looked at the graphic impact of the discontinuity for different kernels and different bandwidths; then we estimated the polynomial regressions with OLS. Once we had looked at discontinuity at different thresholds, we controlled for the presence of discontinuity considering a different variable (the average population) that should not be affected by the treatment, as a robustness check.

Whole sample

A first, evidence of discontinuity was obtained with the *naïve* estimation of the difference of the annual average growth rate in the outcome variable between the treated and untreated regions.

When the whole sample was considered, for the period 1999-2010, a statistically significant (at 1 percent) positive coefficient equal to 1.07 (standard error 0.22) was obtained. This means that the average growth rate in patent applications for Objective 1 regions is on average greater than the growth rate of the untreated regions by 1.07 percentage points. This value became 1.45 (standard error 0.21) and is still significant at 1 percent when the last three years were excluded (1999-2007) and decreased to 0.49 (standard error 0.16) and 0.92 (standard error 0.19), respectively, for the periods 2002-2010 and 2002-2007. These results show a greater impact when the first years of the period are considered (also because the situation is worse for some regions).

In Figures 19, 20, 21, 22 referring respectively to the periods 1999-2010, 1999-2007, 2002-2010 and 2002-2007, the outcome variable is represented in function of the forcing variable (level of per-capita GDP in PPS, UE 15=100, average 88-90), for both groups. The vertical line plotted in the graphs is the cut-off point at the 75 percent threshold; the units on the left are the Objective 1 regions; the units on the right are the non-Objective 1 regions. The results previously obtained are confirmed: the units on the left present a greater variability than the units on the right, which appear more stable. Further, a strong discontinuity in favour of the treated regions was found independently of the time period considered.

Lee e Lemieux (2009) state that the graphic existence of discontinuity is a preliminary evidence in the search for discontinuity: if no graphic evidence is found at the cut-off point, the methodology cannot be applied. In our case, the treated regions were clearly separate from the untreated ones. A non-parametric polynomial flexible regression model (lpoly) with a confidence interval of 95 percent is also represented. The *naïve* estimation and this graphic representation, suggest that Objective 1 regions present a greater growth rate in the outcome variable compared with untreated regions. Nevertheless, the simple difference in the growth rate between the two groups is not enough for a correct evaluation of the Regional Policy. For this reason, discontinuity was estimated with the RDD approach with a local linear regression estimation and standard errors estimated with bootstrap (500 replications). Tables 16 (1999-2010), 17 (1999-2007), 18 (2002-2010) and 19 (2002-

2007), present the results of these estimations with four different kernels (Triangle, Rectangular, Gaussian and Epanechnikov) and three bandwidths (optimal, half and double). The optimal bandwidth was obtained through the Imbens and Kalyanaraman index (2009) that gives the right trade-off between precision (greater number of observations) and distortion (wider interval, greater differences among treated and untreated regions). For all four periods analysed, the results were statistically significant only for the Gaussian and the Epanechnikov kernel. In particular, when the whole period was considered (Table 16), discontinuity was around 1 percentage point and was statistically significant at 10 percent for the optimal bandwidth. It became 1.3 and statistically significant at 1 percent (Epanechnikov kernel) and 5 percent (Gaussian kernel), when the bandwidth was doubled. If the last three years were excluded (1999-2007, Table 17) discontinuity increased both in size and in significance: it was 1.4 percentage points, statistically significant at 5 percent with optimal bandwidth and 1.8 (significant at 1 percent) with double bandwidth. Further, for the half bandwidth a significant (10 percent) discontinuity of about 1 percentage point was found.

When we focused on the period 2002-2010 (Table 18), a significant discontinuity was found only for the double bandwidth: it was equal to 0.6 percentage points and statistically significant at 5 percent (Epanechnikov kernel). On the other hand, on consideration of the central (2002-2007, Table 19), discontinuity was statistically significant for all three bandwidths and was equal to 1.3 (significance 5 percent) for the optimal, 0.8 (1 percent) for the half and 1.4 (1 percent) for the double.

Based on these results, we argue that, independently of the sub-period considered, on the whole Objective 1 regions exhibited a greater growth rate of at least 1 percentage point compared with non-Objective 1 regions. Nevertheless, the graphs underline the presence of some outliers that we exclude from the next sample composition. Figure 23 represents the conditional density discontinuity of the forcing variable, computed with the method of McCrary (2008). An estimation of the density function of regional per-capita GDP at a 95 percent confidence interval is represented. Discontinuity around the cut-off is not statistically significant at 5 percent.

Before analysing the two further sub-samples, we also check how the observed responses of the outcome variable change around the discontinuity if the outcome variable is expressed in terms of a levels variable reflecting the absolute number in patent applications per million rather than as a growth rate in patents per million inhabitants as considered before. We considered the same sub-periods and kernels as in the analysis described above. The results of the non-parametric estimation are displayed in Tables 20, 21, 22 and 23 concerning, respectively, time intervals 1999-2010, 1999-2007, 2002-2010 and 2002-2007. Independently of the time interval and the kernel considered, there were no significant discontinuities when the outcome variable was expressed as difference in level. These findings are confirmed also in Figure 24 (1999-2010), 25 (1999-2007), 26 (2002-2010) and 27 (2002-2007), in which at the cut-off point there are no jumps in the regional outcome variations when moving from the left-side units to the right-side units.

Results highlight a strong discontinuity in the growth rate of the outcome variable that was not found in the difference in levels. This means that a process of convergence has occurred. In the following sub-section, results robustness is tested by considering two restricted samples.

Restricted Sample 1 (R1)

This sample differs from the previous one for the exclusion from analysis of the following regions: Martinique, Guyane1, the Autonomous Region of the Azores, the Autonomous City of Melilla and the Autonomous City of Ceuta. By analysing the *naïve* difference in growth rates, it emerged that in the period 1999-2010, Objective 1 regions had an advantage of 1.32 percentage points (standard error 0.22), statistically significant at 1 percent. On exclusion of the last three years, (1999-2007) the annual average growth rate in Objective 1 patent applications appeared greater than the rate of other regions by 1.57 percentage points and it was statistically significant at 1 percent. This value became 0.71 (standard error 0.15) for the period 2002-2007 and 0.62 (standard error 0.16) for the period 2002-2010, both statistically significant at 1 percent.

In comparison with the sample previously considered, these results are higher in value and in significance. Figures 28 (1999-2010), 29 (1999-2007), 30 (2002-2010) and 31 (2002-2007), confirm the existence of discontinuity in the growth rate of patent applications in favour of the treated regions. The graphs are more stable than the previous sample. The regressions, estimated with the non-parametric method of local linear polynomial, once again showed significant results only for the Gaussian and Epanechnikov kernels. When the whole period was considered (Table 24), for the optimal bandwidth there was a statistically significant discontinuity at 5 percent of 1.19 percentage points with the Epanechnikov kernel and 1.14 with the Gaussian kernel. The size of the discontinuity increased to 1.4 percentage points (significant at 1 percent) when the double bandwidth was considered. Both results increased by about 0.2 percentage points because of the sample restriction. For the period 1999-2007 (Table 25), discontinuity increased noticeably and reached 1.5 (significant at 5 percent) with the optimal bandwidth and 1.1 (significant at 5 percent with the Gaussian kernel and 10 percent with the Epanechnikov kernel) with the half bandwidth. When the double bandwidth was considered, the advantage of the Objective 1 regions was of 1.6 percentage points (significant at 1 percent). This result is similar to the one obtained for the whole sample. Table 26 shows the results for the sub-period 2002-2010, for which they appear more significant. With the optimal and double bandwidths, the advantage of the Objective 1 regions was of about 0.6 percentage points (significant at 10 percent with the optimal and at 5 percent with the double).

When the central period was analysed (Table 27), discontinuity variations as a function of the bandwidth are less important. In particular, for the Epanechnikov kernel, the value went from 0.7 percentage points with the half bandwidth, to 0.8 with the optimal bandwidth to 0.83 with the double bandwidth, all statistically significant at 5 percent; for the Gaussian kernel the values were respectively 0.64, 0.79 and 0.82, and they were significant at 5 percent.

The exclusion of five units improved the significance and stability of the results. In order to boost the robustness of our findings, in the following analysis Alentejo will also be excluded from the sample, as it appears to be an outlier.

Restricted sample 2 (R2)

The *naïve* estimation of the difference in the average growth rate of patent applications still emphasised the presence of a strong discontinuity for the Objective 1 regions. Their advantage was equal to 1.11 percentage points (standard error 0.18) if the whole period was considered (this value was lower of about 0.2 percentage points compared to the previous sample, because Alentejo had the highest growth rate for the period 1999-2010). The advantage of the Objective 1 regions became 1.5 percentage points (standard error 0.22) when the last three years were excluded (in this case the elimination of Alentejo did not produce big variations) and decreased to 0.71 (standard error 0.15) in the period 2002-2007 and to 0.57 (standard error 0.16) in 2002-2010. The value was always significant at 1 percent. The graphic analysis in Figures 32 (1999-2010), 33 (1999-2007), 34 (2002-2010) and 35 (2002-2007), confirms these results: once again, the regions on the left exhibit a higher growth rate than the regions on the right. If we look at the local linear regression, in this case too we find that only the Gaussian and the Epanechnikov kernels are significant. When the whole period is considered (Table 28, 1999-2010) the discontinuity is about 1 percentage point with the optimal bandwidth (significant at 5 percent for Epanechnikov and at 10 percent for Gaussian) and it is equal to 1.1 percentage points with double bandwidth (significant at 5 percent).

In comparison to the previous sample, discontinuity is slightly lower. When we excluded last three years (Table 29, 1999-2007), the two kernels gave quite similar results, in particular discontinuity was about 1.4 percentage points (significant at 1 percent for the Gaussian kernel and 5 percent for the Epanechnikov kernel) with the optimal bandwidth; 1.2 with the half bandwidth and 1.6 with double bandwidth.

The period 2002-2010 (Table 30) exhibits also for this sub-sample feeble evidence of discontinuity with a value of 0.66 percentage points (significant at 10 percent) with optimal bandwidth and 0.6 (significant at 5 percent for the Epanechnikov kernel and at 10 percent for the Gaussian kernel) if the bandwidth is double.

When the central years are considered (Table 31, 2002-2007), the estimated coefficients are almost the same as those obtained for sample R1. A lower variability in the estimation of the discontinuity in relation to bandwidth dimension emerged. The discontinuity varied from 0.7 (half bandwidth) to 0.83 (optimal and double bandwidth) and it was significant at 5 percent.

The discontinuity trend related to bandwidth dimensions can be analysed by looking at Figure 36 (a, b, c) for the Epanechnikov kernel and figure 37 (a, b, c) for the Gaussian kernel. Figure 38 shows the estimation of the McCrary density function for the forcing variable in the sample R2.

This restricted sample had the most stable results, so it was used for other robustness checks. Table 32 shows the parametric estimations (OLS with robust standard errors). Model 5 was chosen as the best model using the AIC. The effect of the Regional Policy was positive and statistically significant at 5 percent and equal to 3.6 annual percentage points. The selected model presents one linear term and one quadratic term. The most similar results to the non-parametric model was the estimation of number 4, in which the effect was of 1.15 percentage points.

Another robustness test is to verify whether there are no jumps in the level of the outcome when the threshold is not identified. The model was tested for a null effect for different values of the forcing variable. In Table 33 the effect is estimated with different kernels (Epanechnikov and Gaussian) and the optimal bandwidth (4.8) for different thresholds (50, 60, 70, 90). The results confirm that there are no significant discontinuities.

Finally, we verified that there is no discontinuity at the cut-off point for another covariate that could not be affected by the treatment: we considered the average population. The estimations were carried out with a non-parametric local linear regression with three kernels (Gaussian, Epanechnikov and Rectangular) with the optimal bandwidth and standard errors computed with bootstrap. Table 34 shows the results and confirms that no significant discontinuity was found.

From our analysis on the investigation of discontinuity in the growth rate of patent applications, we can see that Objective 1 regions who received RTDI transfers experienced a higher growth rate in patent applications than non-Objective 1 regions. Furthermore, these results are not due to the presence of outliers and, in particular, to the presence of regions who exhibited a worse initial situation, because the results are robust to different sample compositions. Although there is some evidence to suggest a greater effect in earlier years, these results are robust to the time period and to the samples being considered[13]. The results obtained were strongly confirmed also in a polynomial parametric regression and were robust to the presence of other cut-off points and to the presence of discontinuity in other covariates, not influenced by the funds. No discontinuity was found if the outcome variable is expressed as a difference in levels. This means that the lagging regions experienced a higher growth rate and had the same variation in levels as the more developed units.

1.7.3 Transport Infrastructures

Analysis of the transport infrastructure field of intervention is quite different and less structured than the one of patents applications. The reason for this lies in the nature of the data. As regards potential road accessibility data, there were no complete time series available, just some specific years, so it was not possible to consider different sub-periods. We refer to the period 2000-2012. Table 35 shows the descriptive statistics for Potential road accessibility (hereafter POT) growth rate, for both groups and for the certified expenditure in Transport Infrastructure. The minimum POT growth rate is zero and the maximum is 9.53 for, respectively, the Reunion and Norte regions, both Objective 1. The value for the Reunion appeared unstable, so we excluded it in the second part of the study (sample TR1). The mean value for the treated group was 5.03, whereas for the untreated group it was 4.01; the standard deviation for the first group was almost the double that of the second group.
The descriptive statistics suggested the results would be different from the case of patent applications, because the difference between the mean values of the two groups was lower and the treated group was characterized by a higher variability. Looking at the certified expenditure, we observed a value that was, on average, higher for non-Objective 1 regions. A first evidence of the discontinuity was given from a *naïve* estimation of the annual average growth rate of the outcome variable, equal to 1.01 (standard error 0.23) and statistically significant at 1 percent. This result means that Objective 1 regions on average have grown more than the non-Objective 1 by one percentage point per year. This is confirmed also in Figure 39, in which another characteristic of the sample is highlighted: unlike in the case of the patent applications, there was no clear jump in proximity with the cut-off point, because the group of the treated NUTS 2 exhibited two opposite trends amongst the regions falling within it. One group of regions that definitely had a higher growth rate than the other (this was mainly composed of Spanish and Portuguese regions, Figure 4), and another group of regions had values more similar to the untreated regions (Italian, German and Greek). This result could be due to the nature of the POT variable and thus not an expression of the presence of outliers. The outcome variable considers only the road network and does not account for other kind of networks[14]. The graphs also emphasise the opportunity for excluding the Reunion from the sample. Table 36 strengthens the presence of a feeble discontinuity; the result was statistically significant only for the double bandwidth for the Gaussian (significant at 10 percent) and the Epanechnikov (significant at 5 percent) kernels and the discontinuity for both was equal to 0.9 percentage points[15].

[13] The analysis was also conducted by considering the number of people employed in technology and knowledge-intensive sectors as outcome variable and looking to the field of expenditure on human resources but not significant results have been obtained; in particular, for the latter there were not enough units in proximity of the threshold.
[14] Variables that consider accessibility to other transport networks are not available. The analysis, in a previous version,also considered the “Kilometres of road, railway and navigable way”, but without significant results.
[15] The standard errors are estimated with bootstrap with 1000 replications.

After these considerations, we decided to exclude the Reunion from the sample, given its location far outside of Europe.

Restricted sample TR1

The exclusion of Reunion increased the mean value of the Objective 1 regions, which became equal to 5.15 (with a minimum value of 2.59 and a maximum value of 9.5), whereas the standard deviation decreased to 1.88. The *naïve* estimation of the annual difference in the average growth rate showed an advantage of about 1.14 percentage points (standard error 0.22) in favour of the Objective 1 regions, statistically significant at 1 percent. The value increased by 0.14 percentage points compared with the previous case. Figure 40 confirms the existence of two opposite trends in the treated group. The results of the non-parametric estimation with the local polynomial regression are presented in Table 37 (the standard errors are still estimated with bootstrap with 1000 replications). The result is similar to that obtained when the whole sample is considered: the estimated discontinuity was about 0.9 and it was statistically significant at 10 percent with both the Epanechnikov and Gaussian kernels, with the double bandwidth.
As we did for the patents, we considered the outcome variable expressed as difference in levels. The results are shown in Table 38 and in Figure 41: no significant discontinuity was found. In the graph, the two opposite trends in the treated group are less defined. Discontinuity in the growth rate was not very strong but it was still significant. In the following part, we look into its robustness. Figure 42 (*a, b, c*) shows the discontinuity trend with the Epanechnikov kernel in relation to bandwidth size. It appears in sections *b* and *c* of the graph. Figure 43 displays the discontinuity in relation to bandwidth size when the Gaussian kernel is considered. In this case, the jump in proximity with the cut-off point is visible also with the half bandwidth, but the high variability of the treated regions does not allow for any significant estimation. Figure 44 presents the estimation of the density function of the forcing variable (McCrary, 2008).
As a robustness check, we also ran the parametric estimation with a different polynomial order (table 39). The results show a problem of strong multicollinearity; indeed, from model 3 onwards, the Variance Inflation Factor (VIF) assumes a value higher than 20 and blows up in models 5 and 6. In order to check if the forcing variable has jumps for other thresholds, the RDD was applied for different cut-off points with different kernels. In particular, we considered the Gaussian and Epanechnikov kernels and cut-off points: 50, 60, 70, 80, 90. In all cases, no significant results were obtained (Table 40). We excluded also the presence of discontinuity for other covariates (average population was considered, as for patent applications); results are presented in Table 41 and the RDD was applied to three kernels at the optimal bandwidth.
We can conclude, on the basis of the results obtained, that for the transport infrastructure the discontinuity observed is less robust than the results obtained for the patent applications. The position of the dots in the scatter plot implies that this finding is due to the heterogeneous composition of the treated group. This is likely linked to the outcome variable used, that considers only the road accessibility and thus improvements in road infrastructures. The regions of the sample received transfers for all kinds of transport projects, so part of the funds may have been devoted to accessibility improvement of other transport networks. For this reason, the result obtained is significant in the identification of the impact of EU Regional Policy transfers to the Objective 1 NUTS 2 regions.

1.8 Conclusions

This essay investigates the effectiveness of EU Regional Policy transfers in two fields of intervention: Research, Technological Development and Innovation, and Transport Infrastructure, through the proxies of patent applications and potential road accessibility respectively, alongside analysis of per-capita GDP. The *sharp* Regression Discontinuity Design was used.
The sample refers to the NUTS 2 regions of the EU with 15 member states. We estimated the effects both with a non-parametric (local linear regression) and parametric (polynomial regression estimated with OLS) approach. The results obtained were tested with the usual robustness checks put forward in the literature. Standard errors were estimated with the bootstrap method (with 500 replications for patents and GDP and 1000 replications for transport[16]), whereas in the parametric regressions, standard errors were robust to heteroskedasticity. The analysis was conducted separately for the two fields of intervention and for per-capita GDP.
First, we assessed the presence of discontinuity by looking at the most widely used outcome variable: the annual average growth rate of per-capita GDP. We considered the Eurostat database on regional accounts and we referred to a fifteen year period (1995-2010) and two sub-periods (1995-2003 and 2003-2010). We took into account several sample compositions in order to exclude the effects of possible outliers. The results obtained did not highlight a clear effect, as statistical significant discontinuity in favour of the treated regions emerged only when the whole period and a Rectangular kernel were considered. However, in most cases the results were not statistically significant. After these considerations, we can conclude that the effects of European Cohesion Policy on the growth rate of per-capita GDP are not clearly defined, particularly in the short term. These results confirm the more general fact that economic activities and structural adaptations need different time intervals for reacting to changes.
The second part of our analysis assessed the impact of the policy focusing on specific fields of intervention and using specific outcome variables for each one. We then considered the impact of transfers in RTDI and Technical Assistance on the growth rate of patent applications per million inhabitants (fractional count; by inventor and priority year). The results demonstrate that Objective 1 regions exhibit a higher (by at least one percentage point) growth rate in patent applications than non-Objective 1. The analysis was structured along two guidelines; one relative to the time intervals and the other one to the composition of the sample. The results appeared robust to both different periods of analysis and sample composition. The entire period of analysis for the outcome variable was 1999-2010, but we looked also at three sub-periods: 1999-2007, 2002-2010 and 2002-2007. The results show that the first three years give an important contribution to the discontinuity in the outcome variable, whilst in the last three years it appears weaker. The significant discontinuity found is not due to the presence of outliers and, in particular, to having included in the sample those regions who had a worse initial situation, because the results are also robust to different sample compositions. Our findings are strongly confirmed also in a polynomial parametric regression and they are robust to the presence of other cut-off points and to a discontinuity in other covariates not influenced by the funds. As an additional check, we considered the outcome variable expressed as difference in levels and no significant discontinuity was found. This means that the backward regions experienced a higher growth rate and the same variation in levels as the more developed regions, and this can be considered as evidence of convergence.

[16] In the case of transport, we considered a greater number of replications because the sample appeared more unstable.

In the second part of the analysis, we looked for the presence of discontinuity in the growth rate of potential road accessibility, as an outcome of expenditure in transport infrastructure. In this case, the results were less strong than those on patent applications and the analysis could not be structured into different time intervals, because of a lack of appropriate data. Data was provided by Stelder (2014) in the context of a European project of construction of a historical archive on road accessibility in Europe. The results show the presence of a feeble discontinuity in favour of the treated regions of 0.9 percentage points, statistically significant only for the double bandwidth. Another important aspect stemming from the analysis is the presence in the treated group of two opposite trends in the growth rate of potential road accessibility: on one side, there are the Spanish and Portuguese regions that experienced greater growth and on the other side, there are the Italian, German and Greek regions. The high variability within the groups contributes to weakening the results on discontinuity. Another element of weakness is that the outcome variable does not account for other transport networks, that might be the object of more improvements in their accessibility, especially in recent years.
The results point to significant growth effects in these indicators for Objective 1 regions above those displayed by non-Objective 1 regions. Indeed, the difference is sufficiently large that when observed in terms of levels effects, the two types of regions become largely indistinguishable in terms of these particular features, exactly as intended by the policy. The innovation-relate results were stronger than those obtained for transport-accessibility, although the patterns of policy-outcomes are remarkably very similar between the two cases. Furthermore, the differences in the growth rates of each outcome variable between the Objective 1 and non-Objective 1 regions show greater differences than in the financial transfers they received, which suggests that at the policy is efficient in terms of value for money.

1.9 Further extensions

Policy evaluation is increasing in importance in both the academic and institutional fields. Project evaluation is one of the main steps for their success. However, no agreement exists to date as to the best approach to be adopted. In this work, we referred to a counterfactual methodology that allows the comparison of groups with similar characteristics and differing only in the treatment; we got some interesting results, especially when specific fields of intervention were considered. Admittedly, the RDD approach has some limitations regarding the identification of the causal effect of the Policy on economic growth, the binary nature of the treatment and, further, the effects on the policy outcome determined by different per-capita aid intensities across regions; despite this, some future extensions are possible.
We can distinguish two different paths for the possible extension of the present research: the first is related to the type of data we have and the second takes hold from the weaknesses of the methodological approach used.
As we mentioned above, we used a reliable and comparable dataset including data on the Structural and Cohesion Funds certified expenditure, provided directly by the European Commission. It would be interesting to account for different per-capita aid intensities across regions.
Starting from this idea, two main extensions of the present work presented seem plausible: first, we can continue to use the Regression Discontinuity Design but introduce the hypothesis of Heterogeneous Local Average Treatment Effect instead of the LATE estimation (Becker 2013); second, we can switch to the Generalised Propensity Score with the estimation of a dose-response

function (Imbens 2000, Hirano and Imbens 2004, Rosenbaum and Robin 1983) in order to obtain the relation existing between the outcome variables and different treatment intensity.

One of the RDD approach's limits is the low number of observations close to the threshold that determines a trade-off between the size of the estimation interval in the proximity of the cut-off point and accuracy of statistical estimates. However, a recent paper by Angrist and Rokkanen (2013) highlights the importance of investigating RD by looking also at observations further away from the cut-off point. This would be interesting in our case, since it would allow for a comparison of regions with different starting points.

Another limitation of the RDD is that this method identifies the causal effect of EU Regional Policy on economic growth without explaining the link between policy intervention and economic growth. Our idea is to deepen the nature of the discontinuity applying an Oaxaca Blinder decomposition (Jann 2008) to allow for identification of the determinants of growth differentials. Finally, it might be interesting to compare the results obtained through a *sharp* approach with those obtained by means of a *fuzzy* RDD.

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1.10 Appendices

1.10.1 Preliminary operations

Table P1- Structural Fund: original data scheme

Country	Reference	Title	Year	FOI Level 1	FOI Level 2	FOI Cd	FOI	FOI CE Structural Fund	FOI CE National	FOI CE Private

Table P2- Cohesion Fund: original data scheme

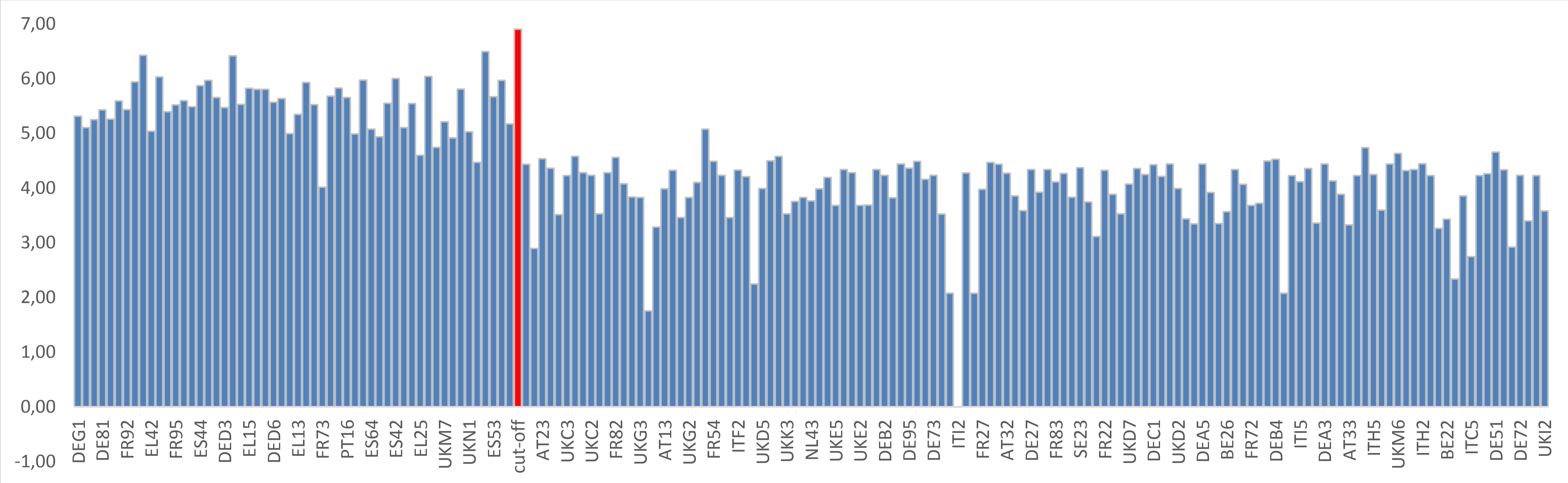
Country	Category	Reference	Title	Year	Certified Expenditure Amount (cumulative amount by year)

Table P3 – Structural Funds and Cohesion Fund: data scheme after transformation

Country	Code	Name_Nuts2	Year	Transport infrastructure	Research, technological development and innovation (RTDI)	Human Resources	FOI CE National	FOI CE Private	CF environmental project	CF transport project	CE Technical Assistance Project	Title

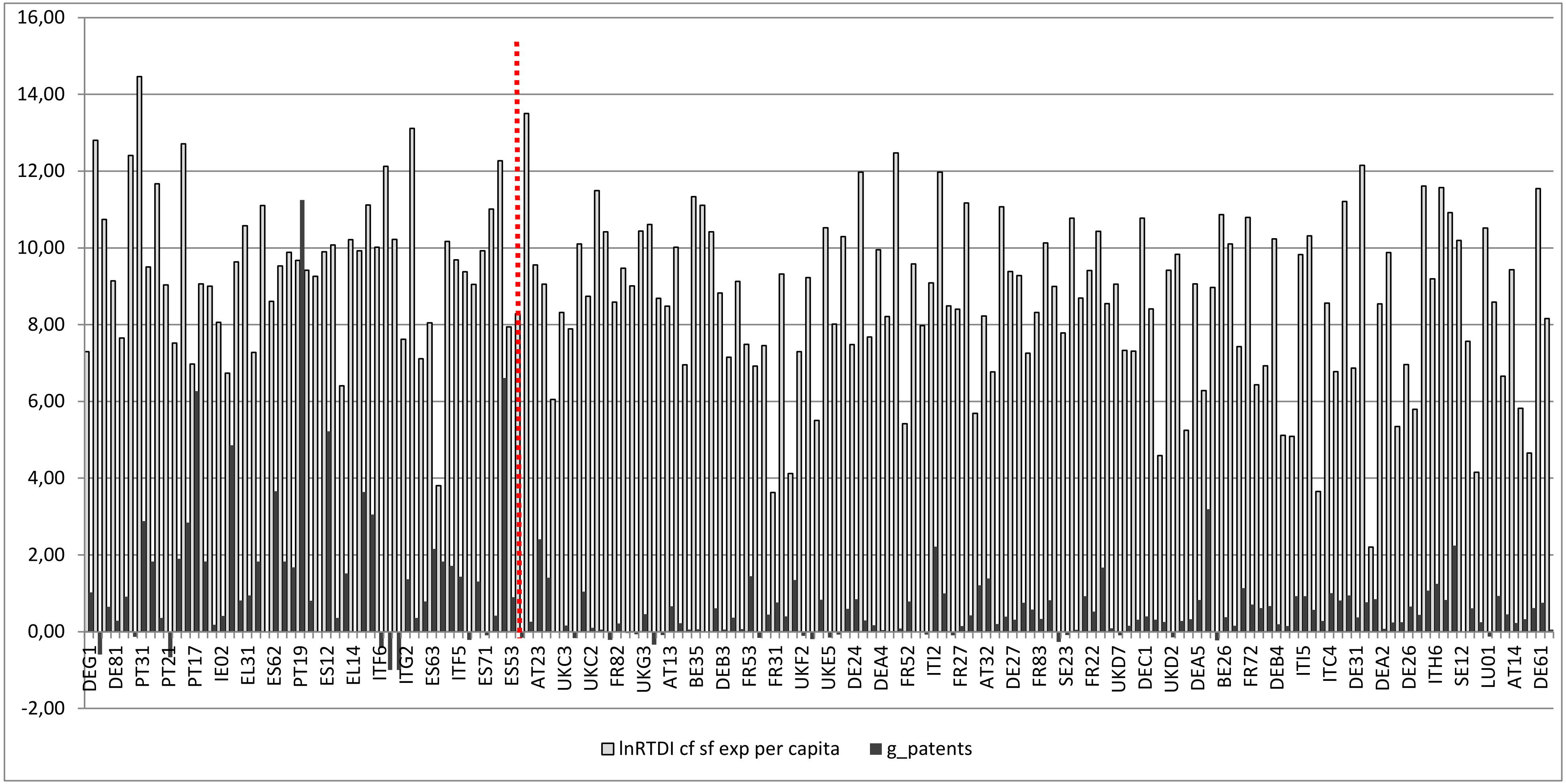
1.10.2 Figures

Figure 1 Per-capita certified expenditure by EU NUTS 2 regions



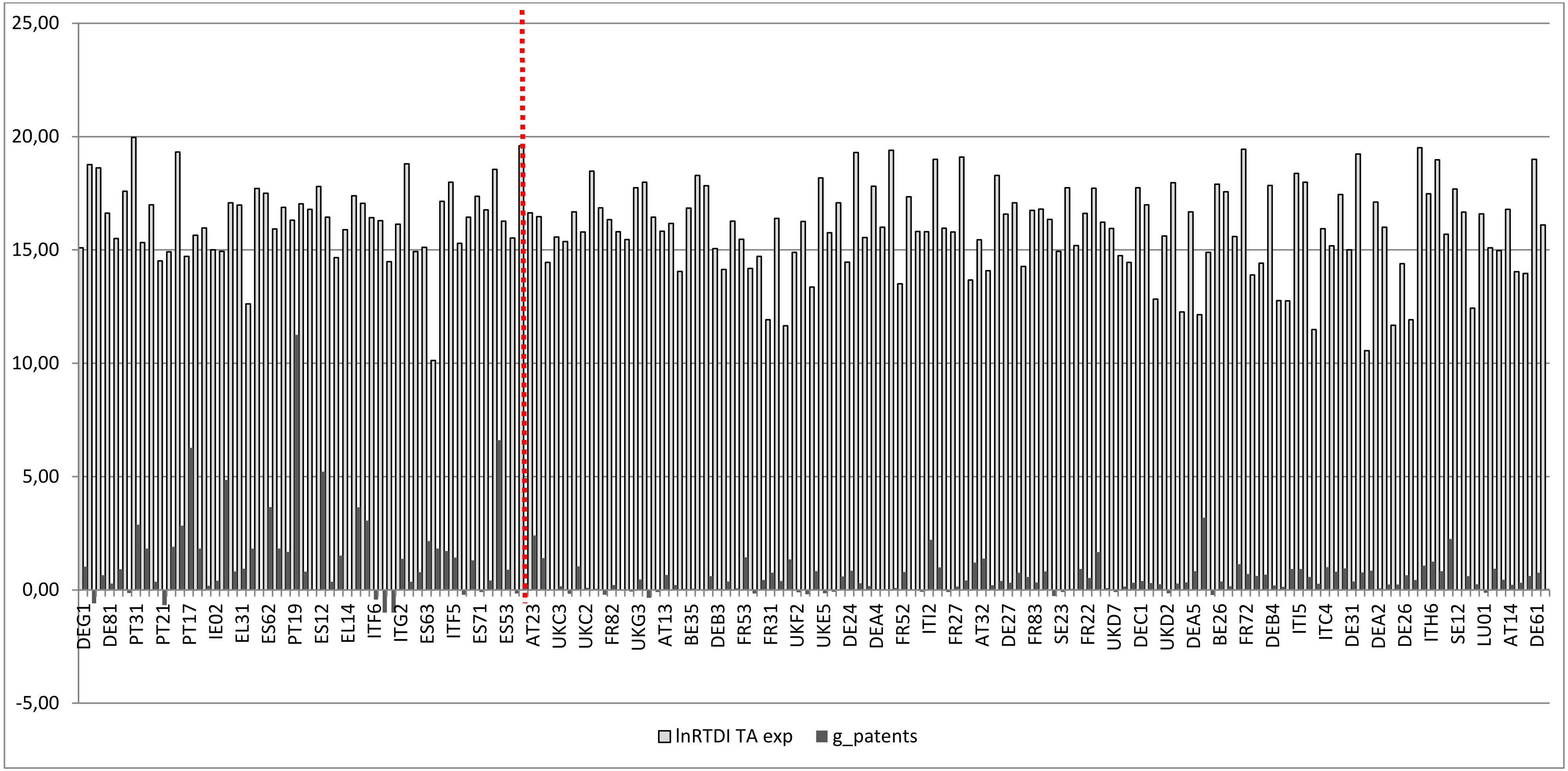
Source: our elaboration on European Commission and Eurostat data

Fig. 2- Logarithm of the per-capita certified expenditure in Research, Technological Development and Innovation (SF) and the Technical Assistance (CF) (2000-2006) and growth rate in patent applications (1999-2010) by EU NUTS 2 regions.



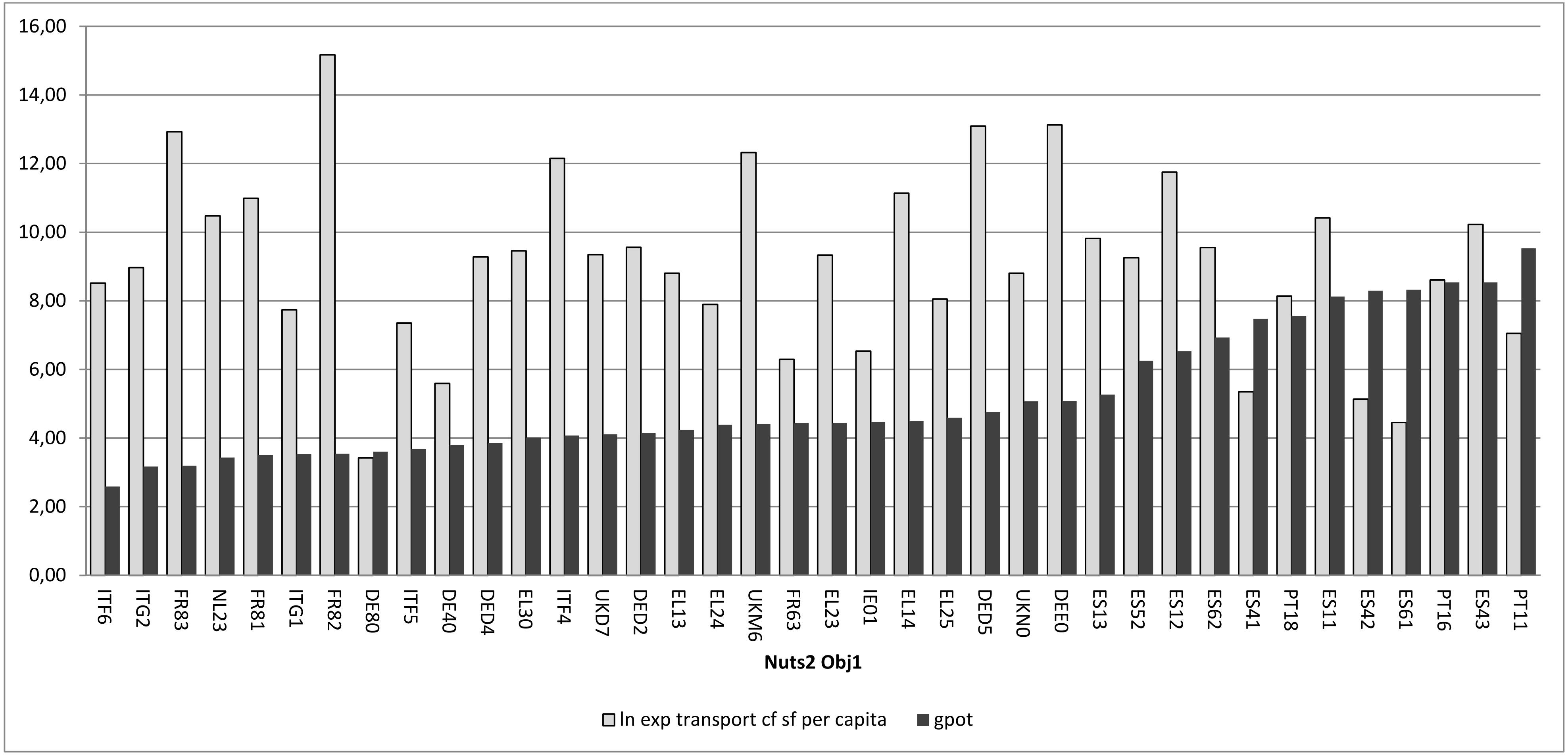
Source: our elaboration on DG Regional Policy data and OECD regpat data

Fig. 3- Logarithm of the certified expenditure in Research, Technological Development and Innovation (SF) and Technical Assistance (CF) (2000-2006) and growth rate in patent applications (1999-2010) by EU NUTS 2 regions.



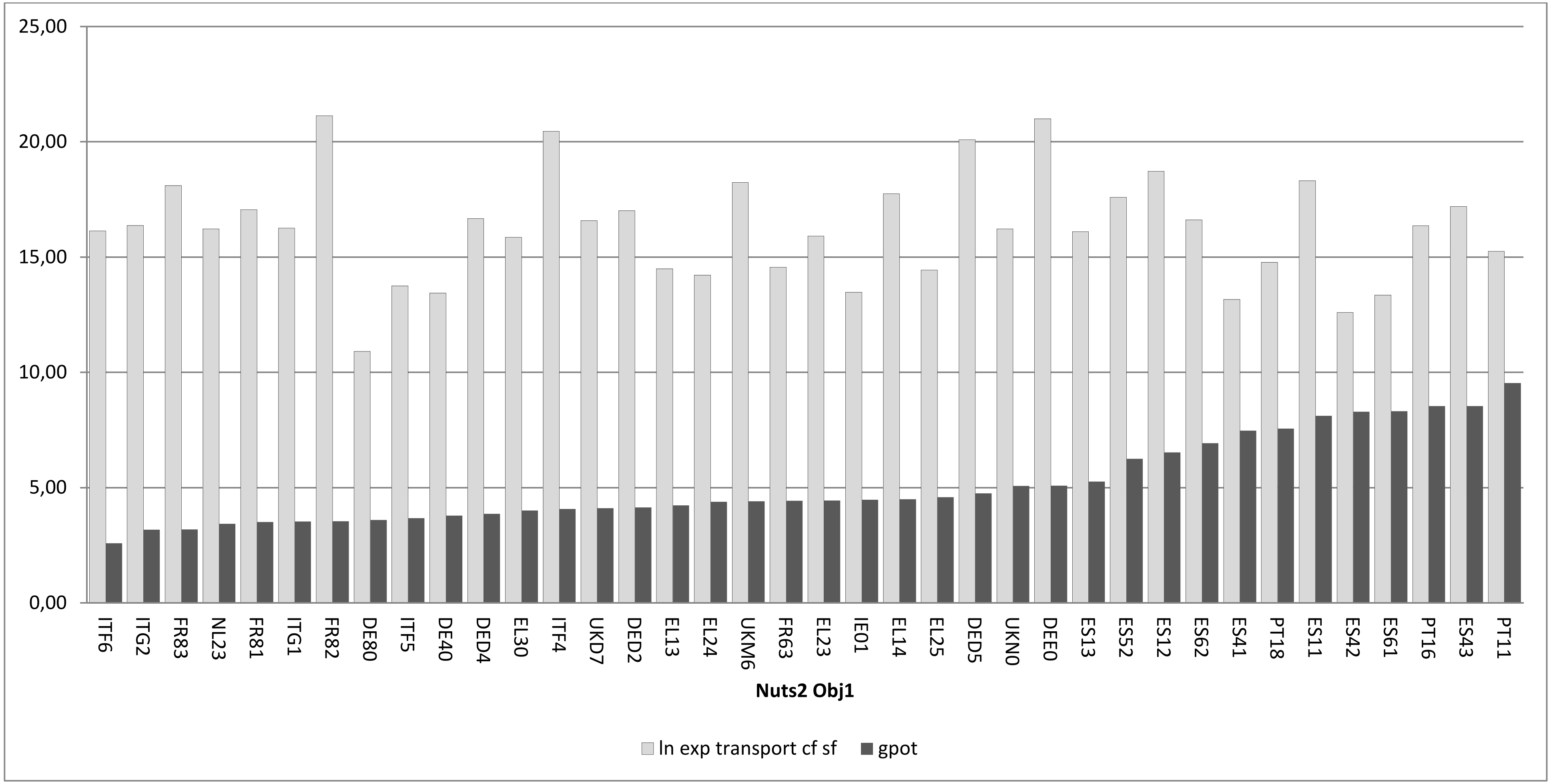
Source: our elaboration on DG Regional Policy data and OECD regpat data

Fig 4- Logarithm of the per capita certified expenditure in Transport (SF and CF) (2000-2006) and growth of Potential accessibility (POT) of road networks (2000-2012) for Objective 1 regions



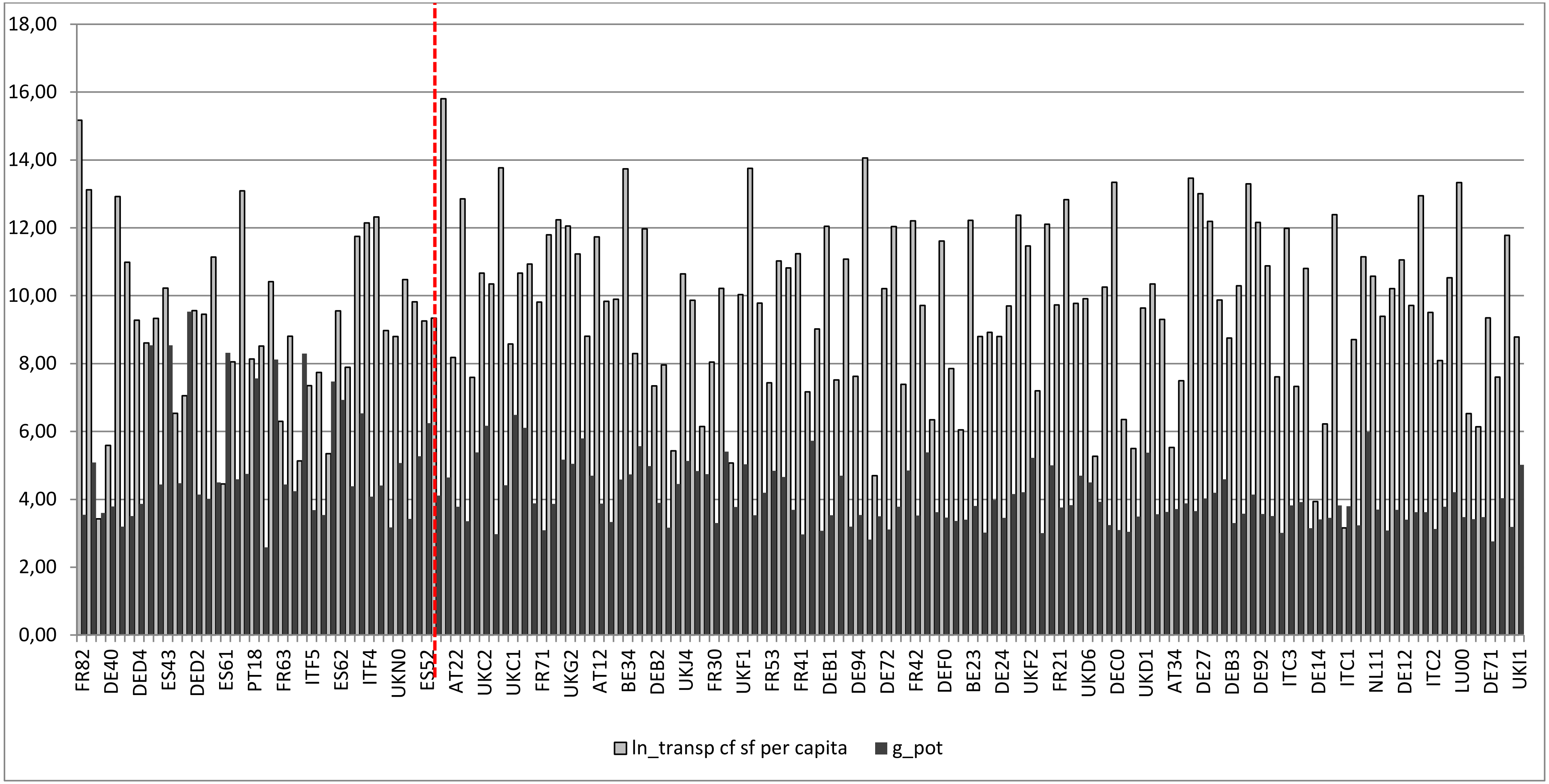
Source: our elaboration on DG Regional Policy data and Stelder (2014) data

Fig 5- Logarithm of the certified expenditure in Transport (SF and CF) (2000-2006) and growth of Potential accessibility (POT) of road networks (2000-2012) for Objective 1 regions



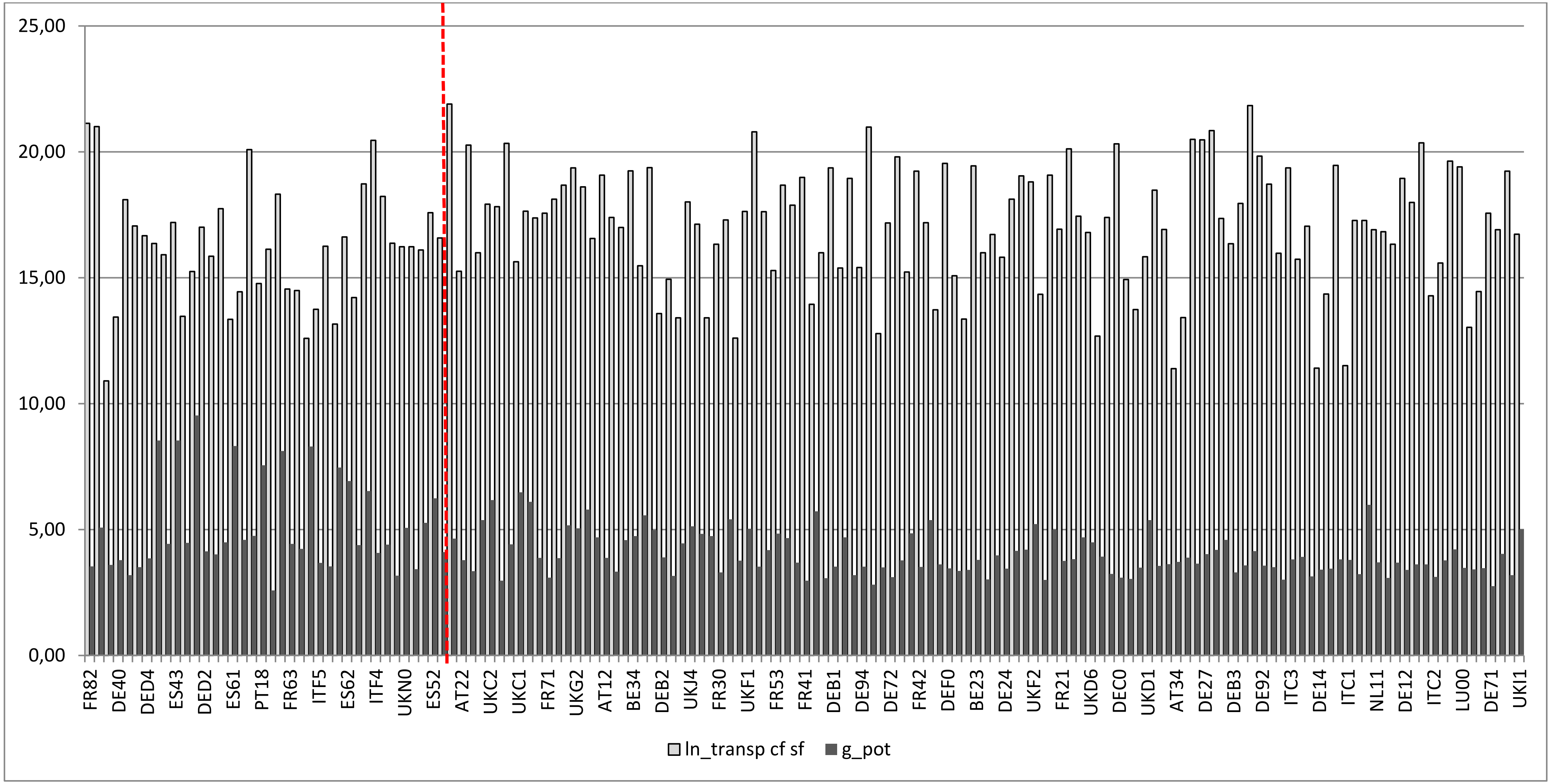
Source: our elaboration on DG Regional Policy data and Stelder (2014) data

Fig. 6- Logarithm of the per capita certified expenditure in Transport (SF e CF) (2000-2006) and growth of Potential accessibility (POT) of road networks (2000-2012) for treated and non treated regions



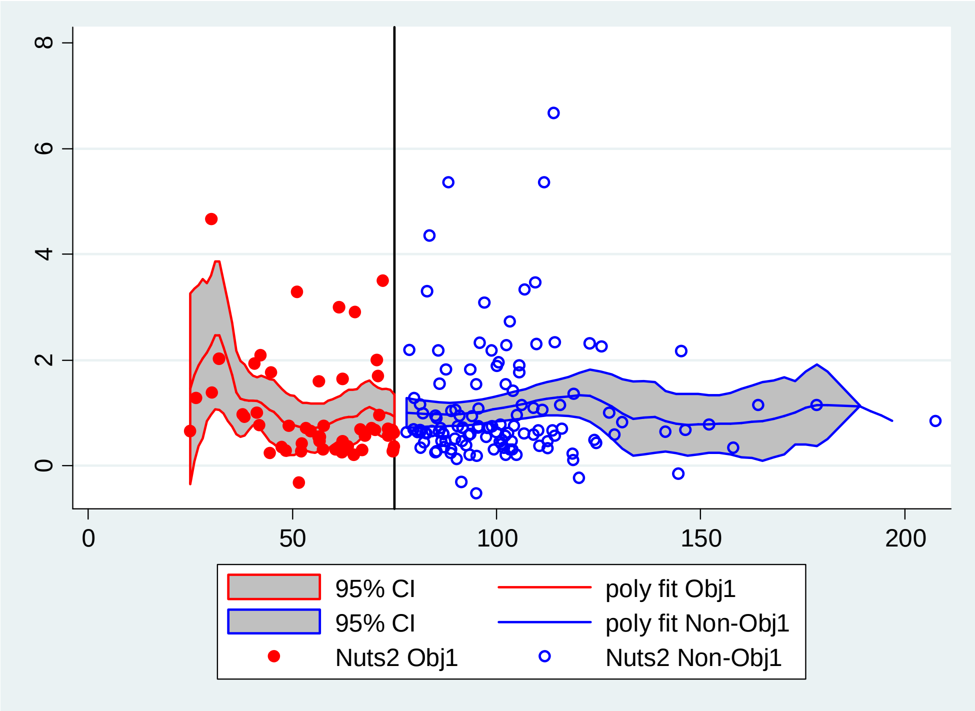
Source: our elaboration on DG Regional Policy data and Stelder (2014) data

Fig. 7: Logarithm of the certified expenditure in Transport (SF e CF) (2000-2006) and growth of Potential accessibility (POT) of road networks (2000-2012) for treated and non treated regions



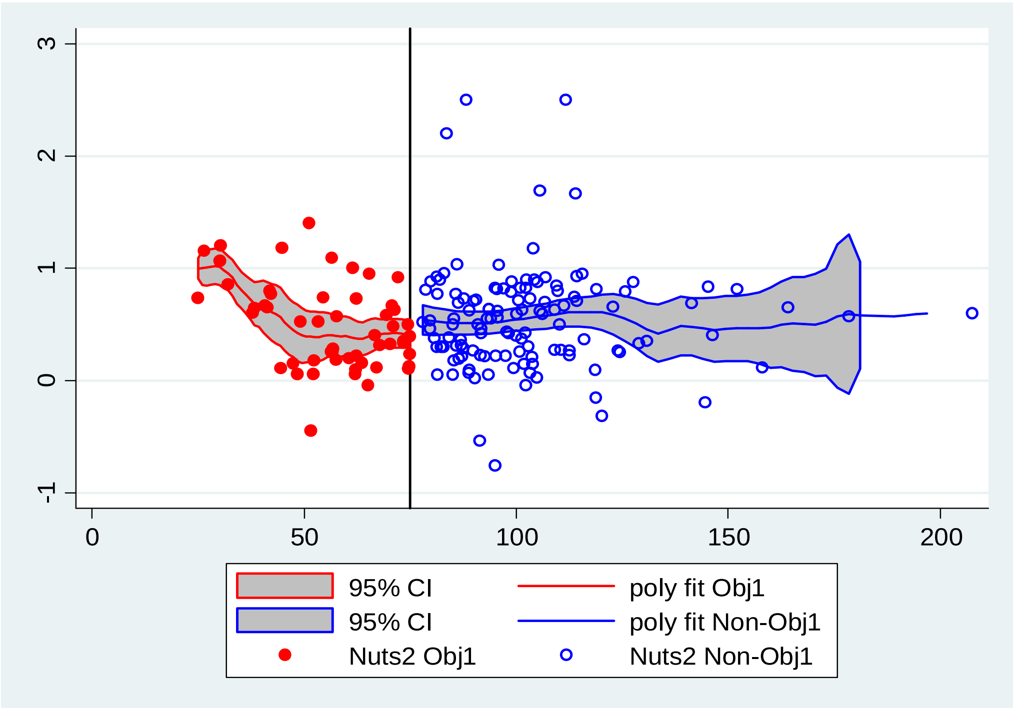
Source: our elaboration on DG Regional Policy data and Stelder (2014) data

Figure 8- Comparison of the annual average growth rate of per-capita GDP between the Objective 1 and non-Objective 1 regions, whole sample (1995-2010)



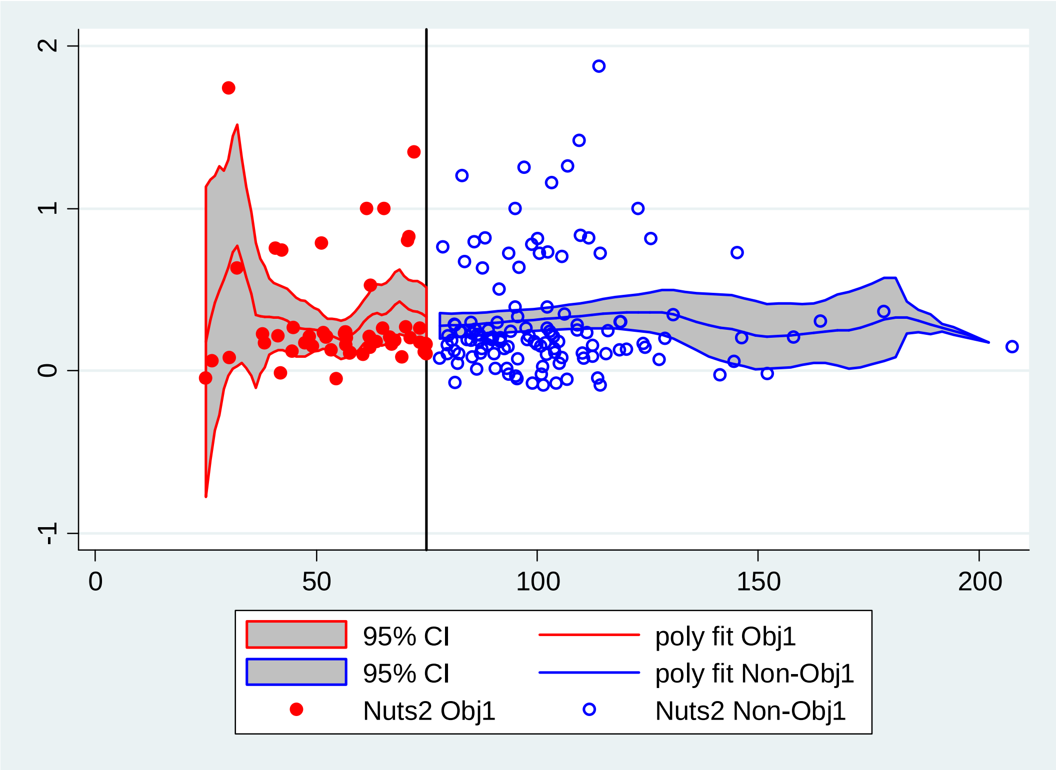
Source: our elaboration on European Commission and Eurostat data

Figure 9- Comparison of the annual average growth rate of per-capita GDP between the Objective 1 and non-Objective 1 regions, whole sample (1995-2003)



Source: our elaboration on European Commission and Eurostat data

Figure 10- Comparison of the annual average growth rate of per-capita GDP between the Objective 1 and non-Objective 1 regions, whole sample (2003-2010)



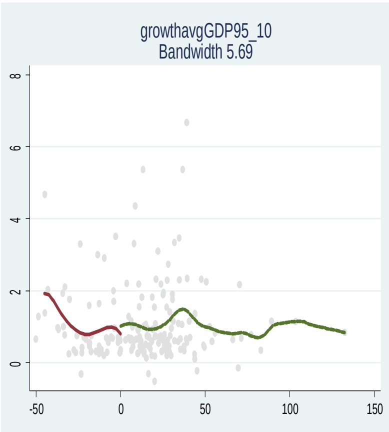
Source: our elaboration on European Commission and Eurostat data

Figure 11-Robustness check: Gaussian and Rectangular kernels, different bandwidths, cut-off=0

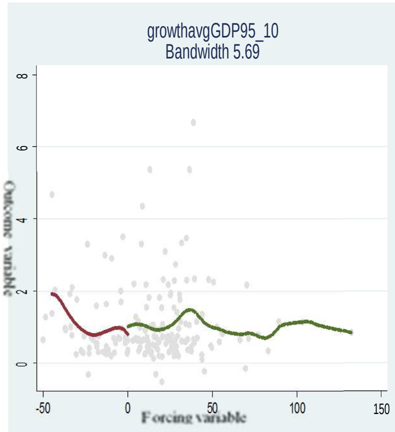
Bandwidth

Optimal	Half	Double

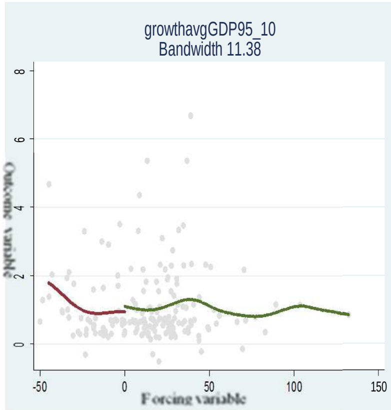
Gaussian kernel



(a)

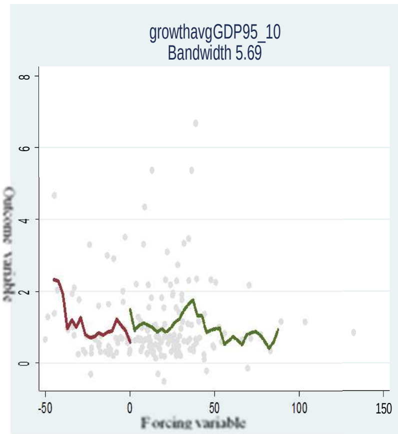


(b)

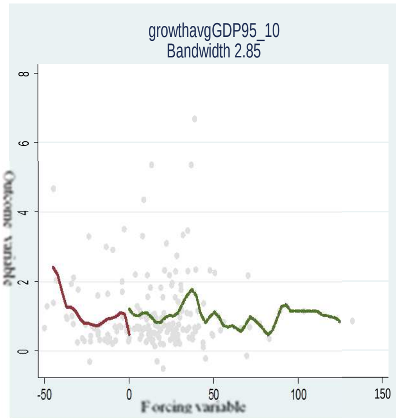


(c)

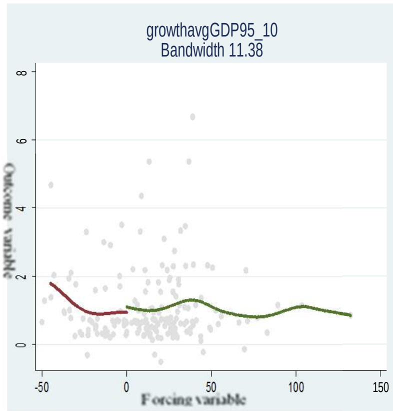
Rectangular kernel



(d)



(e)



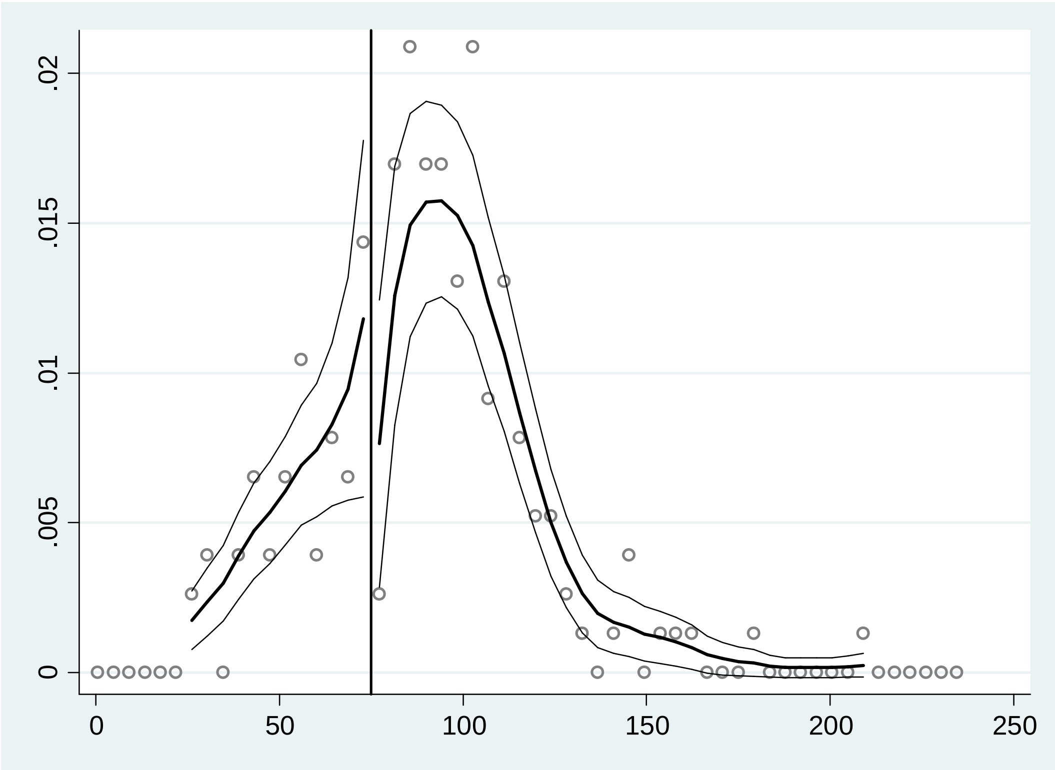
(f)

Outcome variable: annual average growth rate per-capita GDP (1995-2010);

Forcing variable (per-capita GDP in pps, 75%EU15=0, 1988-90)

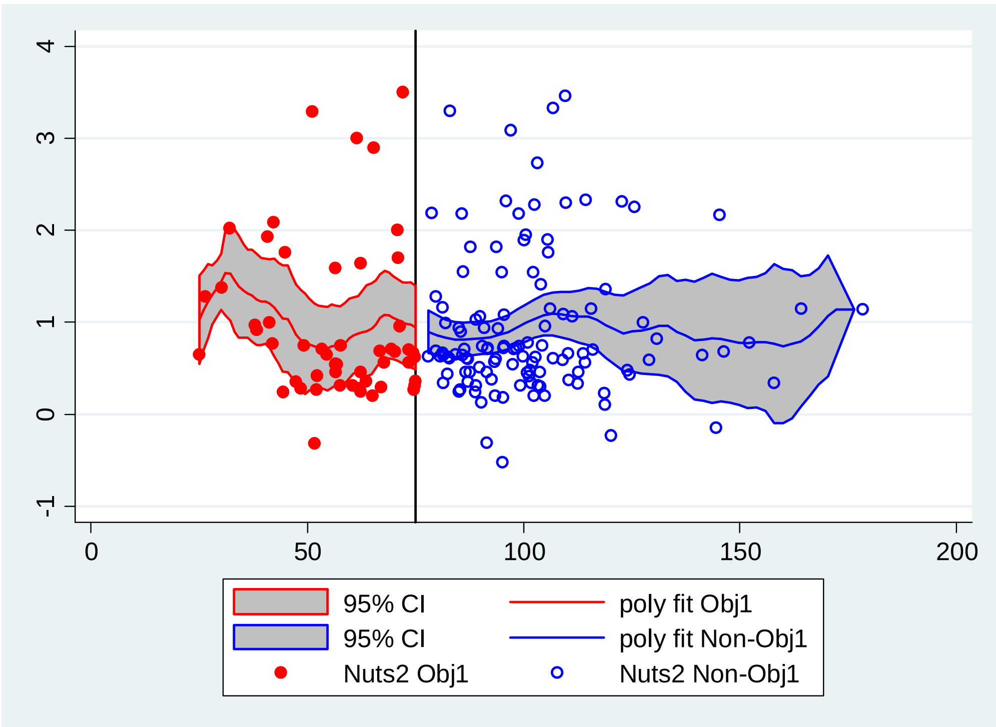
Source: our elaboration on European Commission and Eurostat data

Figure 12- Estimation of the density function of the forcing variable (GDP per capita in PPS, average 1988-1990) at the threshold, whole sample GDP (180 NUTS 2)



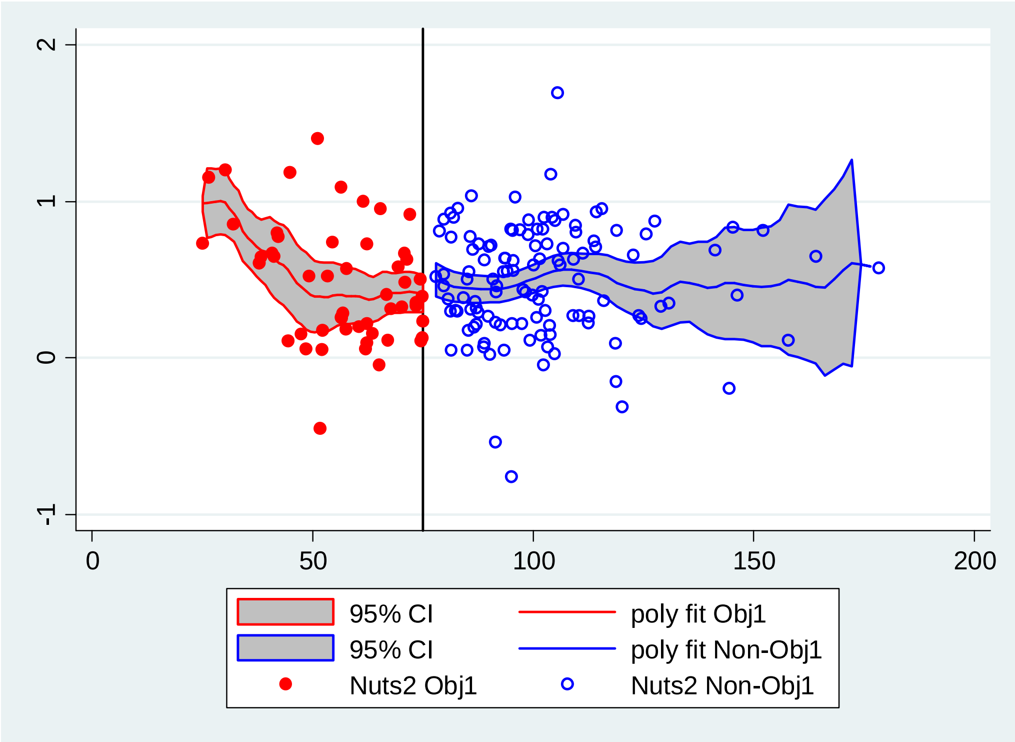
Source: our elaboration on European Commission and Eurostat data

Figure 13- Comparison of the annual average growth rate of per-capita GDP between the Objective 1 and non-Objective 1 regions, sample GDP 1 (1995-2010)



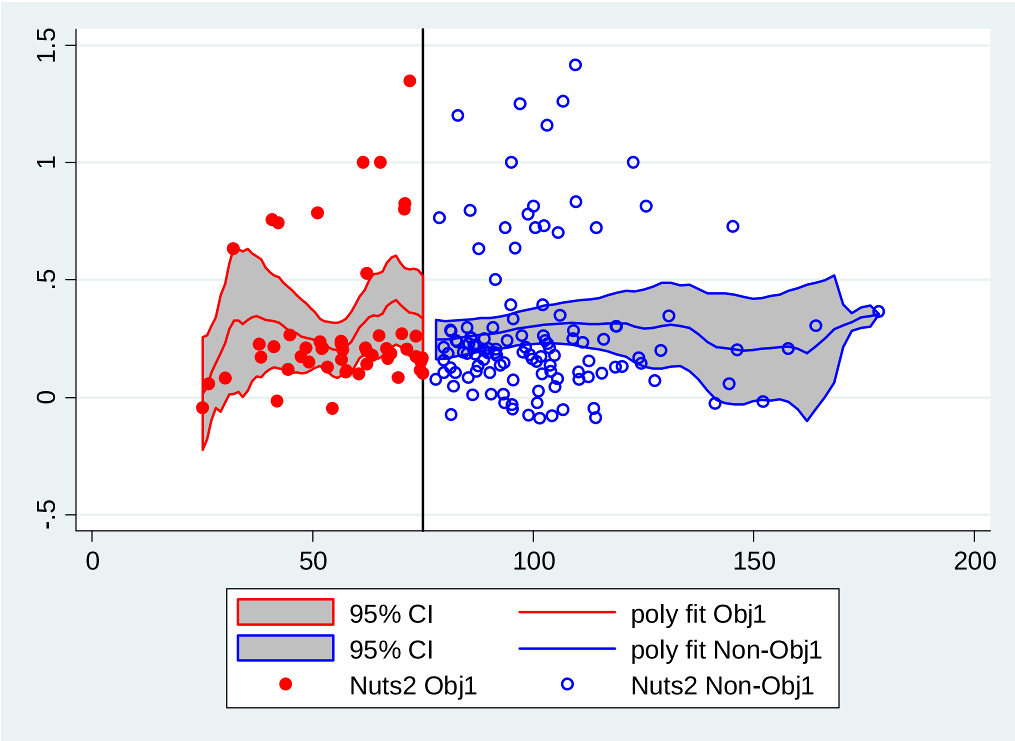
Source: our elaboration on European Commission and Eurostat data

Figure 14- Comparison of the annual average growth rate of per-capita GDP between the Objective 1 and non-Objective 1 regions, sample GDP 1 (1995-2003)



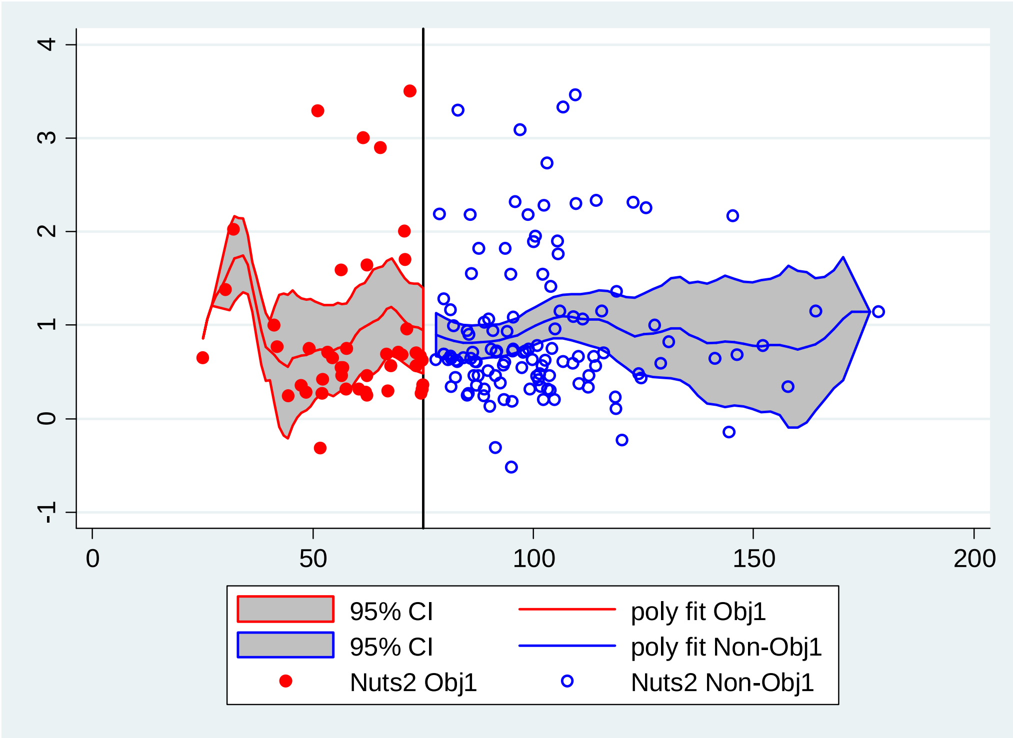
Source: our elaboration on European Commission and Eurostat data

Figure 15- Comparison of the annual average growth rate of per-capita GDP between the Objective 1 and non-Objective 1 regions, sample GDP 1 (2003-2010)



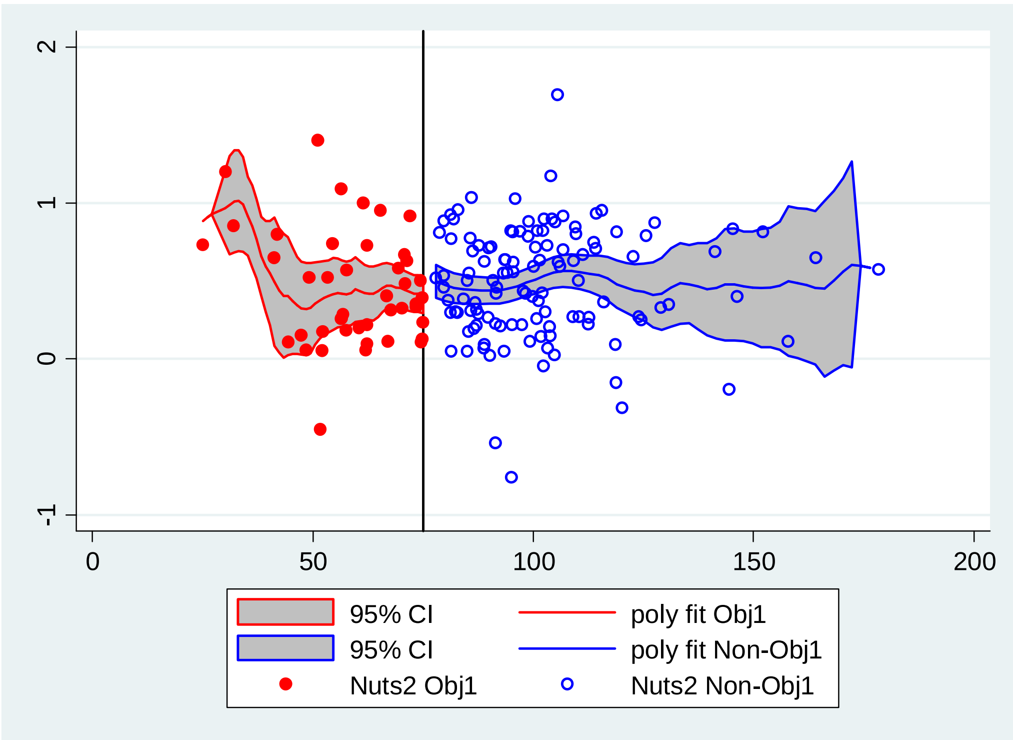
Source: our elaboration on European Commission and Eurostat data

Figure 16- Comparison of the annual average growth rate of per-capita GDP between the Objective 1 and non-Objective 1 regions, sample GDP 2 (1995-2010)



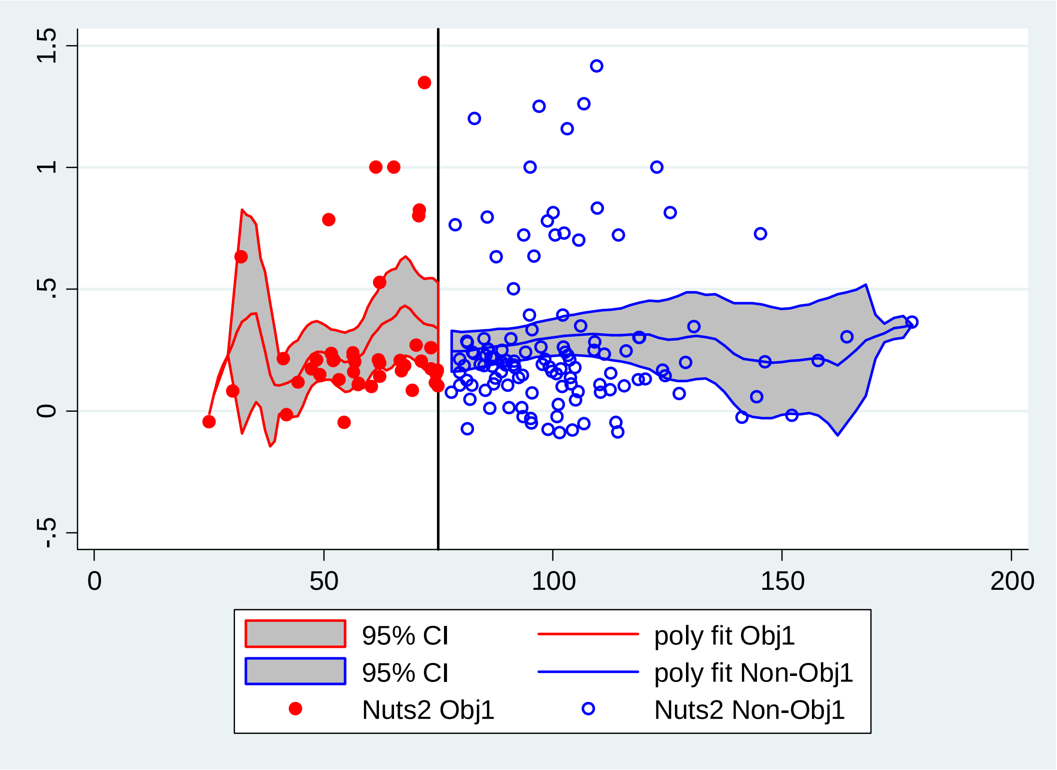
Source: our elaboration on European Commission and Eurostat data

Figure 17- Comparison of the annual average growth rate of per-capita GDP between the Objective 1 and non-Objective 1 regions, sample GDP 2 (1995-2003)



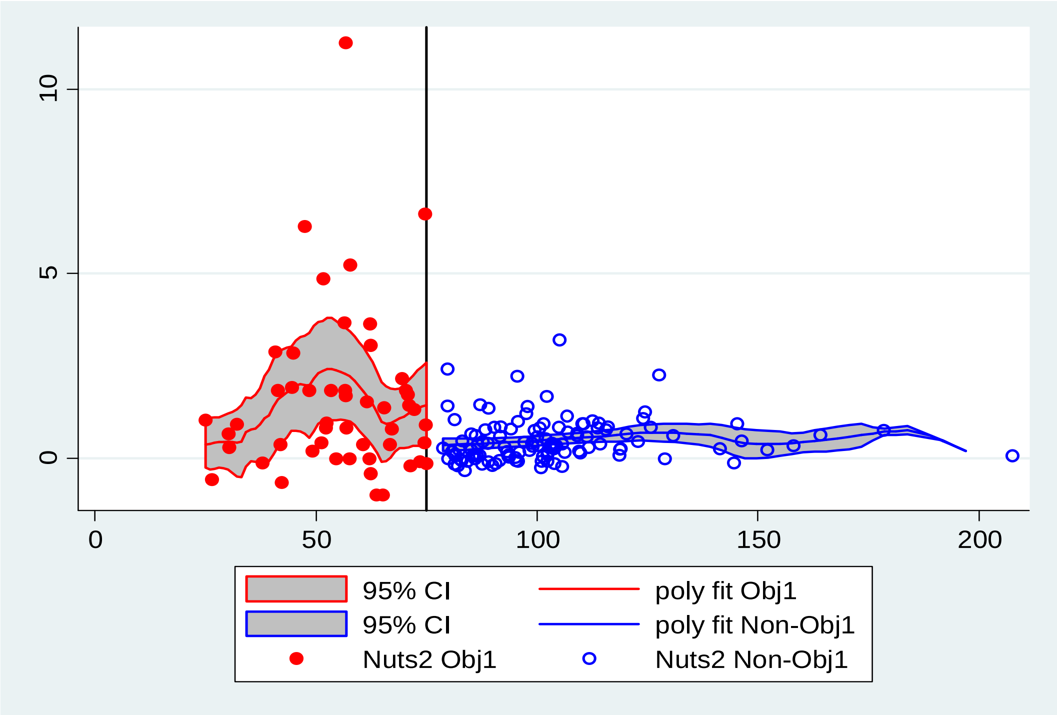
Source: our elaboration on European Commission and Eurostat data

Figure 18- Comparison of the annual average growth rate of per-capita GDP between the Objective 1 and non-Objective 1 regions, sample GDP 2 (2003-2010)



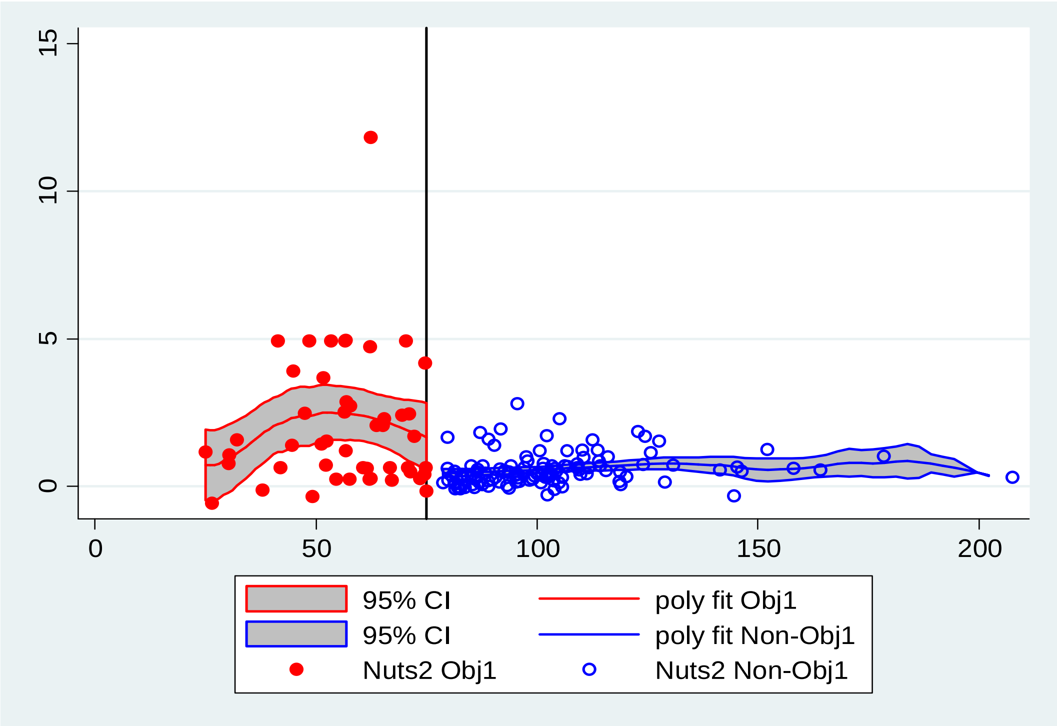
Source: our elaboration on European Commission and Eurostat data

Fig 19- Comparison of the growth rate in patent applications between the Objective 1 and non Objective 1 regions, whole sample, (1999-2010)



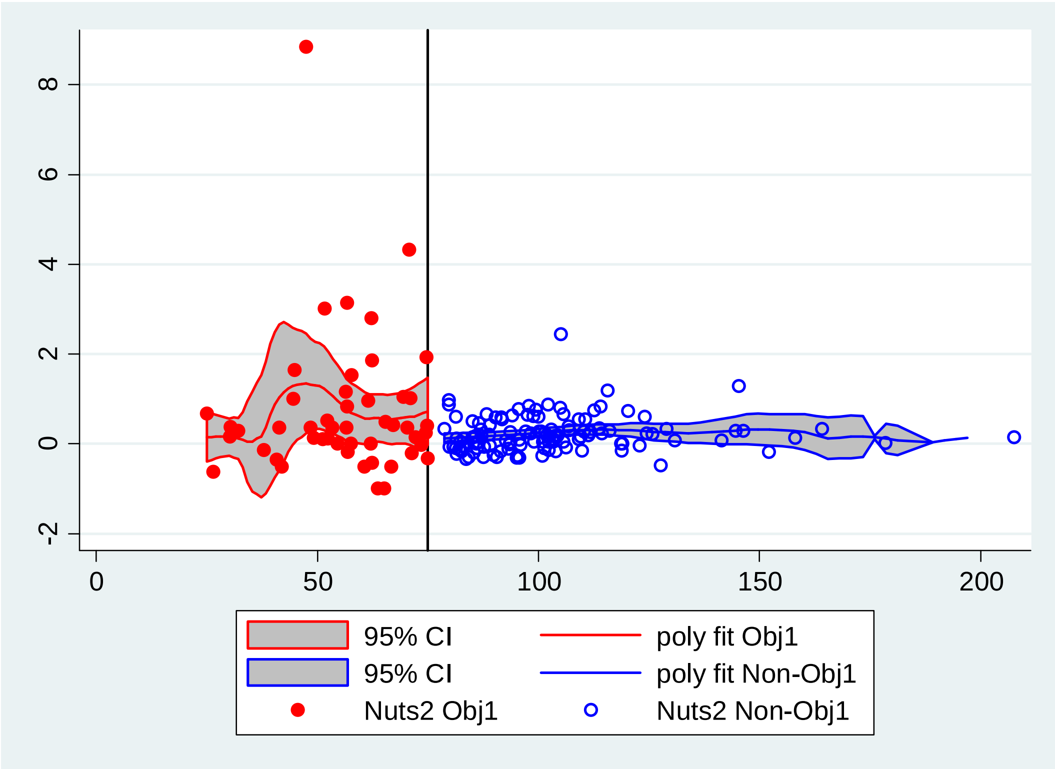
Source: Our elaboration on European Commission and OECD data

Fig 20- Comparison of the growth rate in patent applications between the Objective 1 and non Objective 1 regions, whole sample, (1999-2007)



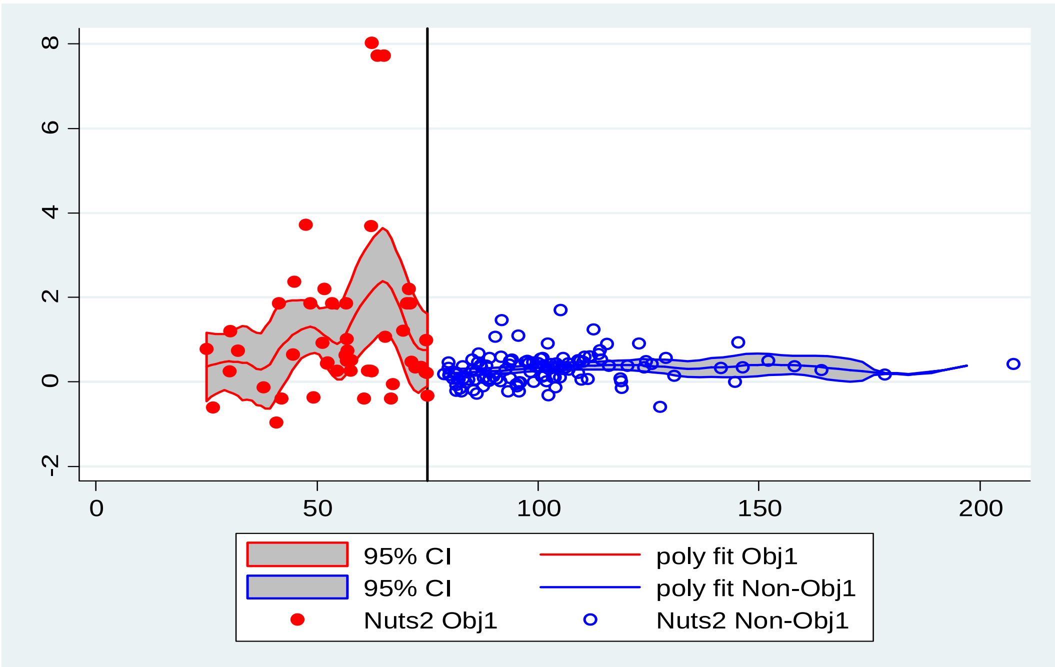
Source: Our elaboration on European Commission and OECD data

Fig 21- Comparison of the growth rate in patent applications between the Objective 1 and non Objective 1 regions, whole sample, (2002-2010)



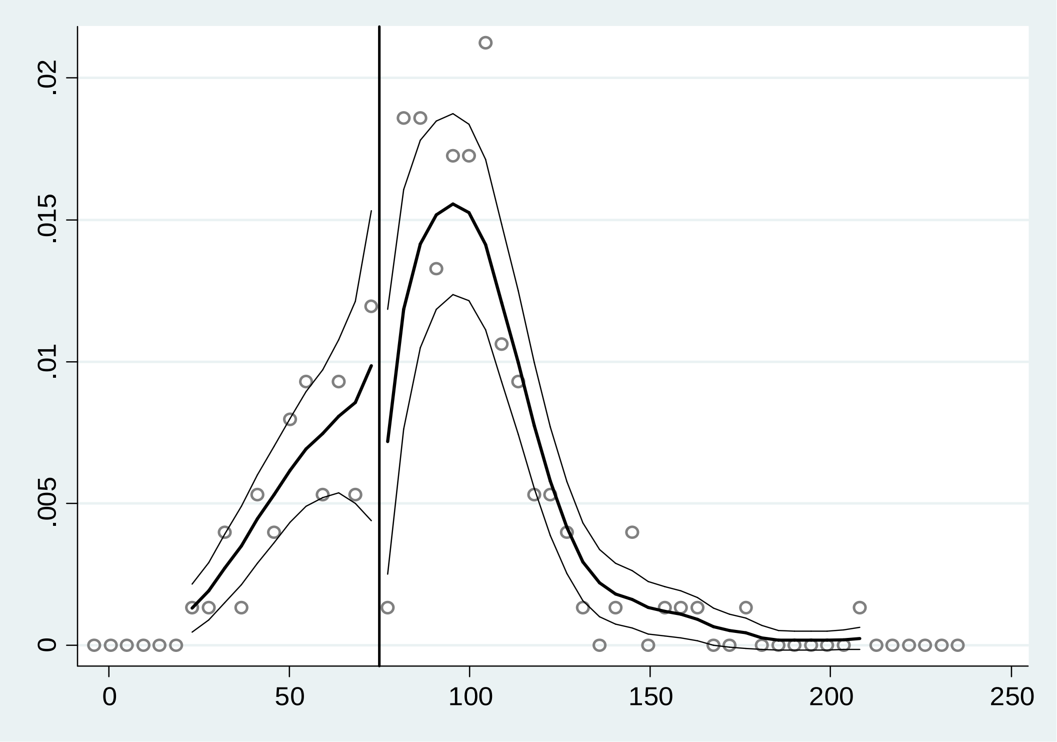
Source: Our elaboration on European Commission and OECD data

Fig 22- Comparison of the growth rate in patent applications between the Objective 1 and non Objective 1 regions, whole sample, (2002-2007)



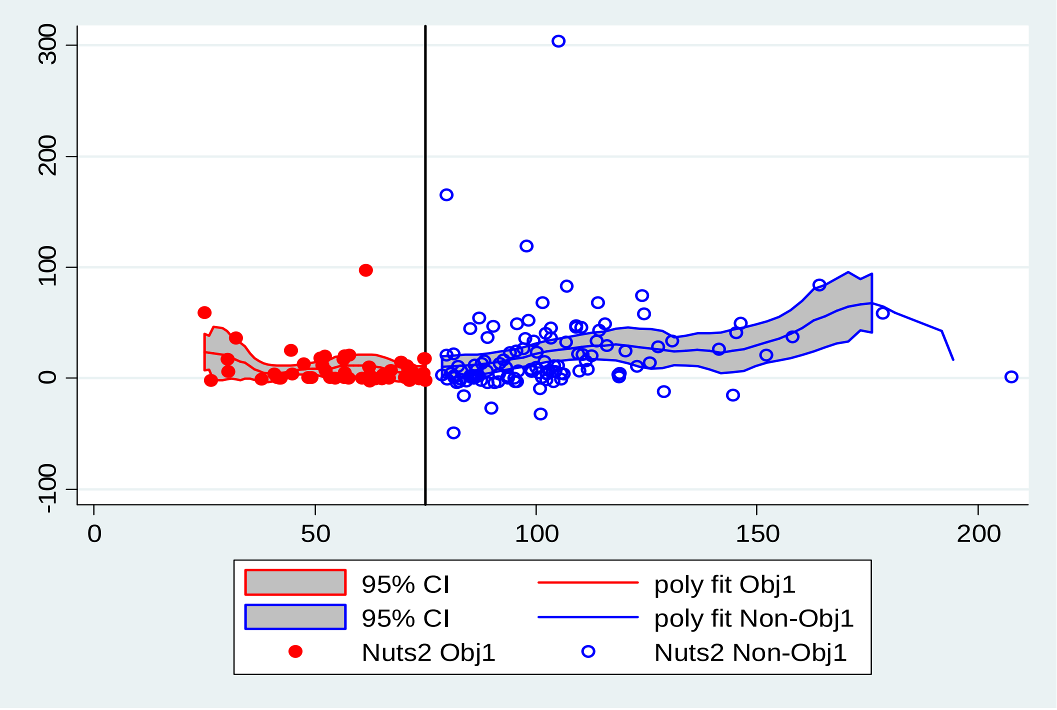
Source: Our elaboration on European Commission and OECD data

Fig. 23: Estimation of the density function of the forcing variable (GDP per capita in PPS, average 1988-1990) at the threshold, whole sample



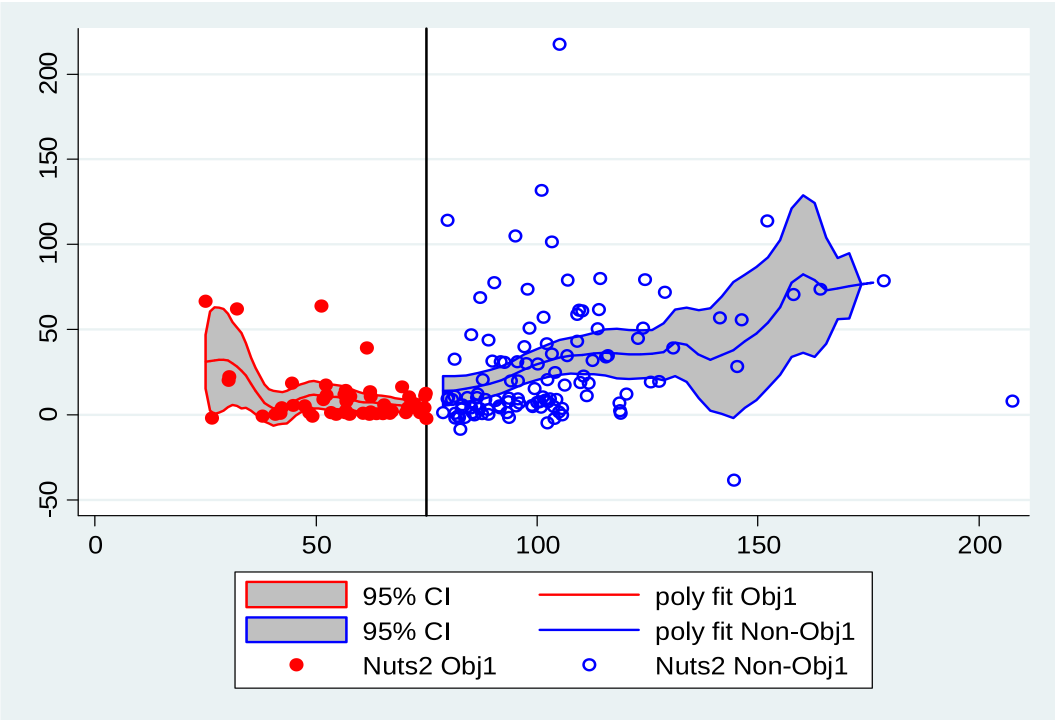
Source: Our elaboration on European Commission and Eurostat data

Fig 24- Comparison of the difference in levels in patent applications between the Objective 1 and non Objective 1 regions, whole sample, (1999-2010)



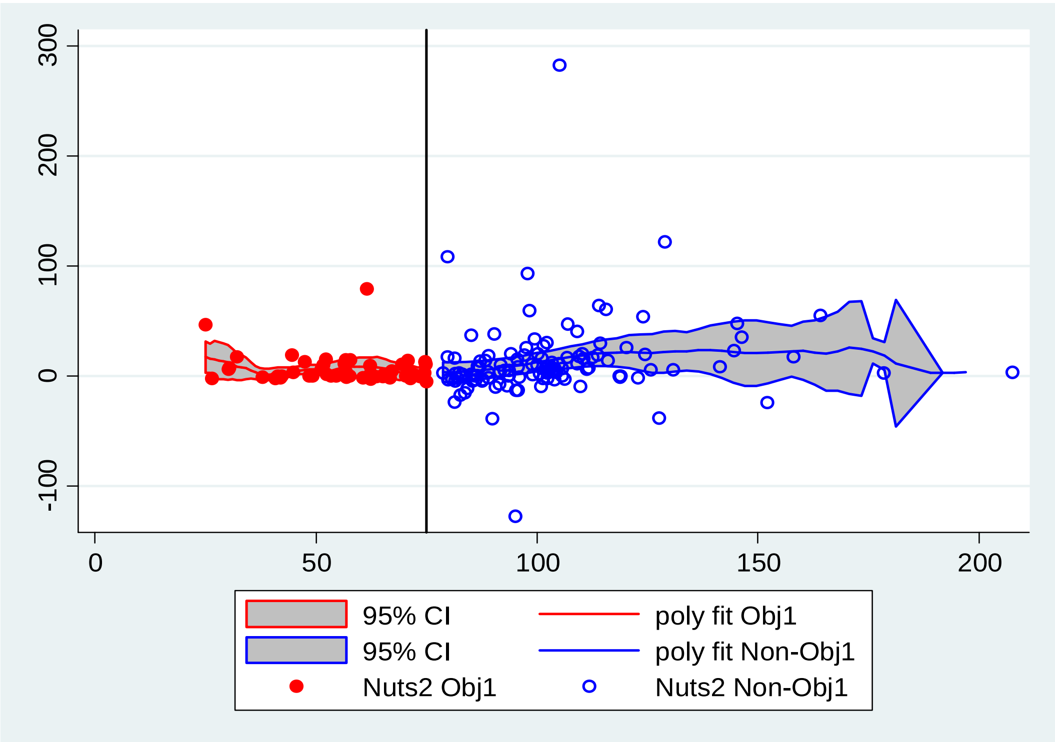
Source: Our elaboration on European Commission and OECD data

Fig 25- Comparison of the difference in levels in patent applications between the Objective 1 and non Objective 1 regions, whole sample, (1999-2007)



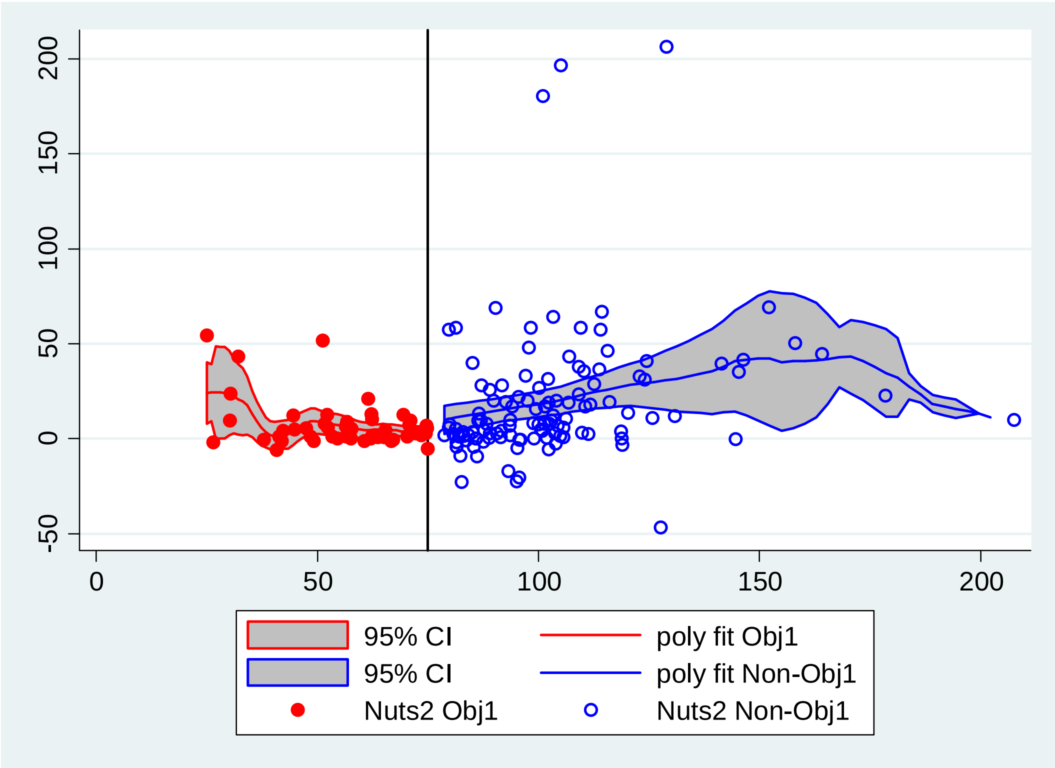
Source: Our elaboration on European Commission and OECD data

Fig 26- Comparison of the difference in levels in patent applications between the Objective 1 and non Objective 1 regions, whole sample, (2002-2010)



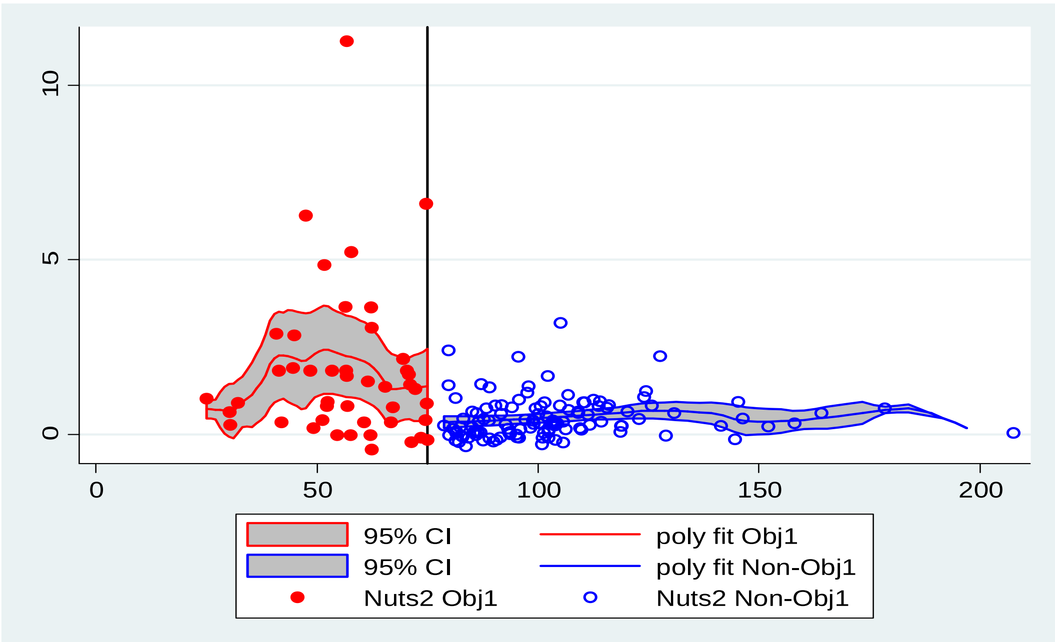
Source: Our elaboration on European Commission and OECD data

Fig 27- Comparison of the difference in levels in patent applications between the Objective 1 and non Objective 1 regions, whole sample, (2002-2007)



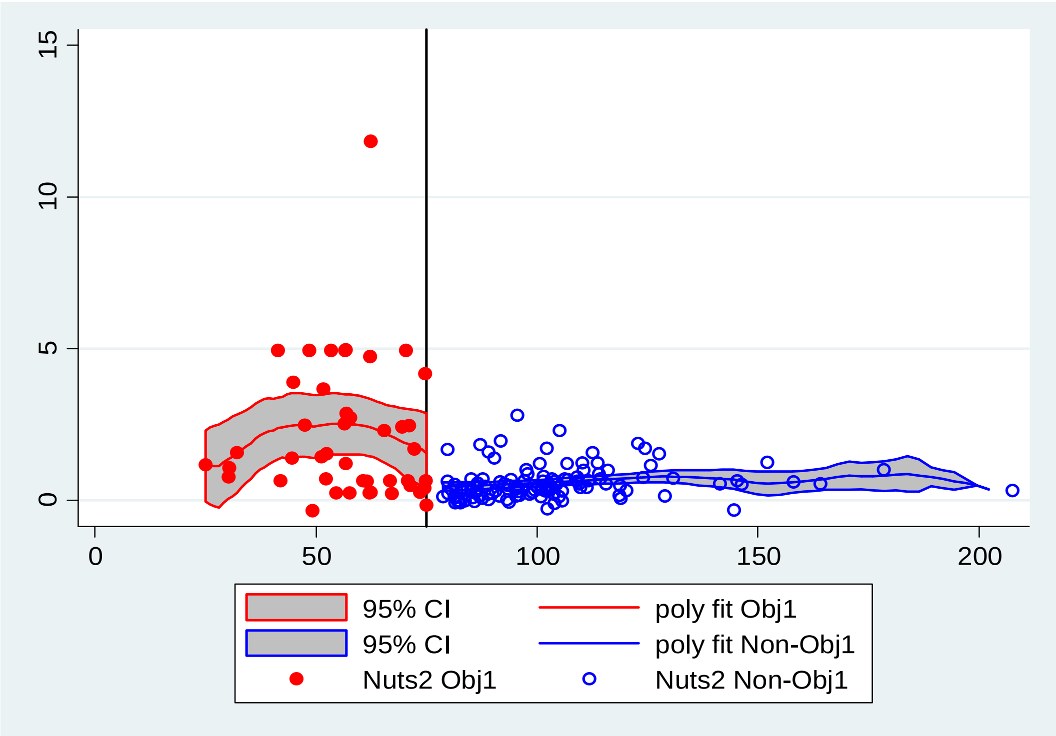
Source: Our elaboration on European Commission and OECD data

Fig 28- Comparison of the growth rate in patent applications between the Objective 1 and non Objective 1 regions, sample R1, (1999-2010)



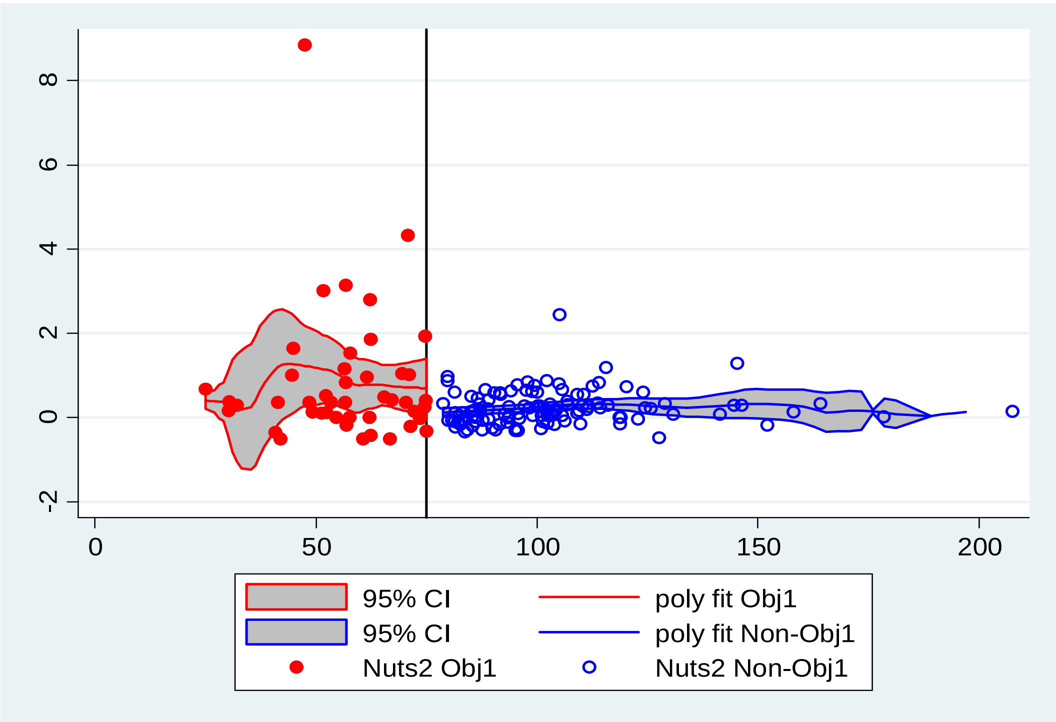
Source: Our elaboration on European Commission and OECD dat

Fig 29- Comparison of the growth rate in patent applications between the Objective 1 and non Objective 1 regions, sample R1, (1999-2007)



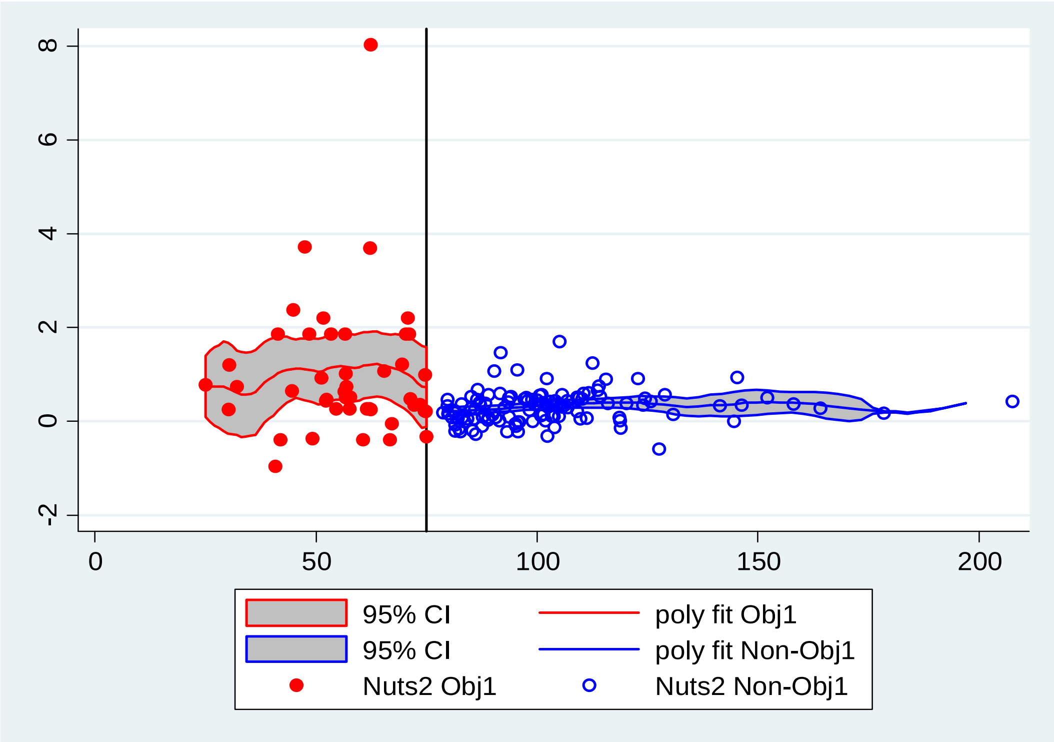
Source: Our elaboration on European Commission and OECD data

Fig 30- Comparison of the growth rate in patent applications between the Objective 1 and non Objective 1 regions, sample R1, (2002-2010)



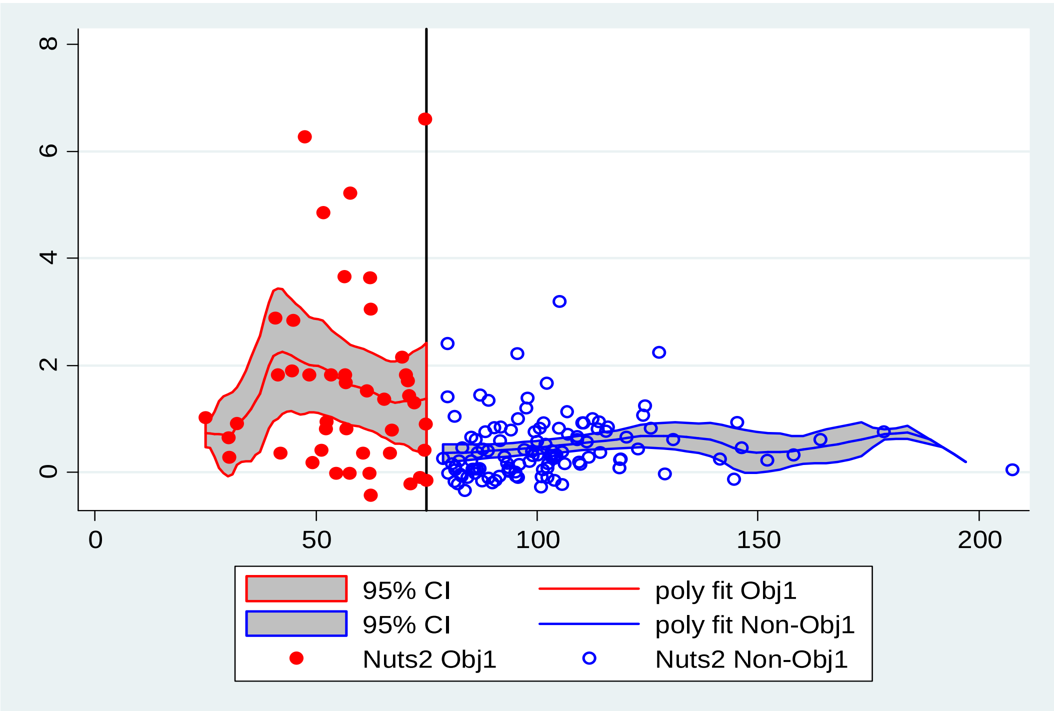
Source: Our elaboration on European Commission and OECD data

Fig 31- Comparison of the growth rate in patent applications between the Objective 1 and non Objective 1 regions, sample R1, (2002-2010)



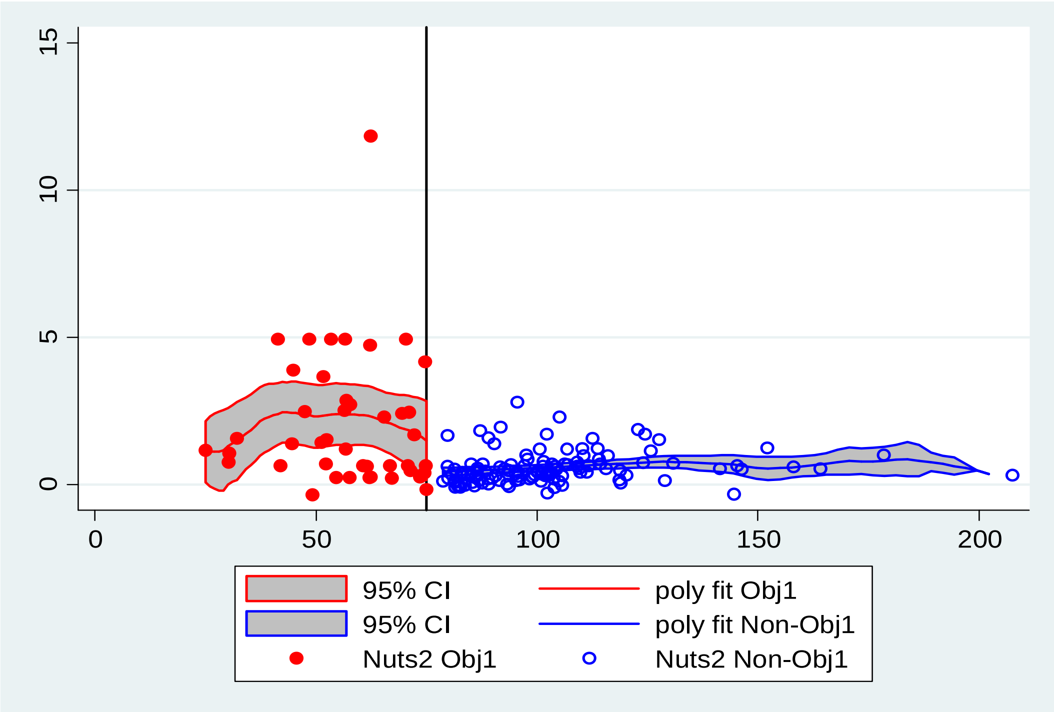
Source: Our elaboration on European Commission and OECD data

Fig 32- Comparison of the growth rate in patent applications between the Objective 1 and non Objective 1 regions, sample R2, (1999-2010)



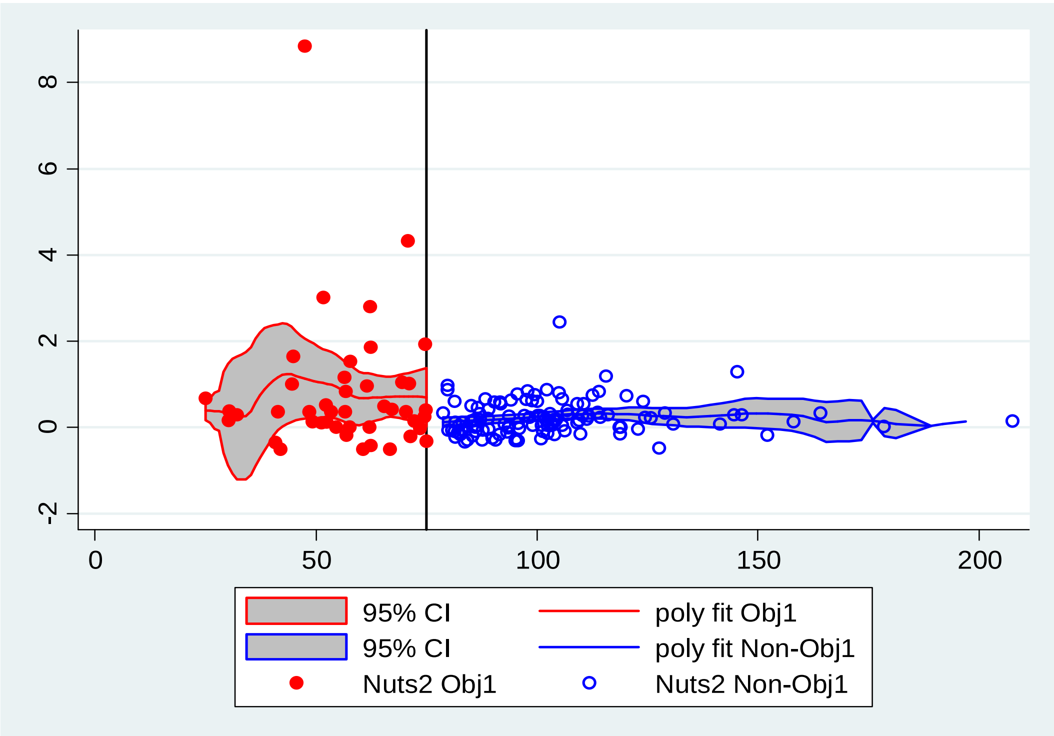
Source: Our elaboration on European Commission and OECD data

Fig 33- Comparison of the growth rate in patent applications between the Objective 1 and non Objective 1 regions, sample R2, (1999-2007)



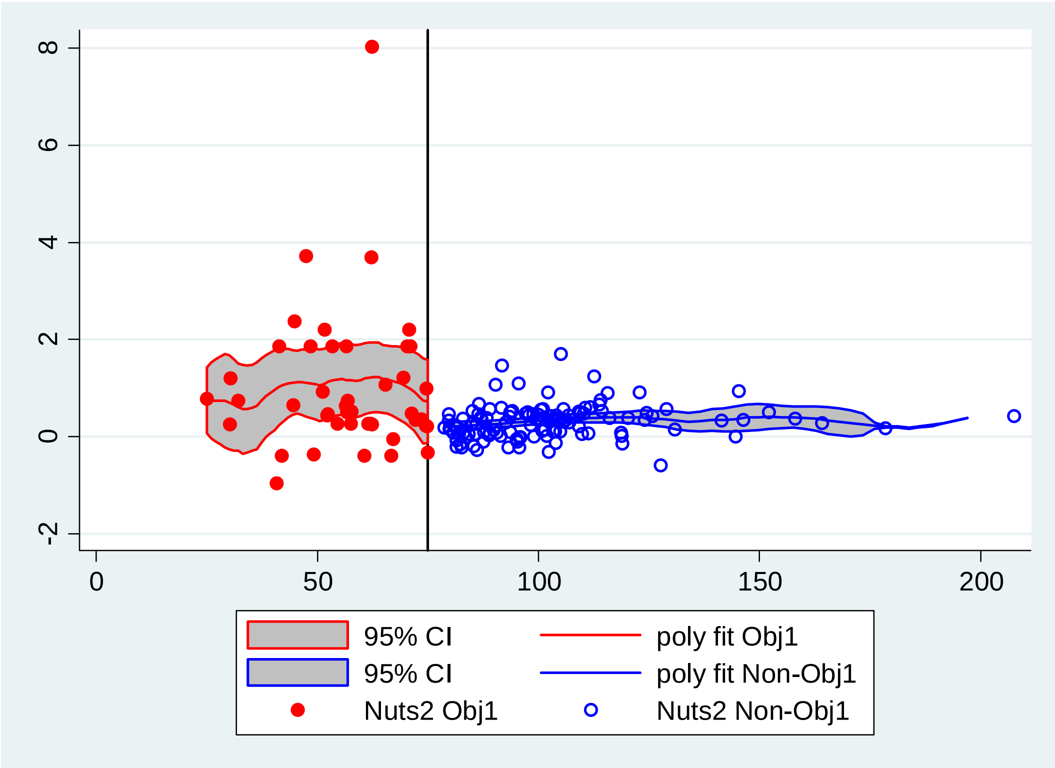
Source: Our elaboration on European Commission and OECD data

Fig 34- Comparison of the growth rate in patent applications between the Objective 1 and non Objective 1 regions, sample R2, (2002-2010)



Source: Our elaboration on European Commission and OECD data

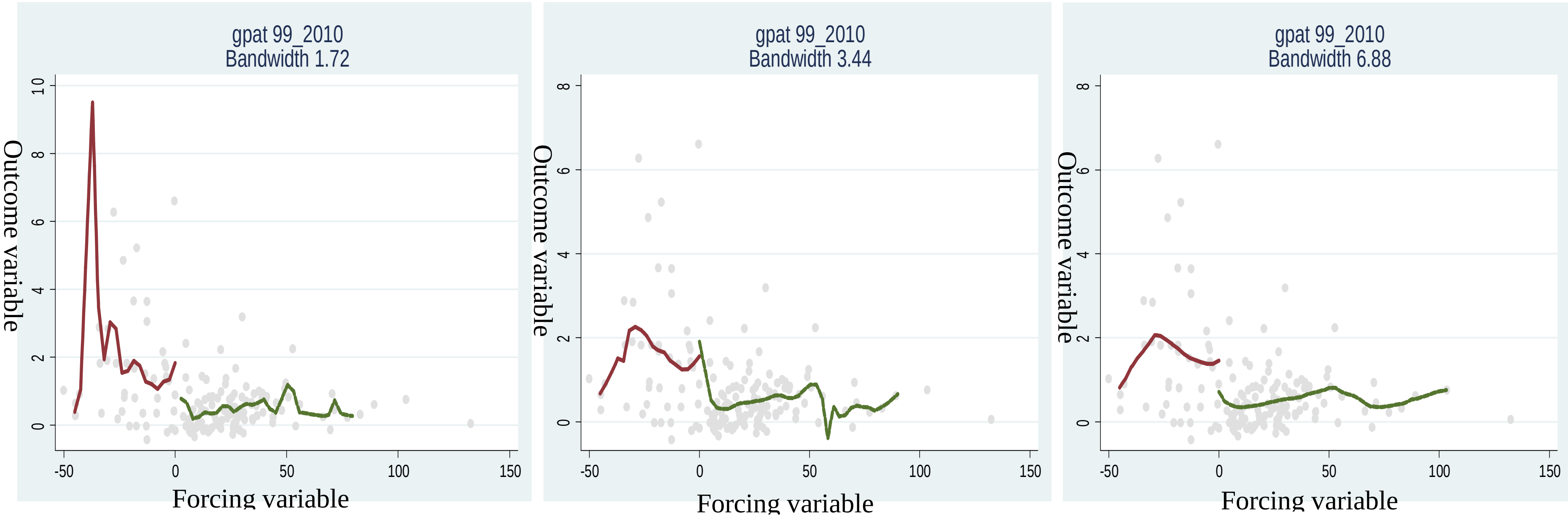
Fig 35- Comparison of the growth rate in patent applications between the Objective 1 and non Objective 1 regions, sample R2, (2002-2007)



Source: Our elaboration on European Commission and OECD data

Fig 36-Robustness check: Epanechnikov kernel, different bandwidths, cut-off=0.

Outcome variable: patent applications growth rate (1999-2010), forcing variable (GDP per capita in PPS (75%EU15=0), 1988-90)

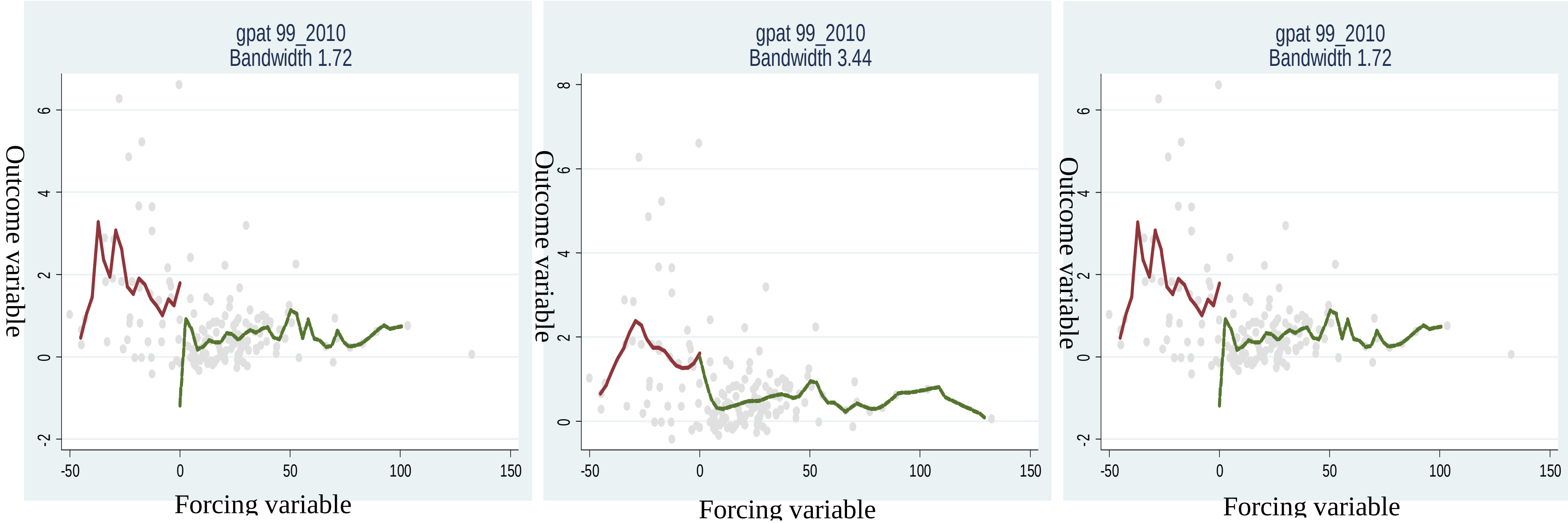


(a) half bandwidth (b)optimal bandwidth (c) double bandwidth

Source: Our elaboration on DG Regio and OECD data

Fig 37-Robustness check: Gaussian kernel, different bandwidths, cut-off=0.

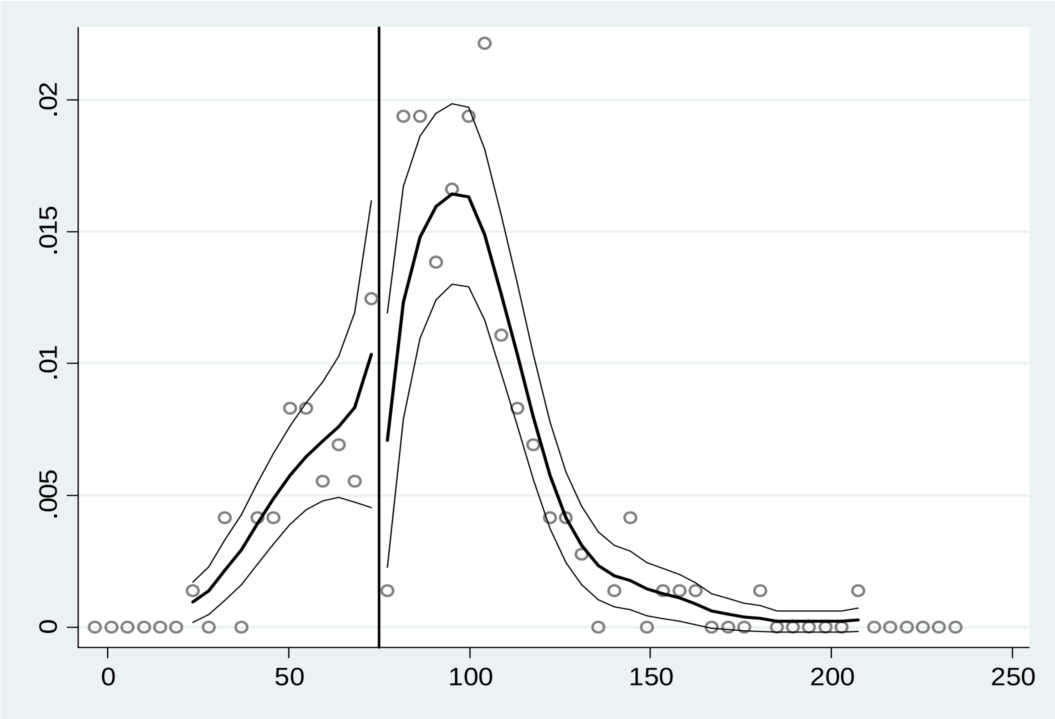
Outcome variable: patent applications growth rate (1999-2010), forcing variable (GDP per capita in PPS (75%EU15=0), 1988-90)



(a) half bandwidth (b)optimal bandwidth (c) double bandwidth

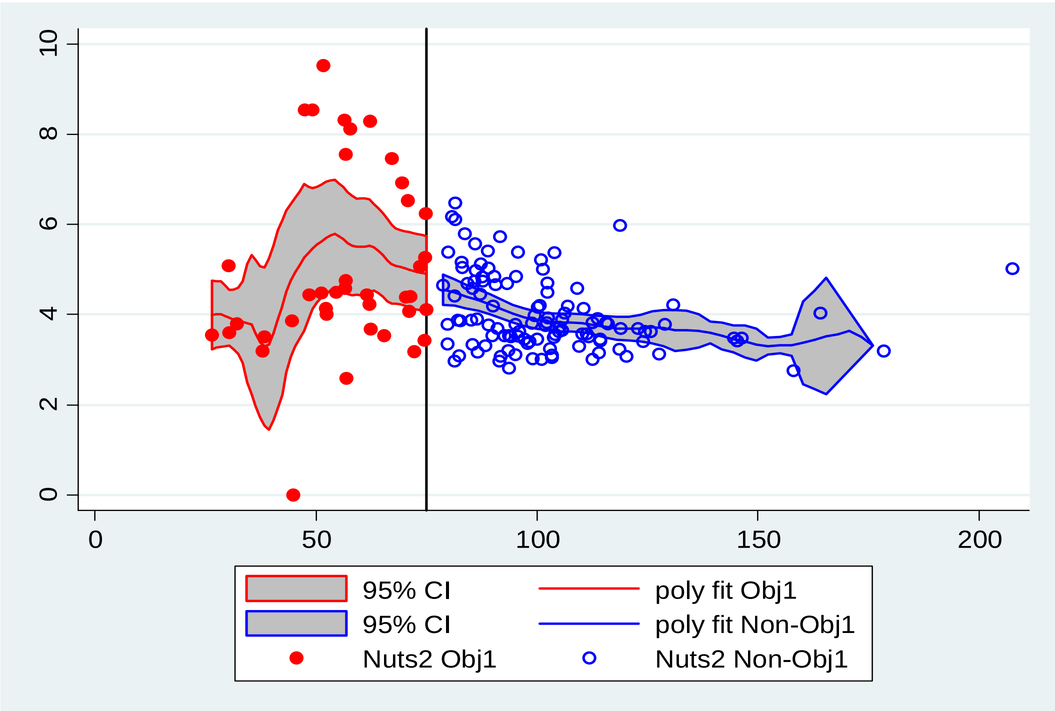
Source: Our elaboration on DG Regio and OECD data

Fig 38- Estimation of the density function of the forcing variable (GDP per capita in PPS, average 1988-1990) at the threshold, sample R2



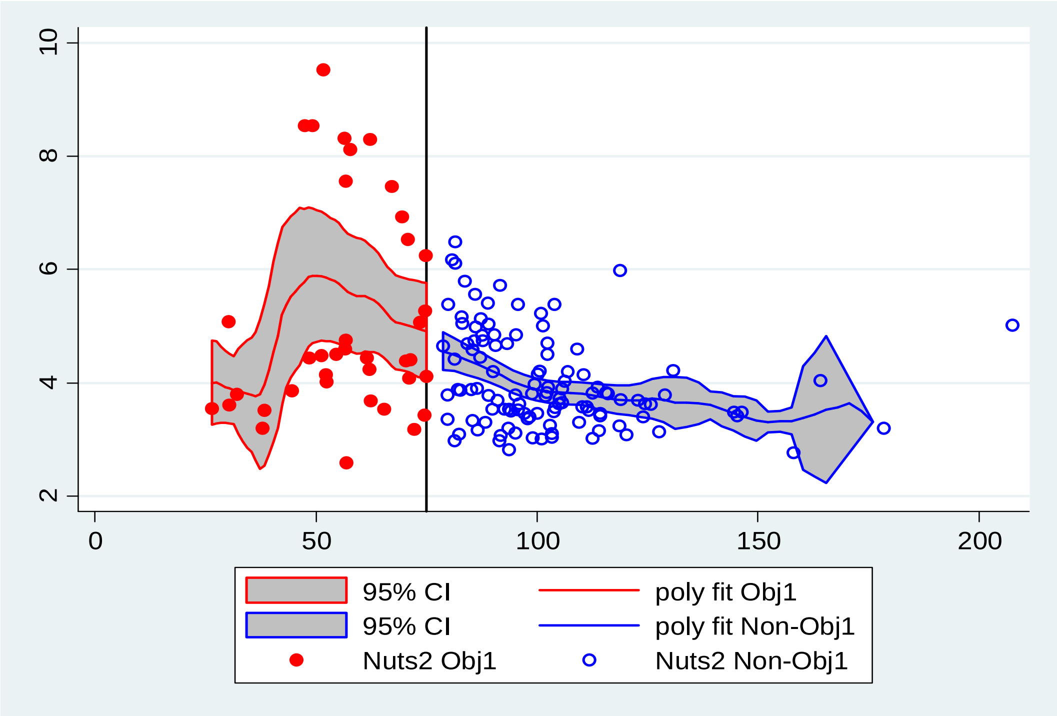
Source: Our elaboration on European Commission and Eurostat data

Fig 39- Comparison of the growth rate in potential road accessibility between the Objective 1 and non objective 1 regions, whole sample, (2000-2012)



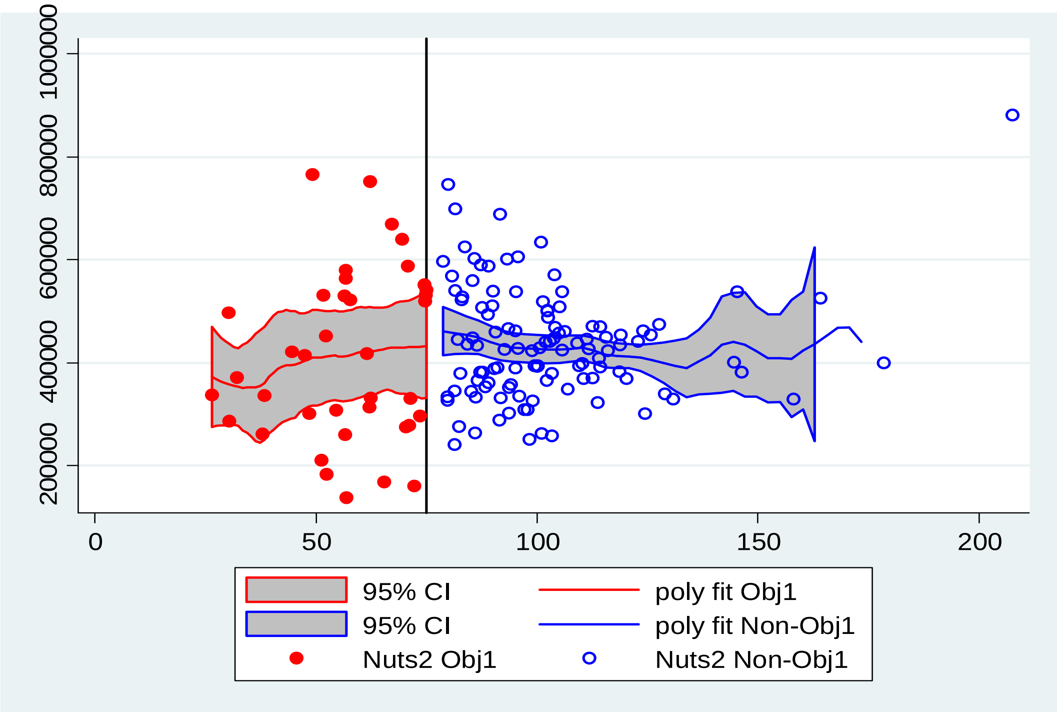
Source: our elaboration on European Commission and Stelder (2014) data

Fig 40- Comparison of the growth rate in potential road accessibility between the Objective 1 and non objective 1 regions, sample TR1, (2000-2012)



Source: our elaboration on European Commission and Stelder (2014) data

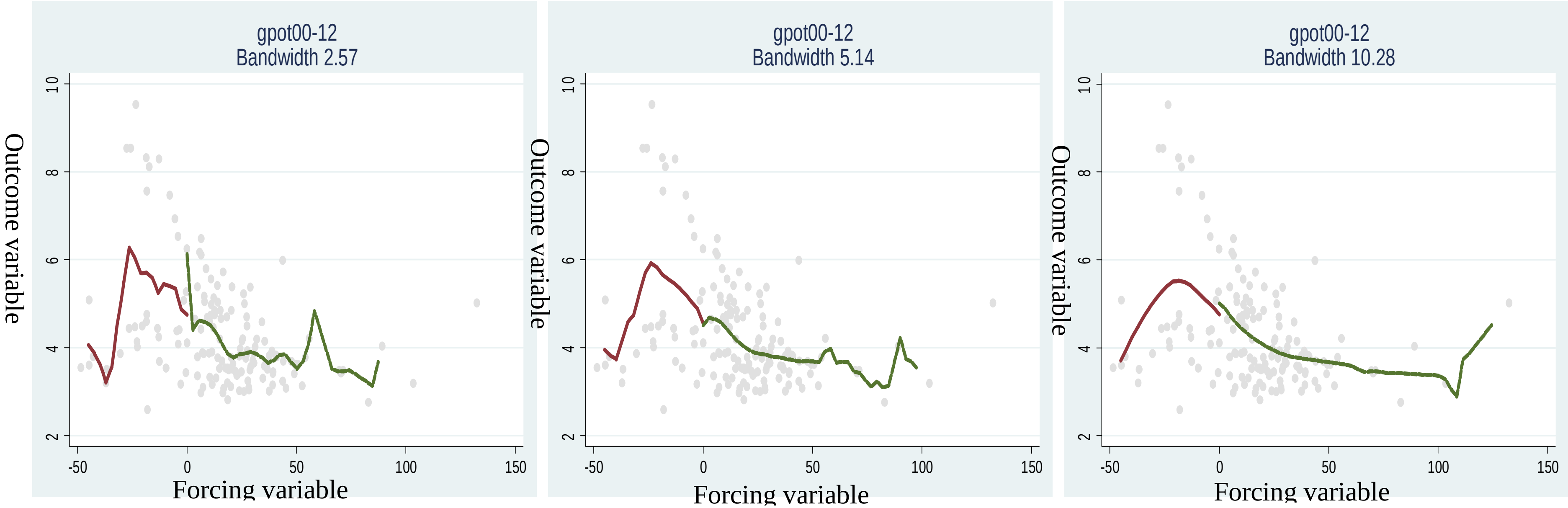
Fig 41- Comparison of the difference in levels in potential road accessibility between the Objective 1 and non objective 1 regions, sample TR1, (2000-2012)



Source: our elaboration on European Commission and Stelder (2014) data

Fig 42- Robustness check: Epanechnikov kernel, different bandwidths, cut-off=0.

Outcome variable: road road accessibility growth rate (2000-2012), forcing variable (GDP per capita in PPS (75%EU15=0), 1988-90)

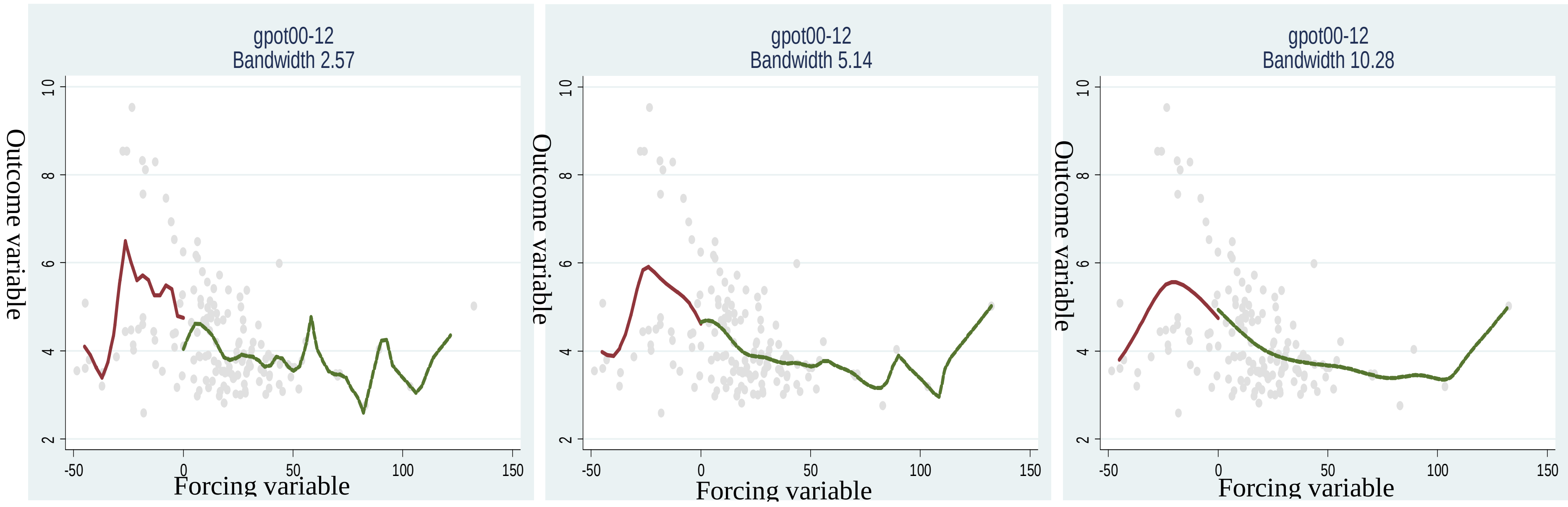


(a) half bandwidth (b)optimal bandwidth (c) double bandwidth

Source: Our elaboration on DG Regio and Stelder (2014) data

Fig 43- Robustness check: Gaussian kernel, different bandwidths, cut-off=0.

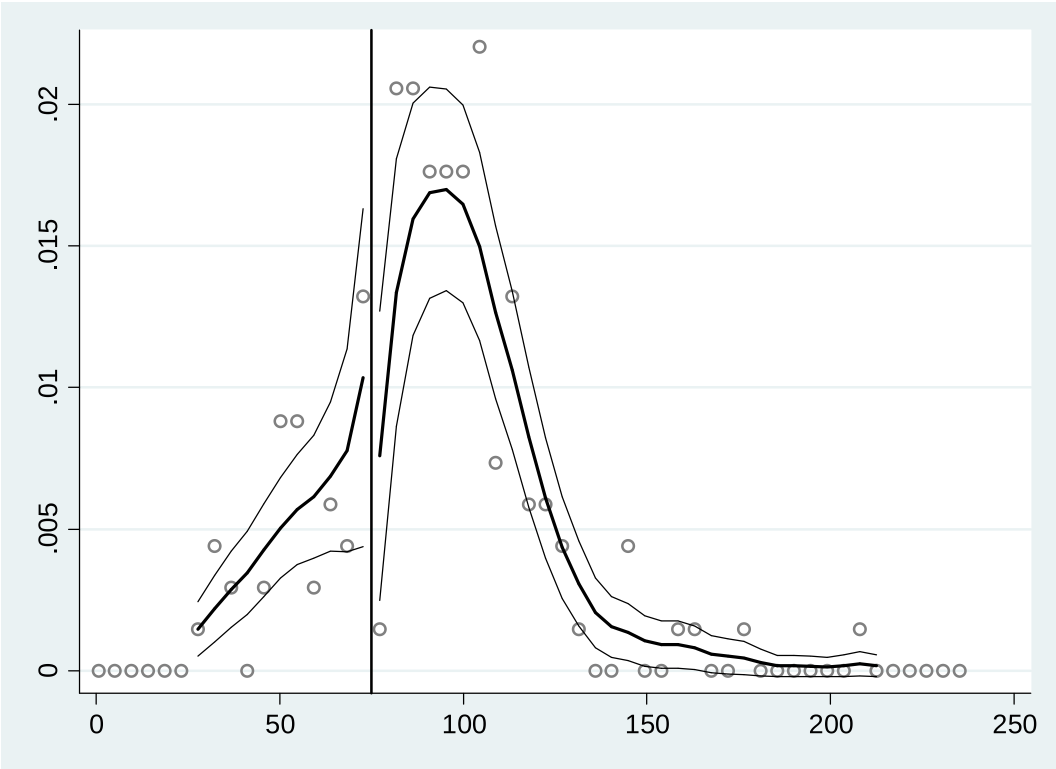
Outcome variable: road road accessibility growth rate (2000-2012), forcing variable (GDP per capita in PPS (75%EU15=0), 1988-90)



(a) half bandwidth (b)optimal bandwidth (c) double bandwidth

Source: Our elaboration on DG Regio and Stelder (2014) data

Fig 44- Estimation of the density function of the forcing variable (GDP per capita in PPS, average 1988-1990) at the threshold, sample TR1



Source: Our elaboration on European Commission and Stelder (2014) data

1.10.3 Tables

Table 1- Main results of the previous literature on the impact of structural funds (SF) on economic growth.

Authors	Year	Approach	Methodology	Outcome variable	Results	Notes (model simulation and case studies)
Bradley	1992	Model simulations	EU-HERMES model		positive effect	ran only for Ireland
Bradley, Fitz Gerald and Kearney	1992	Model simulations	EU-HERMES model		positive effect	ran only for Ireland
Gaspar and Pereira	1992	Model simulations	two-sector endogenous growth model of private, public and human capital accumulation		positive effect	Portugal
Modesto and Neves	1994	Model simulations	EU-HERMIN model		positive effect	Portugal
Goybet and Bertoldi	1994	Model simulations	consider models that range from a neo-Keynesian to a dynamic general equilibrium with endogenous growth		positive effect	
Lolos and Zonzilos	1994	Model simulations	general equilibrium model		Mixed effects	Greece
Bradley, Whelan, and Wright	1995	Model simulations	EU-HERMIN model		positive effect	Ireland
de la Fuente, Vives, Dolado, Faini.	1995	Econometric-regression	growth model	Income per- capita	positive effect	
Herce and Sosvilla-Rivero	1995	Model simulations	EU-HERMIN model		positive effect	Spain
Modesto and Neves	1995	Model simulations	EU-HERMIN model		positive effect	Portugal
Lolos, Suwa-Eisenmann, and Zonzilos	1995	Model simulations	general equilibrium model		Mixed results	Greece

Authors	Year	Approach	Methodology	Outcome variable	Results	Notes (model simulation and case studies)
Gaspar and Pereira	1995	Model simulations	endogenous growth model		positive effect	Greece, Ireland and Portugal
Fagerberg and Verspagen	1996	Econometric-regression	Growth model	Growth rate per-capita GDP	No effects	
Bachtler and Taylor	1996	Case study			difficulty to achieve coherence in these big projects ad hoc	Combine the evaluations of the projects and the official EU surveys
Bachtler and Turok	1997	Case study			difficulty to achieve coherence in these big projects ad hoc	Focus: UK, Germany, The Netherlands, Austria, Finland and Sweden
Huggings	1998	Case study			difficulty to achieve coherence in these big projects ad hoc	Focus: Objective 2 programmes in industrial South Wales
Daucè	1998	Case study			difficulty to achieve coherence in these big projects ad hoc	Focus: most depressed area of Burgundy
Lolos	1998	Case study			difficulty to achieve coherence in these big projects ad hoc	Focus: macroeconomic and structural policies in Greece and Portugal
Pereira	1999	Model simulations	endogenous growth model		positive effect	Greece, Ireland and Portugal
Pereira and Gaspar	1999	Model simulations	endogenous growth model		positive effect	Greece, Ireland and Portugal
Boldrin and Canova	2001	Econometric-regression	Convergence regression	Growth rate per-capita income	No effect-Redistributive function	
Garcia-Milà and McGuire	2001	Econometric-regression	Difference in difference model	Growth per-capita GDP	negative effect	
Cappelen, Castellacci,	2003	Econometric-	growth model	Productivity as a	positive effect	

Authors	Year	Approach	Methodology	Outcome variable	Results	Notes (model simulation and case studies)
Fagerberg, Verspagen		regression		multiplicative function in three meanings of knowledge		
de Freitas, Pereira, & Torres.	2003	Econometric-regression	Barro equations	Income convergence	No effect-not significant	
Rodrìguez-Pose and Fratesi	2004	Econometric-regression	cross-sectional and panel data analysis	Per-capita GDP	positive effect	
Puigcerver-Penalver	2004	Econometric-regression	“hybrid” growth model	Growth rate per-capita income	positive effect(/programming period)	
Beugelsdijk, Eijffinger	2005	Econometric-regression	GMM	growth rate GDP	positive effect	
Antunes and Soukiazis	2005	Econometric-regression	Panel data analysis	Growth rate regional per-capita income	positive effect(/regional area of Portugal)	
Percoco	2005	Econometric-regression	Supply side model	Regional production growth	High volatility	
Ederveen, de Groot, Nahuis	2006	Econometric-regression	Cross-country panel	Growth rate GDP	positive effect (/ institution)	
Bähr	2008	Econometric-regression	pooled cross sectional regression	Growth rate per-capita GDP	positive effect(/decentralization)	
Falk and Sinabell	2008	Econometric-regression	Spatial econometric approach and Blinder-Oaxaca decomposition	Growth rate per-capita GDP	positive effect	
Mohl and Hagen	2008	Econometric-regression	Panel data analysis	Growth rate per-capita GDP	Negative effect or not significant	
Esposti and Bussoletti	2008	Econometric-regression	Augmented conditional regional convergence model	Growth rate Regional GDP	Mixed effects	
Dall’Erba and Le Gallo	2008	Econometric-regression	Neoclassical growth model	Growth per-capita GDP	No effect	
Hagen and Mohl	2008	Econometric-	Generalized	Average GDP growth	positive effect but not	

Authors	Year	Approach	Methodology	Outcome variable	Results	Notes (model simulation and case studies)
		treatment effect	Propensity Score (GPS)	rate real GDP per-capita (in PPP)	satistically significant	
Woster and Slander	2009	Econometric-regression	Panel data analysis	Structural expenditures (the sum of all public spending at all levels of government, for economic purposes)	Increase of the expenditure but effectiveness depends on other conditions	
Bouvet	2010	Econometric-regression	Panel data analysis	Interregional inequalities	Depending on sector	
Becker, Egger, von Ehrlich	2010	Econometric-treatment effect	Fuzzy RDD	Growth rate per-capita GDP	positive effect	
Aiello and Pupo	2012	Econometric-regression	growth model	Growth rate per-capita GDP	No effect-Redistributive function	
Becker, Egger, von Ehrlich	2012	Econometric-treatment effect	Generalized Propensity score	Annual average growth rate of per-capita GDP	positive effect	
Becker, Egger, von Ehrlich	2013	Econometric-treatment effect	RDD with HLATE	Growth rate per-capita GDP	positive effect(/absorptive capacity)	
Pellegrini, Terribile, Tarola, Muccigrosso, Busillo	2013	Econometric-treatment effect	Sharp RDD	Growth rate per-capita GDP	positive effect	
Rodriguez-Pose and Novak	2013	Econometric-regression	Neo-classical empirical model	Growth rate per-capita GDP	Increasing of the effectiveness in successive periods	
Gagliardi and Percoco	2013	Econometric-treatment effect	RDD with spatial heterogeneity	Average GDP growth rate	positive effect(/location)	
Accetturo, de Blasio & Ricci	2014	Econometric-treatment effect	RDD	Local endowments of social capital	Negative effect	

Table 2- Descriptive statistics

	N	Minimum	Maximum	Mean	Std. Deviation
g per-capita GDP 95-10	180	-0.52	6.67	1.0547	1.066
g per-capita GDP 95-10 Non-Obj 1	126	-.52	6.67	1.0718	1.1058
g per-capita GDP 95-10 Obj 1	54	-.32	4.67	1.0148	.9769
Per-capita certified exp	180	0	4.61e+09	2.16e+08	5.47e+08
Per-capita certified exp Non-Obj 1	126	0	1.85e+08	2.92e+07	3.39e+07
Per-capita certified exp Obj 1	54	8428735	4.61e+09	6.52e+08	8.55e+08

Source: our elaboration on European Commission and Eurostat data

Table 3- Annual average growth rate of per-capita GDP, whole sample, period 1995-2010, non-parametric estimations with different kernels and bandwidths.

	(1)	(2)	(3)	(4)
Bw/Kernel	tri	rect	gau	epa
5.69 (optimal)	0.440	-5.527*	0.0579	0.00249
	(3.982)	(2.830)	(0.307)	(0.329)
2.85	0	0	0.220	0.309
	(0)	(0)	(0.351)	(0.434)
11.38	0.145	-1.095	0.158	0.188
	(0.655)	(1.110)	(0.274)	(0.300)

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Source: our elaboration on European Commission and Eurostat data

Table 4- Annual average growth rate of per-capita GDP, whole sample, period 1995-2003, non-parametric estimations with different kernels and bandwidths.

	(1)	(2)	(3)	(4)
Bw/Kernel	tri	rect	gau	epa
3.38 (optimal)	0	0	0.181	0.155
	(0)	(0)	(0.118)	(0.119)
1.69	0	0	0.272**	0.323**
	(0)	(0)	(0.129)	(0.162)
6.76	0.420	0.258	0.217**	0.231**
	(3.583)	(1.914)	(0.106)	(0.102)
Observations	180	180	180	180

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Source: our elaboration on European Commission and Eurostat data

Table 5- Annual average growth rate of per-capita GDP, whole sample, period 2003-2010, non-parametric estimations with different kernels and bandwidths.

Bw/Kernel	(1) tri	(2) rect	(3) gau	(4) epa
2.73 (optimal)	0	0	-0.105	-0.117
	(0)	(0)	(0.104)	(0.105)
1.37	0	0	-0.0833	-0.0626
	(0)	(0)	(0.139)	(0.146)
5.46	0.0444	-2.583	-0.0598	-0.0511
	(1.104)	(1.981)	(0.0948)	(0.0994)
Observations	180	180	180	180

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Source: our elaboration on European Commission and Eurostat data

Table 6- Parametric estimations with different polynomial orders (whole sample, 1995-2010)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
X	1.07e-05		3.72e-06	0.000117	7.19e-05	0.000169	0.00103	0.000778
	(1.62e-05)		(2.40e-05)	(0.000108)	(0.000192)	(0.000186)	(0.000879)	(0.000876)
X2				-3.22e-09	-1.98e-09	-4.80e-09	-5.35e-08	-3.95e-08
				(2.85e-09)	(5.06e-09)	(4.89e-09)	(4.63e-08)	(4.61e-08)
X3							0	0
							(0)	(0)
D		-0.0570	-0.622	0.220	-0.179	4.827**	9.278*	-0.431
		(0.165)	(0.796)	(0.362)	(1.721)	(2.428)	(5.427)	(5.834)
DX			7.47e-05		3.71e-05	-0.00123**	-0.00193**	0.00193
			(9.82e-05)		(0.000170)	(0.000560)	(0.000942)	(0.00141)
DX2						7.86e-08**	1.07e-07**	-3.94e-07**
						(3.67e-08)	(4.73e-08)	(1.55e-07)
DX3								0***
								(0)
Constant	0.926***	1.072***	1.019***	0.0910	0.465	-0.318	-5.122	-3.737
	(0.199)	(0.0987)	(0.356)	(0.948)	(1.645)	(1.604)	(5.293)	(5.282)
R-squared	0.002	0.001	0.006	0.006	0.007	0.042	0.045	0.067
AIC	534.21226	536.83159	537.38208	535.337	537.26508	532.81514	534.22397	530.15524

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Notes: the dependent variable is the annual average growth rate in patent applications (1999-2010); X= Gdp per capita in pps (EU-15=100, average 1988-1990), D=Objective 1 dummy variable; robust standard errors in parentheses.

Source: our elaboration on European Commission and Eurostat data

Table 7- Test for different thresholds of the forcing variable, oprimal bandwidth (5.69) and different kernels.

Cut-off	(1) 50	(2) 60	(5) 80	(6) 90
rect	1.322	0.251	-0.231	-0.777
	(1.895)	(1.093)	(0.540)	(0.707)
gau	0.578	0.372	0.122	-0.627
	(0.643)	(0.618)	(0.416)	(0.429)

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Source: our elaboration on European Commission and Eurostat data

Table 8- Annual average growth rate of per-capita GDP, sample GDP 1, period 1995-2010, non-parametric estimations with different kernels and bandwidths.

Bw/Kernel	(1) tri	(2) rect	(3) gau	(4) epa
4.65 (optimal)	-5.470*	0	-0.110	-0.161
	(2.798)	(0)	(0.280)	(0.277)
2.32	0	0	0.119	0.246
	(0)	(0)	(0.358)	(0.380)
9.30	0.630	0.924	-0.0272	-0.00754
	(0.681)	(2.527)	(0.248)	(0.231)
Observations	174	174	174	174

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Source: our elaboration on European Commission and Eurostat data

Table 9- Annual average growth rate of per-capita GDP, sample GDP 1, period 1995-2003, non-parametric estimations with different kernels and bandwidths.

Bw/Kernel	(1) tri	(2) rect	(3) gau	(4) epa
3.23	0	0	0.0970	0.0688
	(0)	(0)	(0.0952)	(0.0963)
1.61	0	0	0.221*	0.289**
	(0)	(0)	(0.126)	(0.136)
6.47	0.344	0.258	0.143*	0.159*
	(1.201)	(2.548)	(0.0840)	(0.0886)
Observations	174	174	174	174

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Source: our elaboration on European Commission and Eurostat data

Table 10- Annual average growth rate of per-capita GDP, sample GDP 1, period 2003-2010, non-parametric estimations with different kernels and bandwidths.

Bw/Kernel	(1) tri	(2) rect	(3) gau	(4) epa
2.77 (optimal)	0	0	-0.126	-0.134
	(0)	(0)	(0.113)	(0.112)
1.38	0	0	-0.0956	-0.0701
	(0)	(0)	(0.149)	(0.159)
5.53	0.0675	-2.583	-0.0975	-0.0947
	(1.128)	(1.916)	(0.0965)	(0.0951)
Observations	174	174	174	174

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Source: our elaboration on European Commission and Eurostat data

Table 11- Annual average growth rate of per-capita GDP, sample GDP 2, period 1995-2010, non-parametric estimations with different kernels and bandwidths.

Bw/Kernel	(1) tri	(2) rect	(3) gau	(4) epa
4.71	-5.477*	0	-0.193	-0.249
	(2.838)	(0)	(0.271)	(0.266)
2.35	0	0	0.0459	0.134
	(0)	(0)	(0.346)	(0.360)
9.43	0.611	1.003	-0.110	-0.0815
	(0.748)	(2.375)	(0.244)	(0.241)
Observations	165	165	165	165

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Source: our elaboration on European Commission and Eurostat data

Table 12- Annual average growth rate of per-capita GDP, sample GDP 2, period 1995-2003, non-parametric estimations with different kernels and bandwidths.

Bw/Kernel	(1) tri	(2) rect	(3) gau	(4) epa
3.27 (optimal)	0	0	0.0541	0.0195
	(0)	(0)	(0.0946)	(0.106)
1.63	0	0	0.182	0.239
	(0)	(0)	(0.122)	(0.152)
6.53	0.358	0.258	0.0967	0.113
	(0.548)	(2.019)	(0.0849)	(0.0924)
Observations	165	165	165	165

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Source: our elaboration on European Commission and Eurostat data

Table 13- Annual average growth rate of per-capita GDP, sample GDP 2, period 2003-2010, non-parametric estimations with different kernels and bandwidths.

Bw/Kernel	(1) tri	(2) rect	(3) gau	(4) epa
2.81	0	0	-0.141	-0.147
	(0)	(0)	(0.117)	(0.116)
1.40	0	0	-0.110	-0.107
	(0)	(0)	(0.148)	(0.158)
5.61	0.0867	-2.583	-0.113	-0.106
	(1.103)	(1.942)	(0.102)	(0.0970)
Observations	165	165	165	165

Source: our elaboration on European Commission and Eurostat data

Table 14- Parametric estimations with different polynomial orders (sample GDP 2, 1995-2010)

	(1) mod1	(2) mod2	(3) mod3	(4) mod4	(5) mod5	(6) mod6	(7) mod7	(8) mod8
X	8.10e-06		1.08e-05	0.000112	0.000135	0.000152	0.000711	0.000874
	(1.63e-05)		(2.21e-05)	(9.64e-05)	(0.000184)	(0.000190)	(0.00128)	(0.00129)
X2				-3.16e-09	-3.84e-09	-4.38e-09	-3.87e-08	-4.87e-08
				(2.94e-09)	(5.41e-09)	(5.59e-09)	(7.63e-08)	(7.63e-08)
X3							0	0
							(0)	(0)
D		-0.0188	-0.343	0.227	0.410	1.271	3.999	11.84
		(0.149)	(0.615)	(0.261)	(1.352)	(2.005)	(6.704)	(8.809)
DX			4.85e-05		-1.72e-05	-0.000236	-0.000694	-0.00416
			(6.92e-05)		(0.000127)	(0.000440)	(0.00115)	(0.00283)
DX2						1.37e-08	3.33e-08	5.28e-07
						(2.86e-08)	(5.36e-08)	(3.77e-07)
DX3								-0
								(0)
Constant	0.826***	0.930***	0.777**	-0.00628	-0.187	-0.323	-3.263	-4.123
	(0.217)	(0.0703)	(0.318)	(0.773)	(1.482)	(1.524)	(6.969)	(6.990)
R-squared	0.001	0.000	0.005	0.007	0.007	0.008	0.009	0.017
AIC	394.34959	396.5249	397.76652	395.44778	397.43222	399.27012	401.13024	399.77287

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Notes: the dependent variable is the annual average growth rate in patent applications (1999-2010); X= Gdp per capita in pps (EU-15=100, average 1988-1990), D=Objective 1 dummy variable; robust standard errors in parentheses.

Source: our elaboration on European Commission and Eurostat data

Table 15- Descriptive statistics patent and RTDI

	N	Minimum	Maximum	Mean	Std. Deviation
gpat 99_2010	167	-1.00	11.25	.7947	1.39214
gpat 99_2010 Non Obj1	117	-.3418043	3.191992	.4729119	.5845771
gpat 99_2010 Obj1	50	-1.00	11.25	1.547697	2.22055
RTDI	167	25046.85	464357043.14	37229255.5812	69762877.53217
RTDI Non Obj 1	117	38541.29	3.23e+08	3.65e+07	6.68e+07
RTDI obj 1	50	25046.85	4.64e+08	3.90e+07	7.70e+07

Source: our elaboration on DG Regional Policy data and OECD regpat data

Table 16- Growth rate of patent applications, whole sample, period 1999-2010, non-parametric estimations with different kernels and bandwidths

	(1)	(2)	(3)	(4)
Bw/Kernel	tri	rect	gau	epa
6.12 (optimal)	-2.942	-7.093	-0.997*	-0.997*
	(41.22)	(50.18)	(0.574)	(0.583)
3.06	0	0	-0.781	-0.636
	(0)	(0)	(0.745)	(0.825)
12.25	-0.414	0.231	-1.269**	-1.331***
	(1.492)	(1.326)	(0.517)	(0.504)

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Source: our elaboration on European Commission and OECD data

Table 17- Growth rate of patent applications, whole sample, period 1999-2007, non-parametric estimations with different kernels and bandwidths

	(1)	(2)	(3)	(4)
Bw/Kernel	tri	rect	gau	epa
6.67 (optimal)	-0.635	-2.776	-1.439**	-1.426**
	(27.21)	(22.14)	(0.574)	(0.606)
3.34	0	0	-1.089*	-1.106*
	(0)	(0)	(0.586)	(0.623)
13.35	-0.625	-0.705	-1.736***	-1.803***
	(0.955)	(0.807)	(0.573)	(0.559)

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Source: our elaboration on European Commission and OECD data

Table 18- Growth rate of patent applications, whole sample, period 2002-2010, non-parametric estimations with different kernels and bandwidths

Bw/Kernel	(1) tri	(2) rect	(3) gau	(4) epa
3.19 (optimal)	0	0	-0.480	-0.467
	(0)	(0)	(0.351)	(0.342)
1.59	0	0	-0.446	-0.422
	(0)	(0)	(0.413)	(0.432)
6.39	0.297	-0.631	-0.573*	-0.603**
	(7.869)	(13.71)	(0.309)	(0.285)

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Source: our elaboration on European Commission and OECD data

Table 19- Growth rate of patent applications, whole sample, period 2002-2007, non-parametric estimations with different kernels and bandwidths

Bw/Kernel	(1) tri	(2) rect	(3) gau	(4) epa
6.72 (optimal)	0.355	-0.216	-1.279**	-1.343**
	(3.979)	(5.885)	(0.512)	(0.531)
3.36	0	0	-0.775*	-0.861*
	(0)	(0)	(0.433)	(0.461)
13.45	0.106	0.163	-1.402***	-1.424***
	(0.292)	(0.568)	(0.517)	(0.518)

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Source: our elaboration on European Commission and OECD data

Table 20- Difference in levels of patent applications, whole sample, period 1999-2010, non-parametric estimations with different kernels and bandwidths

Bw/Kernel	(1) tri	(2) rect	(3) gau	(4) epa
12.98 (optimal)	36.64	38.41	-2.332	-4.752
	(60.91)	(43.73)	(10.92)	(10.40)
6.49	1.954	-167.4	6.955	11.16
	(3,407)	(2,406)	(20.09)	(21.51)
25.96	6.930	12.02	1.035	2.493
	(22.51)	(16.41)	(7.826)	(7.391)

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Source: our elaboration on European Commission and OECD data

Table 21- Difference in levels of patent applications, whole sample, period 1999-2007, non-parametric estimations with different kernels and bandwidths

Bw/Kernel	(1) tri	(2) rect	(3) gau	(4) epa
8.38 (optimal)	53.76	61.20	2.341	0.452
	(102.1)	(2,076)	(7.326)	(7.753)
4.19	0	0	4.947	5.556
	(0)	(0)	(12.26)	(14.27)
16.76	14.37	13.25	6.914	8.288
	(26.05)	(26.68)	(5.948)	(5.982)

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Source: our elaboration on European Commission and OECD data

Table 22- Difference in levels of patent applications, whole sample, period 2002-2010, non-parametric estimations with different kernels and bandwidths

Bw/Kernel	(1) tri	(2) rect	(3) gau	(4) epa
13.52 (optimal)	24.91	26.43	-6.186	-8.480
	(42.16)	(30.25)	(7.493)	(7.681)
6.75	37.79	-103.1	4.869	11.45
	(1,878)	(2,211)	(13.38)	(14.57)
27.03	5.162	12.68	-4.595	-3.949
	(15.49)	(13.59)	(6.204)	(6.523)

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Source: our elaboration on European Commission and OECD data

Table 23- Difference in levels of patent applications, whole sample, period 2002-2007, non-parametric estimations with different kernels and bandwidths

Bw/Kernel	(1) tri	(2) rect	(3) gau	(4) epa
10 (optimal)	35.66**	48.78	-1.512	-3.276
	(16.19)	(770.4)	(5.157)	(5.748)
5	-85.22	0	2.862	5.845
	(802.3)	(0)	(8.117)	(9.431)
20	5.740	0.0967	1.285	1.846
	(8.500)	(18.79)	(4.911)	(5.614)

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Source: our elaboration on European Commission and OECD data

Table 24- Growth rate of patent applications, sample R1, period 1999-2010, non-parametric estimations with different kernels and bandwidths

	(1)	(2)	(3)	(4)
Bw/Kernel	tri	rect	gau	epa
6.12 (optimal)	-2.940	-7.093	-1.137**	-1.185**
	(45.53)	(46.96)	(0.580)	(0.591)
3.06	0	0	-0.866	-0.813
	(0)	(0)	(0.773)	(0.760)
12.25	-0.333	0.231	-1.337**	-1.381***
	(1.512)	(1.633)	(0.528)	(0.534)

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Source: our elaboration on European Commission and OECD data

Table 25- Growth rate of patent applications, sample R1, period 1999-2007, non-parametric estimations with different kernels and bandwidths

	(1)	(2)	(3)	(4)
Bw/Kernel	tri	rect	gau	epa
6.77 (optimal)	-0.487	-2.776	-1.414**	-1.457**
	(27.74)	(29.55)	(0.555)	(0.629)
3.39	0	0	-1.124**	-1.175*
	(0)	(0)	(0.560)	(0.630)
13.54	-0.607	-0.725	-1.602***	-1.643***
	(0.971)	(0.920)	(0.562)	(0.596)

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Source: our elaboration on European Commission and OECD data

Table 26- Growth rate of patent applications, sample R1, period 2002-2010, non-parametric estimations with different kernels and bandwidths

	(1)	(2)	(3)	(4)
Bw/Kernel	tri	rect	gau	epa
3.16 (optimal)	0	0	-0.589*	-0.623*
	(0)	(0)	(0.346)	(0.360)
1.57	0	0	-0.508	-0.533
	(0)	(0)	(0.417)	(0.431)
6.31	0.178	-0.631	-0.643**	-0.661**
	(11.51)	(3.806)	(0.303)	(0.309)

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Source: our elaboration on European Commission and OECD data

Table 27- Growth rate of patent applications, sample R1, period 2002-2007, non-parametric estimations with different kernels and bandwidths

	(1)	(2)	(3)	(4)
Bw/Kernel	tri	rect	gau	epa
5.15 (optimal)	-0.356	0	-0.791**	-0.836**
	(3.867)	(0)	(0.338)	(0.370)
2.76	0	0	-0.641**	-0.702**
	(0)	(0)	(0.289)	(0.302)
11.03	0.0277	-0.0879	-0.819**	-0.827**
	(0.310)	(3.909)	(0.353)	(0.361)

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Source: our elaboration on European Commission and OECD data

Table 28- Growth rate of patent applications, sample R2, period 1999-2010, non-parametric estimations with different kernels and bandwidths

	(1)	(2)	(3)	(4)
Bw/Kernel	tri	rect	gau	epa
3.44 (optimal)	0	0	-1.061*	-1.072**
	(0)	(0)	(0.548)	(0.509)
1.72	0	0	-0.957	-0.969
	(0)	(0)	(0.717)	(0.676)
6.88	-0.443	-4.191	-1.161**	-1.184**
	(28.07)	(26.17)	(0.481)	(0.460)

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Source: our elaboration on European Commission and OECD data

Table 29- Growth rate of patent applications, sample R2, period 1999-2007, non-parametric estimations with different kernels and bandwidths

	(1)	(2)	(3)	(4)
Bw/Kernel	tri	rect	gau	epa
6.77 (optimal)	-0.484	-2.776	-1.397***	-1.433**
	(27.90)	(24.64)	(0.539)	(0.586)
3.39	0	0	-1.149**	-1.213**
	(0)	(0)	(0.563)	(0.592)
13.54	-0.607	-0.725	-1.551***	-1.586***
	(0.991)	(0.945)	(0.534)	(0.566)

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Source: our elaboration on European Commission and OECD data

Table 30-Growth rate of patent applications, sample R2, period 2002-2010, non-parametric estimations with different kernels and bandwidths

	(1)	(2)	(3)	(4)
Bw/Kernel	tri	rect	gau	epa
3.08 (optimal)	0	0	-0.571	-0.597*
	(0)	(0)	(0.352)	(0.354)
1.54	0	0	-0.530	-0.576
	(0)	(0)	(0.392)	(0.429)
6.16	-0.0499	-0.631	-0.600*	-0.613**
	(10.37)	(11.91)	(0.320)	(0.308)

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Source: our elaboration on European Commission and OECD data

Table 31- Growth rate of patent applications, sample R2, period 2002-2007, non-parametric estimations with different kernels and bandwidths

	(1)	(2)	(3)	(4)
Bw/Kernel	tri	rect	gau	epa
5.55 (optimal)	-0.353	0	-0.792**	-0.838**
	(4.408)	(0)	(0.348)	(0.382)
2.77	0	0	-0.639**	-0.698**
	(0)	(0)	(0.290)	(0.349)
11.09	0.0168	-0.0879	-0.819**	-0.827**
	(0.329)	(4.389)	(0.366)	(0.387)

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Source: our elaboration on European Commission and OECD data

Table 32- Parametric estimations with different polynomial orders

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
X	-9.02e-05***		1.77e-05	7.18e-07	0.000258**	0.000215**	0.000396	0.000260
	(2.52e-05)		(1.70e-05)	(0.000149)	(0.000108)	(0.000102)	(0.000623)	(0.000617)
X2				1.45e-10	-6.94e-09**	-5.72e-09**	-1.59e-08	-8.26e-09
				(4.14e-09)	(2.84e-09)	(2.62e-09)	(3.33e-08)	(3.29e-08)
X3							0	0
							(0)	(0)
Obj1		1.107***	2.081*	1.149**	3.624**	0.917	1.855	-4.468
		(0.258)	(1.165)	(0.451)	(1.415)	(1.948)	(3.866)	(6.770)
DX			-0.000104		-0.000234	0.000437	0.000290	0.00280
			(0.000139)		(0.000154)	(0.000493)	(0.000687)	(0.00253)
DX2						-4.09e-08	-3.51e-08	-3.57e-07
						(3.32e-08)	(3.68e-08)	(3.19e-07)
DX3								0
								(0)
Constant	1.923***	0.473***	0.219	0.431	-1.738*	-1.392	-2.407	-1.645
	(0.379)	(0.0542)	(0.258)	(1.265)	(0.948)	(0.905)	(3.718)	(3.684)
Observations	160	160	160	160	160	160	160	160
R-squared	0.096	0.195	0.204	0.198	0.212	0.219	0.220	0.227
AIC	478.30712	461.66263	462.02673	461.31083	460.47844	460.89608	462.86836	461.36874

Standard errors in parentheses
*** $p<0.01$, ** $p<0.05$, * $p<0.1$

Notes: the dependent variable is the annual average growth rate in patent applications (1999-2010); X= Gdp per capita in pps (EU-15=100, average 1988-1990), D=Objective 1 dummy variable; robust standard errors in parentheses.

Source: our elaboration on European Commission and OECD data

Table 33-Test for different thresholds of the forcing variable, optimal bandwidth (4.8) and different kernels

	(1)	(2)	(3)	(6)
Cut off	50	60	70	90
epa	-0.910	-1.242	-0.0689	-0.166
	(2.037)	(1.807)	(0.718)	(0.302)
gau	-0.549	-1.182	0.0809	-0.0673
	(2.934)	(1.364)	(0.828)	(0.234)

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Source: our elaboration on European Commission and OECD data

Table 34- Robustness check, non-parametric estimation with local linear regression for average population at the threshold (75 percent)

	(1)	(2)	(3)
Bw/kernel	gau	epa	rect
44.36	-470.4	-513.3	-580.8
	(399.0)	(513.8)	(720.2)
22.18	-372.0	-432.8	702.9
	(515.4)	(648.0)	(1,931)
88.72	-442.1	-445.1	-458.0
	(412.8)	(547.1)	(487.3)

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Source: our elaboration on European Commission and OECD data

Table 35- Descriptive statistics growth rate potential road accessibility and transport infrastructure expenditure

	N	Minimum	Maximum	Mean	Std. Deviation
g pot 2000-2012	152	.00	9.53	4.2733	1.32383
g pot 2000-2012 Obj 1	39	0	9.532959	5.025484	2.02942
g pot 2000-2012 non Obj 1	113	2.760698	6.485999	4.013756	.8369294
Transport infrastructure exp	152	54596.43	3018954134.50	137492786.15	333259337.51
Transport infrastructure exp Obj1	39	54596.43	1.26e+09	1.01e+08	2.61e+08
Transport infrastructure exp Non-Obj1	113	88289.09	3.02e+09	1.50e+08	3.55e+08

Source: our elaboration on DG Regional Policy data and Stelder (2014) data

Tab 36- Growth rate of potential road accessibility, whole sample, period 2000-2012, non-parametric estimations with different kernels and bandwidths

	(1)	(2)	(3)	(4)
Bw/kernel	tri	rect	gau	epa
5.14 (optimal)	1.563	0	-0.535	-0.666
	(18.22)	(0)	(0.525)	(0.549)
2.57	0	0	0.0472	0.192
	(0)	(0)	(0.585)	(0.633)
10.29	-0.380	0.236	-0.876*	-0.929**
	(0.915)	(22.29)	(0.480)	(0.473)

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Source: our elaboration on DG Regional Policy data and Stelder (2014) data

Tab 37- Growth rate of potential road accessibility, sample TR1, period 2000-2012, non-parametric estimations with different kernels and bandwidths

	(1)	(2)	(3)	(4)
	tri	rect	gau	epa
5.14 (optimal)	1.567	0	-0.462	-0.604
	(8.411)	(0)	(0.523)	(0.560)
2.57	0	0	0.0945	0.192
	(0)	(0)	(0.570)	(0.630)
10.28	-0.381	0.236	-0.839*	-0.901*
	(0.891)	(22.78)	(0.471)	(0.489)

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Source: our elaboration on DG Regional Policy data and Stelder (2014) data

Tab 38- Difference in levels of potential road accessibility, sample TR1, period 2000-2012, non-parametric estimations with different kernels and bandwidths

	(1)	(2)	(3)	(4)
	tri	rect	gau	epa
46.53(optimal)	29,724	31,559	24,835	22,482
	(90,561)	(93,939)	(55,445)	(52,223)
23.27	51,090	23,674	42,976	49,186
	(930,372)	(2.129e+06)	(69,644)	(70,661)
93.07	18,691	12,785	11,425	11,442
	(59,746)	(58,154)	(50,497)	(49,559)

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Source: our elaboration on DG Regional Policy data and Stelder (2014) data

Tab 39- Parametric estimations with different polynomial orders

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
X	-0.000121***		-7.49e-05*	-0.000129	-0.000518***	-0.000633***	-0.000563	-0.000800
	(3.73e-05)		(3.87e-05)	(0.000200)	(0.000157)	(0.000140)	(0.000845)	(0.000847)
X2				2.12e-09	1.28e-08***	1.61e-08***	1.22e-08	2.56e-08
				(5.95e-09)	(4.30e-09)	(3.63e-09)	(4.50e-08)	(4.52e-08)
X3							0	-0
							(0)	(0)
Obj1		1.144***	-0.334	0.629	-3.182*	-10.91***	-10.55*	-22.79**
		(0.313)	(1.334)	(0.445)	(1.684)	(2.714)	(5.500)	(9.119)
DX			0.000121		0.000361**	0.00229***	0.00223**	0.00709**
			(0.000137)		(0.000161)	(0.000732)	(0.00104)	(0.00331)
DX2						-1.18e-07**	-1.16e-07**	-7.36e-07*
						(4.90e-08)	(5.68e-08)	(4.10e-07)
DX3								0
								(0)
Constant	5.832***	4.014***	5.083***	5.411***	8.690***	9.630***	9.240*	10.56**
	(0.531)	(0.0789)	(0.561)	(1.634)	(1.369)	(1.259)	(5.068)	(5.077)
Observations	150	151	150	150	150	150	150	150
R-squared	0.126	0.151	0.166	0.160	0.187	0.237	0.237	0.255
AIC	481.43973	481.62804	478.50243	477.47501	474.61663	467.13464	469.1317	465.54912

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Notes: the dependent variable is the annual average growth rate in potential transport accessibility (2000-2012); X= Gdp per capita in pps (EU-15=100, average 1988-1990), D=Objective 1 dummy variable; robust standard errors in parentheses.

Source: our elaboration on DG Regional Policy data and Stelder (2014) data

Tab 40-Test for different thresholds of the forcing variable, optimal bandwidth (5.14) and different kernels

	(1)	(2)	(3)	(5)	(6)
Cut off	50	60	70	80	90
epa	-2.776	-1.343	-2.375	0.633	-0.184
	(3.675)	(1.922)	(2.009)	(0.715)	(0.397)
gau	-2.120	-1.088	-2.100	0.698	-0.231
	(2.858)	(2.106)	(1.668)	(0.734)	(0.354)

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Source: our elaboration on DG Regional Policy data and Stelder (2014) data

Tab 41- Robustness check, non-parametric estimation with local linear regression for average population at the threshold (75 percent)

	(1)	(2)	(3)
	gau	epa	rect
25.75 (optimal)	-556.9	-574.3	-445.6
	(407.8)	(414.3)	(534.8)
18.88	-391.2	-389.4	-62.74
	(548.0)	(483.9)	(915.7)
51.5	-626.3	-671.3	-573.7
	(394.8)	(483.6)	(425.9)

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Source: our elaboration on European Commission and Stelder (2014) data

ESSAY 2

CONVERGENCE DYNAMICS IN EUROPEAN REGIONAL WELL-BEING

[Abstract]
Economists have traditionally analysed well-being by mainly focusing on production indicators. In recent years however, non-economic features of the quality of life have been recognised as being as important as production for assessing progress and to comparing different countries' performances. The aim of this paper is to contribute to the empirical literature on the measurement of social and economic progress by calculating a synthetic indicator of well-being at the European regional level. We consider a database of 15 variables and construct six composite indicators that reflect different well-being dimensions: people's health and social conditions; education and life-long learning; household material conditions; knowledge economy; local environment attractiveness in terms of infrastructure endowments and tourist inflows; age and gender equality in labour market conditions. Sub-indicators are then combined in a synthetic index of well-being. Well-being in European regions is analysed both in a synchronic and a diachronic perspective, covering an eleven-year period from 2000 to 2010; it is further compared with levels and trends of per-capita Gross Domestic Product (GDP). We then carry out a cluster analysis to obtain a taxonomy of European regions in terms of well-being levels; we look at regional dynamics and investigate the existence of convergence among European regions, both in terms of well-being index and GDP. Convergence is assessed by considering dispersion over the period analysed of three inequality measures (coefficient of variation, Theil index and Gini index) and by looking at intra-distributional mobility in regional ranking by means of the Kendall index. We find that regions converge in some dimensions of well-being, even if there is no evidence of rank mobility.

Keywords Well-being indicators. Quality of life. Cluster analysis. σ-convergence . γ-convergence. European regions.
JEL Classification I31 . R11 . O18

2.1 Introduction[‡]

GDP "measures what it measures" (Costanza *et al.* 2009, p. 4), but for more than half a century this indicator was misleadingly used as a suitable algorithm for detecting human well-being. In recent years, the multidimensional measurement of economic and social progress has gained increasing importance in academic debate and in the agendas of major international institutions. Many scholars and development organisations share the view that Gross Domestic Product (GDP) is a poor indicator of social welfare and stress the necessity of flanking it with a number of quality of life indicators.
The aim of this paper is threefold: a) to construct an overall index of European Well-Being (EWB) by combining six sub-indicators reflecting different dimensions of human well-being and social development – people's health and social conditions; education and life-long learning; knowledge

[‡] This essay was carried out during my visiting research period at the University of Groningen- Faculty of Spatial Sciences- Department of Economic Geography.

economy; local environment attractiveness in terms of infrastructure endowments and tourist inflows; age and gender inequalities in the labour market and material conditions of households by considering their disposable income; b) to obtain a taxonomy of European regions in terms of well-being by means of a cluster analysis technique; c) to analyse well-being dynamics over time and investigate the existence of convergence among European regions both in terms of quality of life and economic progress, comparing the well-being index with the trend of the Gross Domestic Product. Differently from other works in this field also referring to EU regions (Annoni *et al.* 2012; Eurofound 2012), the analysis covers a period of eleven years- from 2000 to 2010 - and two sub-periods, the first one from 2000 to 2005 and the second one from 2005 to 2010. Convergence is assessed by means of two non-parametric techniques known as σ (Friedman 1992; Sala-i-Martin 1994) and γ convergence (Boyle and McCarthy 1997).
The paper is structured as follows: section 2 gives an overview of how well-being has been measured by international institutions; section 3 looks at well-being measurement in the economic literature; section 4 reviews existing studies on regional convergence in well-being; section 5 presents the different methodologies used and section 6 describes the dataset. Section 7 shows the results in terms of the European Well-Being indicator, presents a taxonomy of the regions for EWB and investigates the presence of σ and γ-convergence. In section 8, the conclusions are drawn.

2.2 Well-being measurement on the agenda of international institutions

Research in this field intensified following publication of the Report by the Commission on the Measurement of Economic Performance and Social Progress chaired by Joseph Stiglitz (Stiglitz *et al.* 2009). Starting from the tenet that “what we measure affects what we do” (p. 7), the report stresses the belief that the use of wrong indicators can produce wrong decisions. The authors consider three conceptual approaches to the measurement of quality of life. The first strand is related to subjective well-being, developed in close connection with psychological research (Kahneman, Diener and Schwartz 1999; Graham 2008). The second approach is rooted in the notion of capabilities (Sen 1985, 2000), according to which a person’s life is a combination of various “doings and beings” (functionings) and the freedom to choose among these functionings (capabilities). The leading idea is that progress is related to people’s quality of life rather than to opulence (Nussbaum 2000, 2011). The third approach, developed within the economic tradition, refers to the notion of fair allocation, weighting different non-monetary dimensions of quality of life (beyond goods and services traded in markets) in a way that respects people’s preferences and following equity criteria (Moulin and Thomson 1997; Maniquet 2007). The Report provides twelve recommendations for the definition of a good multidimensional indicator of well-being, but it intentionally avoids introducing a new indicator. The report’s aim is in fact not to give up GDP (beyond GDP), but to continue considering it alongside other aspects of the multifaceted quality of life phenomenon (GDP and beyond).
The last two decades have witnessed an explosion in the number of alternative indicators and related initiatives from important institutions such as the Organization for Economic Cooperation and Development (OECD), the United Nations Development Programme (UNDP) and the European Union. Since 1990, UNDP has annually calculated the Human Development Index (HDI), based on the capabilities concept (Nussbaum 2000, 2011; Sen 1985, 2000; UNDP 1990, 2010). Some authors argue that the HDI omits important aspects of well-being such as personal safety, social cohesion (Bilbao-Ubillos 2011), and democracy (Dominguez *et al.* 2011). Others underline a problem of redundancy in the information provided by the composite index (Cahill 2005; McGillivray 1991;

Ravallion 1997). In 2010, three new indexes were included in the Human Development Report: the Inequality-adjusted Human Development Index (IHDI), the Gender Inequality Index (GII) and the Multidimensional Poverty Index (MPI) (UNDP 2010). Drawing on the recommendations of the Commission on the Measurement of Economic Performance and Social Progress, for over a decade the OECD has worked towards identifying the best way of measuring societal progress. In 2011, the OECD Better Life Initiative was introduced: a bi-annual assessment of well-being in member countries and in selected emerging economies based on a selection of suitable indicators for comparing eleven dimensions of well-being (OECD 2013). These include health and education, local attractiveness, personal security, overall life satisfaction, as well as more traditional measures such as income. The resulting bi-annual report “How’s Life?” paints a picture of people’s material conditions and quality of life in OECD countries. In 2011 and 2013 OECD designed an interactive e-tool allowing people to create their own “Better Life Index” to “visualize and compare some of the key factors – education, housing, environment, income, jobs, community, health, life satisfaction, safety, work-life balance, civic engagement – that contribute to well-being in OECD countries” (OECD 2011). In 2014, an additional product tool was launched - “How’s Life in your Region?” - which measures well-being at the regional level in eight areas: income, jobs, health, access to services, environment, education, safety, and civic engagement. It is complemented by an interactive web-based tool which allows for comparisons across OECD regions.

The European Union has launched a number of important initiatives aimed at investigating quality of life at the European regional level and to complement the information provided by GDP in the context of policy-making. In August 2009, the European Commission presented “GDP and Beyond Communication”, a road map with five key actions specifically designed to “support the Commission’s aims to develop indicators relevant to the challenges of today” (European Commission 2009) on the assumption that environmental protection, biodiversity and social cohesion are important aspects of economic growth (Eurostat 2008). Several other EU initiatives have sought to develop indicators to complement GDP. The performance of Member States is monitored through the Indicators for Social Inclusion in the European Union. Monitoring of the EU Sustainable Development Strategy is carried out by means of the EU Sustainable Development Indicators (SDIs), a battery of 100 indicators grouped in ten themes regarding the social, economic, environmental and governance frameworks (Adelle and Pallemaerts 2009). Since 2011, the European Statistical System Committee (ESSC) has worked towards developing a set of quality of life indicators for EU countries along ten dimensions: material living conditions, productive or main activity, health, education, leisure and social interactions, economic and physical safety, governance and basic rights, natural and living environment, overall life experience. Further, the European Policy Centre runs the project “Well-being 2030” that goes beyond measuring well-being, exploring how European policy can improve social conditions and how well-being can be measured by focusing on the desires of the citizens (Eurostat 2008). The European Union has been working to overcome the crisis and put in place the conditions for a more competitive economy with higher employment levels. The Europe 2020 strategy is about delivering growth that should be: *smart*, through more effective investments in education, research and innovation; *sustainable*, thanks to a decisive move towards a low-carbon economy; and *inclusive*, with a strong emphasis on job creation and poverty reduction (European Union 2011). The strategy focuses on five ambitious goals in the areas of employment, innovation, education, poverty reduction and climate/energy. When introducing the Europe 2020 strategy, President Barroso declared that: “The last two years have left millions unemployed. The crisis has brought us a burden of debt that will last for many years. It has brought new pressures on our social cohesion” (European Commission 2010). He emphasised that the financial and economic crisis has had a negative impact on citizens' everyday lives and the necessity of strengthening the role of European Institutions in developing new policies and strategies to maintain and improve the quality of life. One of such initiatives is the Eurofound - Quality of Life Survey (EQLS), at its third wave in 2012 (previous waves took place in 2003 and 2007), which examines both the objective circumstances of European citizens' lives and how they feel about those circumstances and their lives in general. It looks at employment, income, education, housing, family, health, work–life balance, life satisfaction and perceived quality of society (Eurofound 2012). The EQLS approach recognises that “quality of life” is a broader concept than “living conditions” and refers to the overall well-being of individuals in a society.

Annoni and Weziak-Bialowska (2012) also analysed the quality of life in European regions. They argue that the ultimate goal of European Cohesion Policy is to foster the economic and social development of lagging regions and construct a synthetic indicator of Quality of Life (QoL) for European regions to assess whether regions are able to guarantee good quality of life levels to their citizens. The QoL report focuses on two main dimensions (Living Standards and Health), each composed of different sub-indices (that are not combined into an overall composite indicator), then used to analyse the regions’ ranking.

2.3 Well-being measurement in the economic literature

The definition of composite indices based on the notion that development entails more than just economic aspects has been a focus of academic debate in recent years. Yet objections to the use of GDP as an indicator of human well-being were first raised many decades ago (Kuznets 1934; Kennedy 1968; Nordhaus and Tobin 1973; Van den Bergh 2007). Nordhaus and Tobin argued that “GNP is not a measure of welfare” (1973, p. 512); they proposed a pioneering measure of economic welfare (MEW) in which they attempted to allow for the more obvious discrepancies between GNP and economic welfare. Their adjustment of GNP relies on three aspects: a) reclassification of GNP expenditure as consumption, investment and intermediate; b) imputation for the services of consumer capital, for leisure and for the product of household work; c) correction for some disamenities of urbanisation (*ibid.*, p. 513). In a second step, they converted the MEW into the SMEW (Sustainable MEW) by taking into account changes in total wealth. The SMEW measures the level of MEW that is compatible with preserving the capital stock. Starting from Nordhaus and Tobin’s approach, two other contributions were developed (Daly and Cobb 1989 and Cobb *et al.* 1995): the Index of Sustainable Economic Welfare (ISEW) and the Genuine Progress Indicator (GPI). These indicators evaluate some environmental factors (the costs of water, air and noise pollution stemming from consumption) and also try to account for the loss of wetlands, farmland, and other natural resource depletion, as well as environmental damage.

Fleurbaey (2009) critically examines different approaches to measuring individual well-being and social welfare alternative to GDP. He analyses four different strands of research: the “corrected GDP”, which takes into account non-market aspects of well-being and concerns about sustainability; the idea of measuring the “gross national happiness”; the “capability approach” proposed by Sen (1985, 2000); the approach based on “synthetic indicators” constructed, following the UNDP experience of Human Development Index, as a weighted means of different aspects of human well-being. Research on the measurement of human well-being generally starts from the consideration that GDP focuses solely on income and resources; it measures only mean values (instead of ends) and, as a consequence is not a satisfactory indicator of well-being. Scholars agree that well-being is a multidimensional concept which includes both the objective life conditions of individuals and their subjective evaluation; it is a dynamic concept (Boulanger *et al.* 2009; Gough *et al.* 2006; Stiglitz *et al.* 2009) and it should be seen as a system in which *functionings* (in the sense of Sen's approach), personal resources, and external conditions fit together and determine each other (Eurostat 2008).

A significant share of this literature stems from the UNDP HDI experience. Alkire (2002) and Alkire and Foster (2010) adjust the HDI to reflect the distribution of human development achievements across the population and across dimensions, using an inequality measure. Bilbao-Ubillos (2013) build a "Composite, Dynamic Human Development Index", by incorporating additional points essential to the current concept of human development and provide a dynamic factor that distinguishes between countries based on the achievements attained. To allow for comparisons between poor and non-poor human development levels both within and across countries, Grimm *et al.* (2008) suggest a transparent, simple to calculate, and easy to interpret methodology for computing the overall HDI and its three components (Life Expectancy, Education and GDP) for quintiles of income distribution. They want to contribute to measuring human development and sensitise policy makers to a broader concept of inequality that goes beyond income and includes education and life expectancy. Fukuda-Parr *et al.* (2009) measure economic and social rights fulfilment. Other authors refer to specific determinants of human development (Edgier and Tatlidil 2006; Morrison and Murtin 2012).

Marchante *et al.* (2006b) construct an augmented version of the HDI for the period 1980-2001, estimated by incorporating indicators of health, education and per-capita income. They also investigate convergence in well-being levels across Spanish regions (NUTS 2) by means of two non-parametric statistics, known as σ-convergence, and γ-convergence.

Bleys (2012) classifies the range of progress indicators already available in the literature, describing the advantages and downsides of each of them. He develops an alternative classification scheme based on the different approaches used to quantitatively capture different well-being notions. He reviews 23 alternative measures for policy-making and looks into the different classifications available in the literature, dividing them into three areas[1]. Osberg and Sharpe (2002, 2005) summarise a methodology for constructing an Index of Economic Well-Being (IEWB) for some OECD countries (the US, the UK, Canada, Australia, Norway and Sweden) for the period 1980 to 1999. They provide consistent and simultaneous assessment of consumption, accumulation, distribution and security, and compare the implications of using IEWB instead of GDP. A further indicator - the Well-being and Progress Index (WIP) - is proposed by D'Acci (2011). This includes several aspects of well-being and progress such as human rights, economic well-being, equality, education and research, quality of urban environment, ecological behaviour, subjective well-being, longevity and violent crime. The WIP is computed as the arithmetic average of these indices and it is then compared with GDP, HDI and the Quality of Life index. He finds that WIP and GDP are, on average, highly correlated: the level of WIP is higher for richer countries and vice-versa.

2.4 Regional convergence in well-being

Academic research into convergence across countries and regions has a history of over half a century. These studies have gained in prominence since publication of the works of Solow (1956, 1957) and

[1] For a survey of synthetic indicators of well-being see Bandura (2008); Gadrey and Jany-Catrice (2006); Stiglitz *et al.* (2009); Annoni and Weziak-Bialowolska (2012); Costanza *et al.* (2009).

Swan (1956) on the neoclassical growth model focused on GDP dynamics. According to neoclassical theory, all economies in the world converge towards the same steady state (absolute β-convergence). However, many authors (de la Fuente 1997; Islam 2003; Sala-i-Martin 1996; to name but a few) find divergence in growth trends among countries and regions, highlighting that a number of structural parameters influence economic performance and produce different steady-states (conditional β-convergence - Barro and Sala-i-Martin 1992; Sala-i-Martin 1996). The concept of β-convergence is usually studied in close connection with the concept of σ-convergence, which refers to a reduction in the dispersion of per-capita income over time. Friedman (1992) puts forward a measurement of σ-convergence that simply calculates the inter-temporal change in cross-sectional dispersion – i.e. the coefficient of variation trends – of the variable under consideration. Many empirical works reveal the presence of σ-divergence across countries over the last fifty years (Decancq *et al.* 2009; Milanovic 2005; Pritchett 1997; World Bank 2006).

From this multidimensional view of development, a new strand of research emerged, which investigates convergence in terms of indicators related to different aspects of the quality of life and human well-being. Mayer-Foulkes (2003) analyses convergence in life expectancy (modelled in terms of physical and human capital and technology)[2] and find the existence of convergence clubs[3]. Global convergence on the other hand is found to be weak using both the Solow model (1957) and the Howitt and Mayer-Foulkes (2005) endogenous model on technology-convergence-clubs. Mayer-Foulkes (2010) conducts a cross-country analysis of the HDI components of income, life expectancy, literacy and gross enrolment ratios, by using simultaneous growth regressions to decompose absolute divergence/convergence for the HDI components. The results show that each human development component follows its own set of transitions; consequently, development is not a smooth process. They also indicate that improving market efficiency has smaller returns than complementing them with institutions to coordinate urbanisation and investment in human capital. Indeed, urbanisation itself can foster development involving all aspects of economic, political and social life as well as human development. Sab and Smith (2001) examine convergence across countries in terms of health and education levels over the period 1970-1996. The results show that investments in education and health are highly linked; unconditional convergence is found for life expectancy, child survival and enrolment rates, whether all human capital indicators show conditional convergence. Mazumdar (2003) tests convergence in per-capita GDP and in "living standards" including indicators such as child survival rate, life expectancy at birth, adult literacy rate, and calories intake, considering both the full sample and three income sub-groups. Results show divergence in almost all cases and for all indicators. Konya and Guisan (2008) study β and σ-convergence in HDI considering both the countries that joined the EU before the 2004 enlargement and all current EU members. They find that for all groups of countries considered, the HDI grew more in backward countries than in developed countries (i.e. country convergence in the β sense). HDI levels convergence is also the focus of Noorbakhsh's study (2006) that focuses on cross-country disparities. He finds evidence of weak absolute convergence over the period 1975-2002; however, it is not a homogenous process. In particular, some countries – mainly in Asia and Latin America – show considerable progress, whilst sub-Saharan Africa shows low human development with no evidence of increasing trends. Jordà and

[2] Referring to evidence that life expectancy rises with income and that as an effect of technological progress, higher life expectancies were later obtained for the same income, they derived a Solow model with a broader notion of capital, which includes physical, human and health capital.

[3] Convergence club models present a paradigm allowing for the definition of states of development; in other words, they define growth models with multiple steady states.

Sarabia (2014) study HDI convergence across 132 countries using a semi-parametric method and a five-year interval for the period 1980-2005. EU member states convergence between 1970 and 1990 was assessed by Giannias *et al.* (1999) not only in terms of economic indicators, but also in terms of social and quality of life indicators. Their results confirm that real convergence was achieved between 1970-75 for most of the countries analysed. McMichael *et al.* (2004) and Moser, Shkolnikov and Leon (2005) show that life expectancy divergence replaced convergence in the late 1980s. This result is confirmed in several other works that show results on income divergence and life expectancy convergence turning to divergence (Bloom, Canning and Sevilla 2003; Castellacci 2006, 2008; Konya 2011; Mayer-Foulkes 2010; Taylor 2009; Ram 2006; Edwards 2010). Some authors focus on regional convergence within specific countries (Irish regions in O'Leary 2001, Spanish regions in Marchante *et al.* 2006a, 2006b, Italian regions in Berloffa and Modena 2012 and in Capriati 2011). As well as the definition of a wider set of quality of life indicators and a more comprehensive composite index of well-being for EU NUTS 2 regions, the goal of this paper is to assess convergence looking at both the most widely used economic indicator (per-capita GDP) and the well-being index defined above. To the best of our knowledge, there are no previous works that calculate a well-being index for EU NUTS 2 regions and investigates σ- and γ-convergence by using non-parametric techniques and comparing the results with per-capita GDP. However, our work presents the typical limitations of this kind of empirical literature, mainly regarding the degree of subjectivity in deciding both variables and their relative weights for use in the construction of sub-indicators, first, and the final composite index, later. Further, the choice of variables used in the analysis is considerably influenced by the limited availability of medium and long-term data necessary to the study of convergence patterns. We take on board various insights derived from related works on the subject. In order to reduce arbitrariness in weighting, the simple average is chosen: although conferring an equal weight to each variable/indicator too seems arbitrary, this method is widely used (UNDP; Annoni *et al.* 2012; Marchante *et al.* 2006 a, b; to name some) and empirically justified (Ogwang and Abdon 2003).

2.5 Methodology

Data is extracted from the Eurostat regional statistics database; the units under analysis are the NUTS 2 regions of the European Union with 27 member states. We initially consider an eleven-year period (2000-2010) for 15 variables, but by reason of recurrent missing values, the analysis ends up testing only three years (2000-2005-2010). The study considers changes between the end and the beginning of the period and in two sub-periods in order to capture differences in short term tendencies. Besides the restrictions on variables and periods due to the data unavailability, in some cases a few missing values still persist[4] few missing values still persist. This problem is solved using (where possible) the multiple imputation technique (Rubin 2004). In a multi-dimensional perspective, we consider six pillars of well-being (Health, Education, Knowledge Economy, Local Attractiveness, Labour Market Equality, Material Conditions) and combine them in order to obtain the overall European Well-Being indicator (EWB). The selected sample consists of 216 NUTS 2 regions, this is the largest possible sample given the Eurostat regional level data available[5].

[4] Variables H1, H2 and H4 (see Table 1).

[5] In the choice of the sample, we faced a trade-off between the largest number of variables and the largest number of regions, because two variables – patent applications and availability of hospital beds – presented missing values for entire countries (Germany and UK) and their inclusion would reduce the sample by almost 100 units. After proving that the

Since the indicators in the dataset have different measurement units, normalisation is required prior to data processing (Freudenberg 2003; Jacobs *et al.* 2004). Following the methodology used in Marchante *et al.* (2006 a, b), Giannias *et al.* (1999), Mazumdar (2002) and Jordà and Sarabia (2014), a Min-Max normalisation is adopted. It makes the indicators have an identical range [0, 1] by subtracting the minimum value and dividing this difference by the range of the indicator values. Each variable of the six indices $x_{i,j}^{t}$ is normalised by calculating the scaled value $mmx\_X_{i,j}^{t}$, for each region j and for each year t:

$$mmx\_X_{i,j}^{t} = \frac{(x_{i,j}^{t} - x_{i,j\,min})}{(x_{i,j\,max} - x_{i,j\,min})}$$

Where $x_{i,j}^{t}$ is the observed value of the variable *i* in region *j* and year *t*; $x_{i,j\,min}$ and $x_{i,j\,max}$ are the minimum and the maximum values observed for variable *i* in the period under consideration, respectively.

The internal consistency of the indicators for each well-being dimension is evaluated considering the structure of correlations between variables, by means of the Principal Component Analysis and its usual related tests, such as the Measures of Sampling Adequacy and Bartlett test (Hair *et al*. 2014).

Considering we have no information on the subjective weightings of variables used for the construction of the well-being index, we use the system of equal weights (EW), as suggested by Hagerty and Land (2007), Ongwang and Abdou (2003), and Sharpe *et al.* (2013). This methodology results in the lowest level of disagreement among large variance in individuals' weightings[6]. Consequently each sub-index *I* will be computed following the expression:

$$I_{k,j}^{t} = \sum_{i=1}^{n} \frac{1}{n} mmx\_X_{k,i,j}^{t}$$

where *k* identifies the dimension, *i* the variables and *j* the regions, while *n* is the number of variables included in the index.

Analogously, the EWB is given by the expression:

$$EWB_{j}^{t} = \sum_{k=1}^{6} \frac{1}{6} I_{k,j}^{t}$$

that is the arithmetic average of the sub-indexes previously computed.

A map of well-being distribution across European regions is then obtained using a cluster analysis. Cluster analysis (CLA) is a group of multivariate techniques to classify objects based on the characteristics they possess (Hair *et al.* 2014). The classification aims to reduce the dimensionality of a dataset by exploiting the similarities/dissimilarities between cases. CLA techniques address three main research questions: the formation of a taxonomy, a data simplification and the identification of relationships. Selection of the variables used to characterise the objects being clustered is strictly related to the fulfilment of these objectives. Further, we evaluate the adequacy of the sample size, issues of outliers and multicollinearity, the measure of similarity to be adopted and the

results obtained on the largest sample are robust to the inclusion/exclusion of those variables, we decide to include as many regions as possible.

[6] Moreover the use of subjective weighting scheme could involve other kind of issues related to how one should weight the raw data on the valuations of each individual. If the population of each country is adopted, this may skew the results in favour of the more populous nations, as it is conceivable that many people will hold valuations similar to the results in their country (Hagerty and Land 2007, Sharpe *et al.* 2013).

standardisation of the data. Similarity is essential because it measures the correspondence or resemblance between objects[7]. In our analysis, we apply the squared Euclidean distance given by the sum of the squared differences without taking the square root that is highly recommended with the Centroids and Ward methods (Hair *et al.* 2014). After these steps, the partitioning procedure begins. The goal of partitioning procedures is to maximise the distance between groups while minimising differences within the group's members. Cluster procedures can be hierarchical, non-hierarchical or a combination of both. Hierarchical procedures involve *n-1* clustering decisions (*n* is the number of objects) that combine observations into a hierarchy. They can operate with two kind of methods: agglomerative methods, in which clusters start with single objects then joined by other single clusters; divisive methods, in which all observations start in a single cluster and are successively divided until each is in a single cluster.

The next step is the choice of the clustering algorithm, i.e. the rules by which similarity is defined between multiple-member clusters in the clustering process. The selection criteria could differ and hence different classifications may be obtained for the same data, even using the same distance measure. The most common linkage rules are (Spath 1980):

- Single linkage (nearest-neighbour method). The similarity between two clusters is determined by the shortest distance between the two closest elements in the different clusters. This is the most versatile agglomerative algorithm, because it can define a wide range of clustering patterns; this is however also its main problem when clusters are poorly delineated.
- Complete linkage (farthest-neighbour method), cluster similarity is based on maximum distance between observations in each cluster, all objects in a cluster are linked to each other at some maximum distance; it generates the most compact clustering solutions.
- Average Linkage, similarity is based on all members of the clusters rather than on a single pair of extreme values, so it is less affected by outliers.
- Centroid Method, by which the similarity between two clusters is the distance between the cluster centroids.
- Ward's Method (Ward 1963), which differs from the previous methods because the similarity between two clusters is the sum of squares within the clusters summed over all variables. The selection of the two clusters to combine is based on the combination of the clusters which minimizes the within-cluster sum of squares across the set of separate clusters. This method tends to produce clusters with the same number of observations.

In contrast to hierarchical methods are non-hierarchical procedures. The latter do not require the treelike construction process, but assign objects into clusters after specification of the number of clusters. The first step is the selection of the clusters seeds (the starting point for each cluster) specified by the researcher or generated from the sample. The next step is to assign each observation to one of the cluster seeds based on similarity. The most common group of this kind of algorithm is known as K-means (Hartigan 1975). K-means algorithms divide the data into a user-specified number of clusters and then iteratively reassign observations to clusters until the minimisation of distance of observation within the cluster and maximisation of distance between clusters is reached. Hierarchical and non-hierarchical methods both present some advantages and disadvantages (Hair *et*

[7] There is a wide variety of inter-object similarity measures, but the most widely used methods are three: correlational measures, distance measures and association measures. Correlational measures compute the correlation between the objects: an increase in correlation means an increase in similarity (this method is rarely used in CLA). Distance measures are the most commonly used: they represent similarity as the proximity between observations across the variables in the cluster-variate.

al. 2014). In our case, a combination of the two approaches seems to be the best choice. First, a hierarchical procedure generates a complete set of cluster solutions; it establishes the applicable cluster solutions and the appropriate number of clusters; after this, observations can be clustered by a non-hierarchical method. We exploit the advantages of both methods: the hierarchical technique facilitates a comprehensive evaluation of a wide range of cluster solutions, whereas the non-hierarchical clustering better optimises this cluster solution by reassigning observations until maximum similarity within clusters is achieved.

After having clustered the European regions along the EWB dimensions, we assess convergence by considering the synthetic indicators of each domain: the final EU well-being indicator and per-capita GDP (for comparison). In the economic literature, convergence has been interpreted from a variety of theoretical perspectives and has been empirically investigated through different methodologies. As in Marchante *et al.* (2006b), we investigate the convergence process in the well-being levels across regions by means of two non-parametric statistics, known as σ-convergence (Friedman 1992; Sala-i-Martin 1994), and γ-convergence (Boyle and McCarthy 1997), the latter using Kendall's index of rank concordance (Siegel 1956). The σ-convergence trend detects the occurrence of a reduction in regional dispersion over time, whilst the γ-convergence dynamics focus on regions' positions in the well-being ranking. The adoption of non-parametric methods avoids issues related to the definition of the correct functional form, typical of the classical model of convergence analysis, and the problems of model misspecification. The evolution of index dispersion over the study period is explored by calculating three inequality measures: the coefficient of variation (Giannias *et al.* 1999; Marchante *et al.* 2006a, b) and the Theil and Gini indices (Jordà and Sarabia 2014).
The coefficient of variation of the index $I_{k,j}^{t}$ is given by:

$$CV_t(I_{k,j}^{t}) = \frac{sd\ (I_{k,j}^{t})}{\mu(I_{k,j}^{t})}$$

that is the standard deviation of $(\cdot)$, divided by the mean of $(\cdot)$.
In addition, the Gini and Theil Entropy indices are computed. The Theil index is a special case of the generalised entropy measure, for which the sensitivity parameter – the parameter which determines the weight assigned to the upper tail – is set to 1 (for the Theil index all the regions have the same weight independently from their level of development) (Cowell 2011).
The expressions of the Gini and Theil indices are the following:

$$G^{(t)} = \frac{1}{2n^2\mu(I^{(t)})}\sum_{i=1}^{n}\sum_{j=1}^{n}|I_i^{(t)} - I_j^{(t)}|$$

$$T^{(t)} = \frac{1}{n}\sum_{i=1}^{n}\frac{I_i^{(t)}}{\mu(I^{(t)}}\ log\left(\frac{I_i^{(t)}}{\mu(I^{(t)}}\right)$$

Where $I_i^{(t)}$ denotes the sub-index or the EWB Index for the region *i* at time *t*, *μ* is the arithmetic mean of the indicator under study and *n* is the number of regions. The inclusion of different inequality measures responds to the problems related to the use of variance in the inequality measurement (Cowell 2011).
Following O'Leary (2001) we also calculate the rate of *σ*-convergence as the annual percentage between each inequality measure at time *T* and its value at time *t* (with *T*>*t*) where a negative (positive) value implies convergence (divergence).

The analysis provides a broad picture of the evolution of inequality in the eleven year interval considered, allowing us to determine whether regional disparities in terms of well-being effectively decreased.

Sala-i-Martin (1996) argues that convergence is a broader concept which is concerned with assessing the mobility of unities (countries, regions) over time within the given distribution of the variable of interest (β-convergence). If backward regions grow faster than more advantaged regions in the variable of interest, there is absolute β-convergence. σ and β-convergence are two related concepts, even if they do not always show up together. Quah (1996) and Sala-i-Martin (1996) show that β-convergence is necessary but not sufficient for σ-convergence, while σ-convergence is sufficient but not necessary for β-convergence.

Boyle and McCarthy (1997) propose to investigate β-convergence looking at intra-distributional mobility over time given by changes in regional rankings in terms of well-being, considering the Kendall index of rank concordance proposed by Siegel (1956). They argue that this index is a direct measure of β-convergence, while Barro regressions are indirect. This method of assessing β-convergence is labeled γ-convergence. We consider the binary version of Kendall's index, which takes into account concordance between the ranks in year T and the initial year (in our case 2000), for both the different dimensions of well-being and the EWB Index:

$$k_T = \frac{Var\left[AR\left(I_j^T\right) \ + AR\left(I_j^{2000}\right) \ \right]}{Var\left[2 * AR\left(I_j^{2000}\right) \ \right]};$$

where $AR\left(I_j^T\right)$ is the actual rank of region j in year T in the cross-sectional distribution of the index I, k_T ranges between 0 and 1: the closer k_T is to zero the greater is the mobility within the distribution and the stronger the γ-convergence.

As in Boyle and McCarthy (1997), we test the null hypothesis that no association exists between ranks in year T and in the year 2000. If the null hypothesis is rejected we have no β-convergence. In the binary version of Kendall's index, the test statistic is the following:

$$\chi^2 = 2 * (S - 1) * k_T$$

It is distributed as chi-squared with $(S - 1)$ degree of freedom, where S is the total number of European regions considered. σ and β-convergence statistics are computed also for per-capita GDP for comparison.

2.6 Data and variables

Following the recommendations of some recent literature, we include in the analysis social and civic dimensions of well-being other than production and income variables and construct a composite index of well-being called EWB (European Well-Being). It takes into account six different factors affecting quality of life: 1) health and social conditions; 2) education and training; 3) material conditions; 4) knowledge economy; 5) local attractiveness; 6) labour market. The first three dimensions recall the basic aspects of the UNDP-HDI. However, compared with the HDI, we highlight three main changes: the higher level of development of the regions considered than the underdeveloped countries for which the HDI is conceived; the switch from a production index (GDP) to per-capita disposable income as a measure of material standards (Stiglitz *et al.* 2009, p. 8) and the lack of relevant data for European NUTS 2. The last three dimensions of the overall well-being index reflect important aspects of social and civic regional disparities.

Since each index must represent a positive dimension of well-being (i.e. an increase of the index is perceived as an increase in the quality of life), variables with a negative polarity for well-being are transformed by calculating their reciprocal value, before being used in the analysis. The statistical structure of the data is preliminarily assessed by means of a Principal Component Analysis (PCA)[8] through analysis of the structure of correlations between variables and other related specific tests, such as the Measures of Sampling Adequacy and the Bartlett test (Hair *et al.* 2014).

2.6.1 Health and social conditions

This index summarizes two important aspects of citizens' lives. First, it looks at social conditions including aspects related to population density (H1), secondly it looks at life expectancy (H2) and infant mortality rates at birth (H3). The study of the impact of population density upon a multidimensional concept of quality of life is relatively recent. Cramer *et al.* (2003) develop a comprehensive, global index of quality of life, and relate the sub-indices and global index to various socio-demographic variables, somatic health and density of population in the residential area; more recently Fassio *et al.* (2013) have shown that population density influences psychological, relational and environmental quality of life. The concept of population density is directly related to the local liveability of places. Dodds (1997) states that people derive pleasure directly from the natural beauty and liveability of places, as the biophysical context affects our daily lives. Life expectancy at birth represents the standard procedure for measuring the length of human life used by the UNDP Report (UNDP 1990, 2010). The infant mortality rate measures deaths during the first year of life per 1000 live births and is a more sensible measure for policies aimed at improving social health, hygiene and nutrition.

Applying the EW method, the Index of Health is given by:

$$Health_{j,t} = \sum_{i=1}^{3} \frac{1}{3} mmx\_H_{i,j,t}$$

where mmx_H_i are the *i* variables (normalised) included in the index.

The principal component analysis (PCA) is applied to the normalised values of the variables[9]. The correlation matrix shows good correlation between variables assessed by means of Kaiser's measure of sampling adequacy (hereafter MSA) falling within the acceptable range (at least .50) for each year (Hair *et al.* 2014). As a further validation of the suitability of the correlation structure of the data, we use the Bartlett Test of Sphericity that compares the correlation matrix with the identity matrix. We find a small p-value (<0.05) for all years, which means that our correlation matrix is significantly different from a zero correlations matrix.

2.6.2 Material conditions

The income index is given by household's disposable income per-capita. Stiglitz *et al.* (2009) suggest switching from variables related to production, such as GDP, to those that measure disposable income. Material living conditions, determining people's ability to satisfy their needs and aspirations, are essential components of well-being (OECD 2013).

2.6.3 Education and Training

[8] PCA is used only to investigate the statistical consistency of the variables because we need to have quantitative comparable measures and not only ordinal measure and we also want to make spatial comparison (Somarriba and Pena 2008).

[9] Detailed information on the results of the principal component analysis for each domain is available from the author upon request.

The index of education aims to identify the level of educational attainment. The assessment of the individual returns from education on productivity and earnings were considered in the works of Becker (1964) and Mincer (1974), first, and in Harmon *et al.* (2003) and Hanushek and Woessmann (2008) more recently. Education influences many important aspects of people's lives (Michalos 2008). Indeed, education entails externalities or spillovers effects which involve different aspects of a country's progress. The empirical literature finds a positive relation between higher-quality education and better public health and environmental care, greater social cohesion and civil rights protection (Acemoglu and Angrist 2001; Lochner and Moretti 2004; Milligan *et al.* 2004; Moretti 2004; Miyamoto and Chevalier 2010; OECD 1998, 2010; Sianesi and Van Reenen 2003; Hanushek and Woessmann 2007).

The indicator takes into account the percentage of people who have completed at least the compulsory school level (secondary education attainment) (E1), the participation of adults in life-long learning and training (E2), and with a negative polarity the percentage of young people who are not employed nor involved in any education programme or training, NEET (E3).

The Education Index is given by:

$$Education_{j,t} = \sum_{i=1}^{3} \frac{1}{3} mmx\_E_{i,j,t}$$

Applying the PCA technique, the measure of sampling adequacy falls in the acceptable range (>0.5) and the Bartlett test confirms the significance of the correlations.

2.6.4 Knowledge Economy

Research and innovation influence economic well-being and competitiveness (Annoni and Dijkstra 2013; Annoni and Kozovska 2010; Schwab and Porter 2007; IMD 2008; Huggins and Davies 2006). The index aims to represent regions' potential to adapt to changing demand; it covers not only expenditure on innovation, but also the availability of human capital with technological skills and people employed in R&D. We consider regions' potential to innovate by means of: Total intramural R&D expenditure (Gross Domestic Expenditure on R&D) (K1), Human resources in Science and Technology in percentage of active population (K2), and Employment in technology and knowledge-intensive sectors (K3).

The index is again computed using an equal weight for each variable:

$$KnowledgeEco_{j,t} = \sum_{i=1}^{3} \frac{1}{3} mmx\_K_{i,j,t}$$

The Bartlett test finds that correlations are strongly significant when taken collectively (p-value <0.001), whereas the overall MSA, as well as the measure of sampling adequacy for each variable, falls in the middling range (0.70 or above).

2.6.5 Local Attractiveness

This indicator aims to capture the attractiveness of regions. The issue of the quality of life tends to be more and more important for the attractiveness of spaces in the context of increasing commuting and social demand for a good living environment (Kwiatek-Sołtys and Mainet 2014). Attractiveness is a broad concept that is closely interconnected with the notion of competitiveness and with the quality of the tourism experience. Measuring visitor numbers is a direct and objective means of assessing success in tourism (Dupeyras and MacCallum 2013). As a proxy for local attractiveness, we use the number of arrivals at tourist accommodation establishments (LA1). Further, we consider a proxy for people's perception of safety measured by the reciprocal of the numbers of victims in road accidents (killed per million inhabitants) (LA2)[10].

The Local Attractiveness Index is computed as follow:

$$LocalAtt_{j,t} = \sum_{i=1}^{2} \frac{1}{2} mmx\_LA_{i,j,t}$$

The correlations among variables produce an MSA for each variable that falls, according to Kaiser's classification, in the acceptable range (0.50), supported also by a Bartlett test (<0.01).

2.6.6 Labour Market Equality

This index looks at discrimination in the labour market. The real possibility of finding a job is not equal among European regions. With regard to job opportunities, the level of age and gender discrimination varies considerably across regions. We implement two measures of inequality across generations and gender in the labour market. The first one is given by the ratio of youth to total unemployment rate for each region *j* and year *t* (Youth); the second one (Women) is the ratio of females to total employment. The Labour Market Equality Index is defined as follows

$$LabourMarketEq_{j,t} = \frac{1}{2} mmx\_Youth_{j,t} + \frac{1}{2} mmx\_Women_{j,t}$$

Where:

$$Youth_j = \frac{Employment\ Young\ (15\text{–}34y)}{Total\ employment\ (15\text{–}64y)}$$ I.e. the share of young people employed on the total employed;

$$Women_j = \frac{Employment\ Women\ (15\text{–}64y)}{Total\ employment\ (15\text{–}64y)}$$ I.e. the share of women employed on the number of total employed.

The overall MSA (0.5) and Bartlett test (sig. <0.01) confirm the existence of a good degree of correlation among variables; analogously, the MSA for each variable falls above the acceptable range for all the variables.

All the indicators described above are included in the [0, 1] interval.

2.7 Results

2.7.1 A well-being Index across European Regions

As we pointed out above, the main contribution of our work is to provide both a wider set of quality of life indicators and a more comprehensive composite index of well-being.

The European Well-Being Index (EWB) is given by the simple average of the six sub-indicators defined above. An "Equal Weight" approach is again applied:

$$EWB_{j,t} = \frac{1}{6} Health_{j,t} + \frac{1}{6} Education_{j,t} + \frac{1}{6} Material\ conditions_{j,t} + \frac{1}{6} KnowledgeEco_{j,t} + \frac{1}{6} LocalEnv_{j,t} + \frac{1}{6} LabourMarketEq_{j,t}$$

This index varies for each region *j* and year *t* among the [0, 1] interval.

The statistical consistency of the indicator is assessed by means of a Principal Component Analysis; it reveals a good structure of correlation among the sub-indices (Table 2). The overall MSA falls in

[10] Unfortunately, there are no more variables available to capture people's perception of safety in their given region..

the acceptable range (>0.6) and the Bartlett test confirms the significance of correlations with a p-value lower than 0.0001. The variance explained by the first principal component (which considers six variables) is 48%; this is an acceptable value.

Figure 1 shows the histograms of the EWB values for the 216 European NUTS 2 of the sample in ascending order. The lowest values are shown by the regions of Bulgaria, Romania, Hungary, Poland, Slovakia and the Czech Republic; whereas the highest values are those of Sweden, Austria, Netherlands, the UK, Belgium, Spain and Germany. Even though the regional ranking is different, considering per-capita GDP in 2010 (Figure 2), countries at the bottom and at the top of the list are almost the same. The coefficient of correlation between per-capita GDP and EWB is high (almost around 0.9) for all the years considered and it is always statistically significant at the 0.01 level. This result is confirmed also in Figure 3 (a, b) where the two indices are compared at the beginning (2000-3a) and at the end of the period (2010-3b). However, there was a smooth reduction of the correlation over the course of the eleven years, from 0.913 in 2000 to 0.877 in 2010; the scatter plots also confirms this result. However, despite this high correlation amongst the two indicators, differences in well-being between regions do not necessarily reproduce those based on standard economic indicators, since they look to different features of economic and social progress.

2.7.2 A taxonomy of European regions in EWB

By means of the cluster analysis, we pursue the threefold goal of (a) obtaining a taxonomy of European regions in well-being dimensions, (b) simplifying the data and (c) capturing relationships between regions. The primary objective is to develop a taxonomy that segments EU NUTS 2 into groups with homogeneous compositions in terms of well-being. The variables used as *clustering variables* are the sub-indices for the year 2010 (we have six clustering variables). The problem of multicollinearity is excluded *a priori*, because the correlations structure of the variables was already investigated in the principal component analysis. Further, the variables do not suffer from the problem of heterogeneous scale, because they were standardised before aggregation into sub-indices. Since all the six clustering variables are metric, we use as similarity measure the squared Euclidean distance. Given that our sample consists of 216 observations we consider meaningful, following Hair *et al.* (2014) a sample representation in which groups include at least 10 percent of the sample size. As mentioned in the previous section, we apply a two-step cluster analysis: first with a hierarchical method, in order to determine the appropriate number of clusters, and later with a non-hierarchical method, for the “fine-tuning” of the results, profile and validation of the final cluster solution.

Step 1: Hierarchical Cluster Analysis

In this step, we define the preliminary cluster solutions that will be later analysed with the non-hierarchical method. We use the squared Euclidean measure for similarity and the Ward method.

The results of the hierarchical clustering are reported in Table 3. The table shows an extract of the agglomeration schedule integrated with three more columns (number of clusters, differences and percentage increase in heterogeneity) that help in the definition of the cluster solution. The best cluster solution is chosen by applying the *stopping rule*, based on assessing the changes in heterogeneity. When large increases in heterogeneity occur when moving from one stage to the next, it is best to select the previous cluster solution. In our case, the best solution seems to be step 211, with five clusters, since the increase in heterogeneity in the next step is of about 19.2%. This result is confirmed also in Figure 4 and Figure 5. The scree diagram (Figure 4), which connects the increase in heterogeneity with the number of clusters, shows a break in the line in correspondence with the number five, suggesting to opt for this solution. The dendogram (Figure 5) also gives a visual display of the agglomeration schedule for the illustration of hierarchical clustering. Before proceeding with the non-hierarchical analysis, we investigate if the differences between clusters are distinctive and significant. The profile of the clusters is presented in Table 4 and Figure 6. First, we examine the distinctiveness, looking at the F-statistics from one-way ANOVAs in order to see if there are statistically significant differences in the six clustering variables among the five clusters. The independent variable is the cluster membership and the dependent variables are the clustering variables. The results confirm that each of the five clusters is distinctive. Further, we look at the cluster mean values and observations.

Cluster 1 contains 46 observations and has a relatively low mean on Local Attractiveness and the highest score for Material Conditions and Knowledge Economy. Cluster 2 includes 68 observations; it has the highest score for Health and a relatively low value for Local Attractiveness. Cluster 3 contains 43 observations; it has the lowest value for Local Attractiveness and a relatively high value for Labour Market Equality. Cluster 4 has 28 observations and is characterised by the lowest score on Knowledge Economy and a relatively high value on Health. Cluster 5 contains the highest score on Labour Market Equality. However, cluster size and observation assignments will change in the non-hierarchical analysis; the final meanings of the five clusters will thus be discussed in the next step.

Step 2: Non-Hierarchical Cluster Analysis

Non-hierarchical clustering methods have the advantage of better "optimising" cluster solutions by reassigning observations until maximum similarity within clusters is achieved. In this section, we use the K-means method and the cluster solution of the hierarchical method (five clusters) to develop the optimal cluster solutions with the non-hierarchical method, avoiding the issue of arbitrariness in the choice of the number of clusters. The results are shown in Table 5. Comparing these results with the hierarchical analysis, there are slight differences of a few units in the clusters compositions and Figure 7 confirms that the means of the variables in each cluster have a similar trend with both methods. The one-way ANOVA test, also for the K-means cluster solutions, confirms that, among the five clusters, there are statistically significant differences in the six clustering variables (Table 5).

Looking at the cluster profile and their compositions, we give an interpretation of the clusters obtained with the K-means method:

- Cluster 1 contains 29 observations; it has a relatively low value for Local Attractiveness, the lowest value for Labour Market Equality and a relatively high value for Health (table 5 and figure 7). The Health mean value for this cluster is higher than EU (216 NUTS) average. Looking at the regions included in this group (Table 6) and at Figures 8[11] emerges that it includes regions with good living standards, but with low values of per-capita GDP (Figure 8-g). These are the Italian "Mezzogiorno", some Spanish and Portuguese regions, together with some Greek and Czech regions. This is the *Middle-low well-being* regions cluster.
- Cluster 2 includes 65 observations. It shows the highest value for Health and a relatively high value for Material Conditions; on the other hand, it has a relatively low value for Local Attractiveness (lower than EU average) (Table 5 and Figure 7). The box-plots show that this group is characterized by better living conditions than the previous one for all indicators except Education. Looking at its composition, there are some regions from Belgium,

[11] In these figures, per-capita GDP is used as an evaluation variable.

Germany, North Italy, France and Sweden; consequently, it can be labelled as the group of regions with *Middle well-being*.

- Cluster 3 has 44 observations; it shows values lower than the national average (almost equal only for Labour Market Equality). It has the lowest mean values for Health, Material Conditions and Education (Figure 7). Figure 8-g shows that this group is characterised also by regions with the lowest per-capita GDP values. It includes the least developed European regions (from Bulgaria, the Czech Republic, Latvia, Lithuania, Hungary, Poland, Romania and Slovakia). This is the *Low well-being* group.
- Cluster 4 groups 34 observations. Opposite to the previous cluster, it has higher values than the European average for all variables (Table 5). This result is confirmed by Figure 7 and Figures 8. Figure 8-g in particular represents the box-plot for per-capita GDP; it shows that this cluster contains the regions with the highest mean values also for this productive indicator. Table 6-d proves this result, since it includes the wealthier regions of our 216 NUTS 2 (from Belgium, Germany, North Holland, Sweden and the UK, plus three capital city-regions: Prague, Ile-de-France and Madrid). This is the group of the *High well-being* regions.
- Cluster 5 has 44 observations; the mean values of the variables are around the EU average for Health, Material Conditions and Knowledge Economy, whereas values for Education and Local Attractiveness are higher (Table 5). Table 6-e displays that this group is characterised by regions with middle or high values of the indicators (Figures 7 and 8). It includes many regions from the UK, the less developed regions from the Netherlands (that are however above the European average), Austria and the wealthiest regions of Spain. By reason of these considerations, we can name the group as the *Middle-high well-being* regions.

A map of the taxonomy of European regions in well-being dimensions is shown in Figure 9.
The final stage relies on the processes of cluster validation and profiling. First, cluster stability is assessed. Given that the software chose the first seed points, we sort the observation in a different way and then we perform the cluster analysis once again using the same K-means method. The new cluster solution is compared with the previous one with a cross-classification[12] (Table 7). The result supports the validity of the cluster analysis, since the five cluster solutions appear strongly stable with zero percent cases of switching to another cluster between solutions[13]. A further robustness check is the assessment of the validity criterion, in order to verify the predictive validity of the analysis. We choose two variables that have a theoretical cluster relationship with the clustering variables but were not included in the analysis: per-capita GDP and EWB Index. Our aim is to verify if there are significant differences in these variables across the clusters, using a MANOVA model estimation. Table 8 displays the results. The overall MANOVA model is significant, independently of the index used; the individual F-statistics are also significant. The results demonstrate evidence of the criterion validity, since the cluster solution can predict also other key outcomes.
As a final robustness check, we perform the cluster analysis also for the solutions with four and six clusters, even if the break-down in the scree plot is clearly identified in correspondence of five

[12] Using the cluster membership from the first K-means solution as one variable and the cluster membership variable from the second K-means as the other variable.
[13] The only changes that interested the cluster label are: cluster 1 becomes 3; cluster 2 becomes 5; 3 turns to 2 and 5 to 1; 4 remains unchanged.

clusters[14]. In both cases, the results have some problems of sample representativeness. With six clusters there is a group with only six units (less than 10% of the sample), whereas in the four cluster solutions there is an excessively wide group including 90 units (almost half the sample); we thus argue that the five clusters solutions is still the best.

The cluster analysis gives us a taxonomy of well-being for the European regions considered in the year 2010. Adopting a diachronic perspective, in the following section, we look at the evolution of well-being between the beginning and the end of the eleven-year period analysed.

2.7.3 Assessing convergence in European Well-Being

In this section, we investigate σ-convergence across European regions as regards both the EWB index and each of its components; we then compare the results obtained with per-capita GDP σ-convergence.

We calculate different indices of dispersion: the coefficient of variation, the Theil index and the Gini index, in order to assess if disparities have decreased over time. We consider both the whole period (2000-2010) and two sub-periods (2000-2005 and 2005-2010). As in Jordà *et al.* (2014), to facilitate comparison of the results we consider the number indices with the year 2000 as base. The evolution of the three indices in the period considered is presented in Figure 10 and Table 9. Considering the EWB, it has a clear decreasing trend (Figure 10-g) independently of the measure of inequality considered. The σ-convergence rate in the whole period ranges from 0.50, if we consider the Theil index, to 3.23, if we look at the Gini coefficient.

The reduction of dispersion concerns both sub-periods. If we consider per-capita GDP, the reduction of disparities is even higher for all measures of inequality, but the main decrease is found in the first sub-period and is relatively feeble (with a convergence rate of 0.46) in the second. Figure 11 shows the coefficients of variation of per-capita GDP and EWB. This latter has a stable decreasing trend throughout the years considered, whilst for GDP the curve becomes quite flat after 2005. The trend in terms of GDP is similar for the Material Conditions Index, which represents the economic dimension of EWB and has an overall σ-convergence rate ranging from 8.22 (Gini) to 18.77 (Theil). Looking at the evolution of the inequality indices for the remaining dimensions, we find a triangular curve for the Health, Local Attractiveness and, though in a less marked way, Education indices. This means that in the first five years there was an increase in cross-EU regions disparities in these dimensions, followed in the next five years by a reduction in the inequality measures. In other words, regions tend to became more similar. An opposite tendency (convex curve) is on the other hand observed for the Labour Market Equality index. This shows a reduction in disparities in the first sub-period, followed by an increase in later years. This means that in recent years, European regions have become less similar in terms of gender and intra-generational equality in the labour market. The Knowledge Economy index presents a decreasing trend for both sub-periods, even if the main reduction occurs in the first five years considered (ranging from 9.20 to 15.38).

These results confirm the general scenario found in some previous convergence analysis studies (Marchante *et al.* 2006; European Commission 2013) which highlight a general convergence trend, slowed down in more recent years by the effects of the crisis. To focus on the mobility of regions over time within the cross-regional distribution of each dimension (γ-convergence), we consider Kendall's index of rank concordance (Table 10). For each sub-index as well as for the two overall indicators, EWB and per-capita GDP, Kendall's index tends to one. There is thus no evidence of rank

[14] The results of these additional analyses are available from the author upon request.

mobility within the distribution. This means that the process of σ-convergence did not significantly affect the relative positions of European regions. In other words, backward regions were not able to improve their conditions enough to modify their regional ranking. The null hypothesis of no association among the ranks in different years (which means convergence is happening) is always rejected with a significance level of 0.5%, so the absence of γ-convergence is confirmed.
In conclusion, neither significant improvements nor worsening occurred for the overall well-being indicator, per-capita GDP and the single dimension indices in regional intra-distributional mobility over the period analysed.

2.8 Conclusions

The aim of this paper is to contribute to the empirical literature on the measurement of social and economic progress by calculating a synthetic indicator of well-being for 216 NUTS 2 regions of the European Union (27 member states). With this goal in mind, we consider a database of 15 variables and construct six composite indicators that reflect different dimensions of human well-being and social development: people's health and social conditions; education and life-long learning; material conditions of households by considering their disposable income; knowledge economy; local attractiveness (in terms of infrastructure and tourist inflows); age and gender inequalities in the labour market. All these sub-indicators are then combined in a synthetic index of well-being, the European Well-Being index (EWB).
The aim of the paper is threefold: the construction of six sub-indices and a synthetic indicator of well-being; the definition of a taxonomy of European regions in relation to these dimensions; the assessment of well-being and per-capita GDP convergence/divergence processes across regions over the period considered. The analysis focuses on a period of eleven years, from 2000 to 2010, and two sub-periods, the first one from 2000 to 2005 and the second one from 2005 to 2010. The analysis of the distribution of well-being across European regions is carried out by performing a cluster analysis on the six sub-indices. By reason of the unavailability of data for complete time series for a long enough period, regional convergence is investigated by means of two non-parametric techniques, σ-convergence and γ-convergence.
The cluster analysis results show that European regions can be grouped into five different sets in relation to their level of well-being. The first group contains 29 observations, characterized by low levels of per-capita GDP and relatively good standards of living (especially for the essential aspects of human well-being: health, education and material conditions – the dimensions of the HDI); for this reason the cluster is named *Middle-low well-being* regions. Cluster 2 includes 65 observations; it is characterised by the highest value for health and a relatively high value for material conditions; it shows higher values than the previous group in all dimensions (except for education) also for those not considered in the HDI. Per-capita GDP is also higher; this group is the cluster of *Middle well-being* regions. The next cluster has 44 observations; it shows values in line with the European average in terms of the Labour Market Equality Index but lower for the other dimensions of well-being; further, for the domains of Health, Material Conditions and Education, it shows the worst results on average when compared to the other clusters and is also characterised by the lowest per-capita GDP values. It includes regions from the least developed European countries and we label it the *Low well-being* group. The fourth cluster has 34 observations; opposite to the previous one, it has higher values than the European average for all the clustering variables; furthermore, it shows the highest mean values of per-capita GDP. For these reasons, it is labelled as the group of *High well-*

being regions. The last group contains 44 observations; it is characterised by regions with middle or high values of the indicators. In particular, the mean values of the variables are around the EU average for Health, Material Conditions and Knowledge Economy, whereas it shows higher values for Education and Local Attractiveness. Given these considerations, we name this group the *Middle-high well-being* regions.

These results highlight two main points: the first suggests, once again, that well-being is not completely disconnected from the productive aspects captured by GDP, supporting the idea that is not necessary to go beyond GDP but to consider additional dimensions that it does not account for. Secondly, it confirms the important issue of the persistence of differences not only between countries but also within the regions of the same country: as shown above, not all the regions of a same country are included in the same group (figure 9). Assessment of the well-being dynamics across regions is performed by looking at the existence of convergence processes. The analysis in terms of σ-convergence, aimed to verify if disparities decreased over time, is conducted by using three different measures of dispersion: the coefficient of variation, the Theil index and the Gini index. The results show that, in terms of the EWB index, European regions converged in the ten year interval analysed, independently of the measure of inequality used. The σ-convergence rate during the period goes from 0.50, if we consider the Theil index, to 3.23, if we look at the Gini coefficient. The reduction of inequalities interested both sub-periods, but was more marked in the first one. Looking at per-capita GDP, the decrease is higher in value, even if the convergence process is almost completely concentrated in the first sub-period and is relatively feeble (with a convergence rate of 0.46) in the second. The trend of the inequality measures of GDP is also found for the economic dimension of the EWB, the Material Conditions index, characterised by an overall σ-convergence rate of at least 8.22 (Gini coefficient), even if it shows a less marked slow-down in the second sub-period. A concave curve is found for the Health, Local Attractiveness and, though less markedly, Education indices. Relatively to these areas, in the first five years there was an increase in cross-EU regional disparities followed by a reduction in the inequality measures in the following five years. In other words, for these dimensions the first five years of the new millennium were characterised by divergence, even though regions were becoming more similar in terms of GDP. Further, as regards these domains, European regions began to converge in the second sub-period when instead the GDP convergence slowed down. Conversely, a convex line is obtained for the Labour Market Equality Index, meaning that gender and intra-generational disparities across regions have increased in the labour market in more recent years. A decreasing trend for both sub-periods characterised, instead, the Knowledge Economy Index, even if convergence in the second sub-period was weaker. In conclusion, we can say that, in the first sub-period, for half of the well-being dimensions (Material conditions, Knowledge Economy and, in some measure, Labour Market Equality) we find convergence; in the second sub-period all indices converge (except for Labour Market Equality), albeit more slowly than in the past.

The analysis in terms of intra-distributional mobility assessed by means of the Kendall Index of rank concordance (γ convergence), shows no evidence of mobility of the regions across ranks. The σ-convergence process did not affect the relative position of European regions which remained almost unchanged in the time range considered; in fact, the null hypothesis of no association among ranks in different years (which means convergence is happening) is always significantly rejected (with α at 0.5%).

In conclusion, results clearly show that differences in well-being between regions do not necessarily reproduce those based on standard economic indicators. Regional differences in well-being are at least as relevant as those in terms of per capita GDP, suggesting the need to give more attention in public policy goals and design to quality-of-life features of economic progress.

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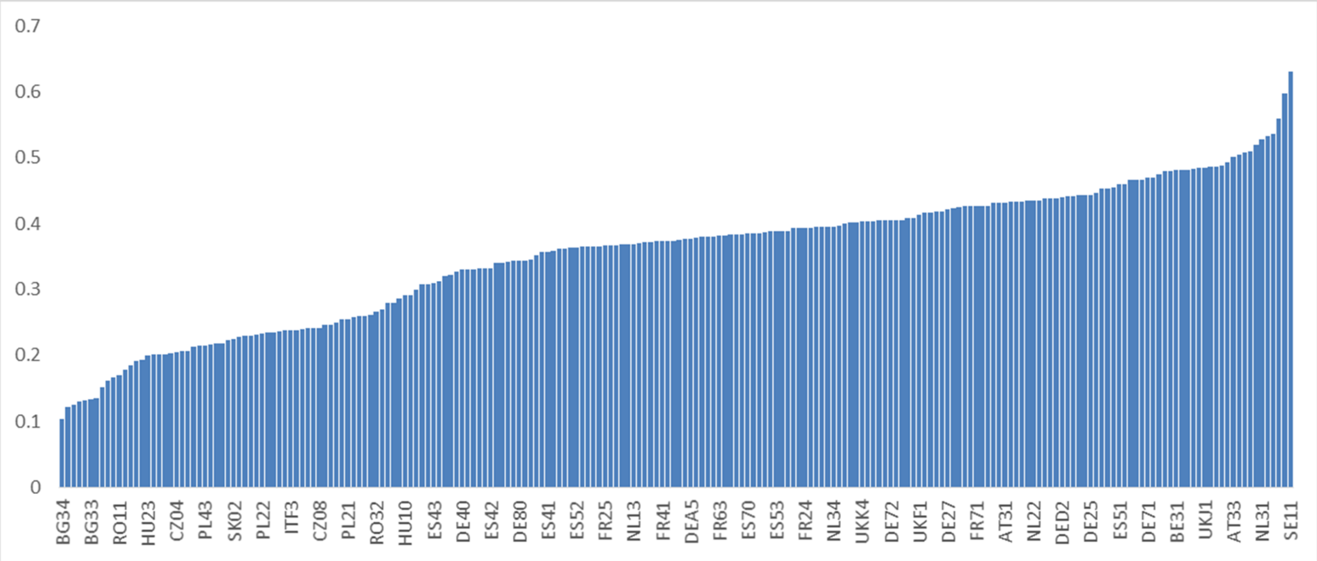
2.9 Appendices

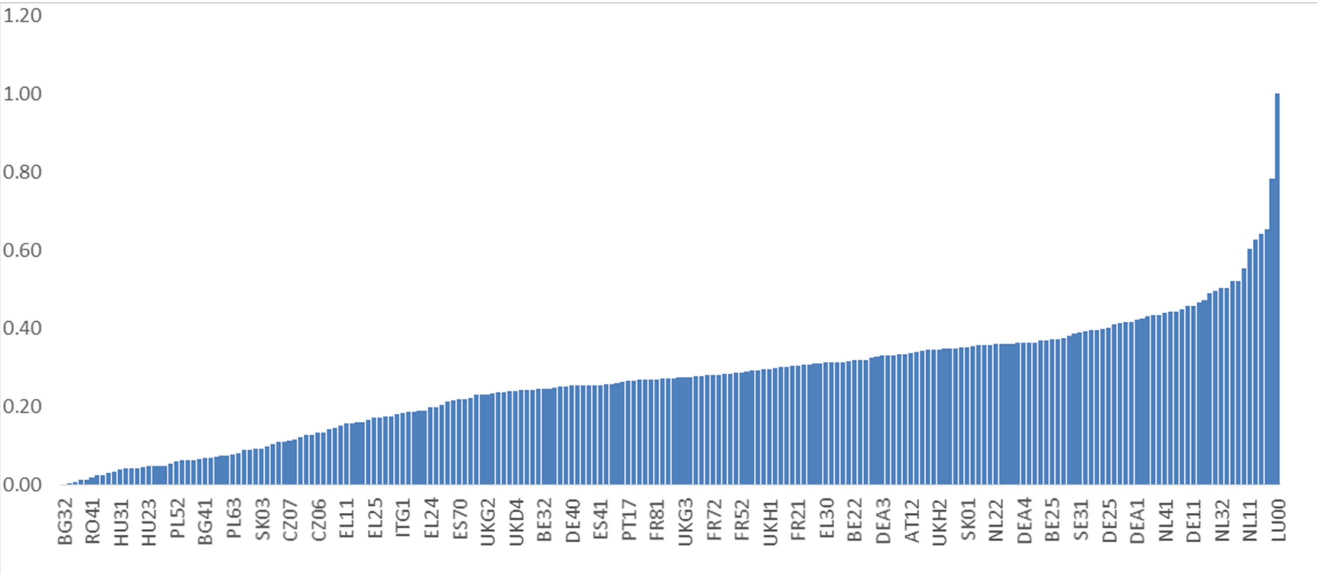
2.9.1 Figures

Figure 1- EWB values (2010)



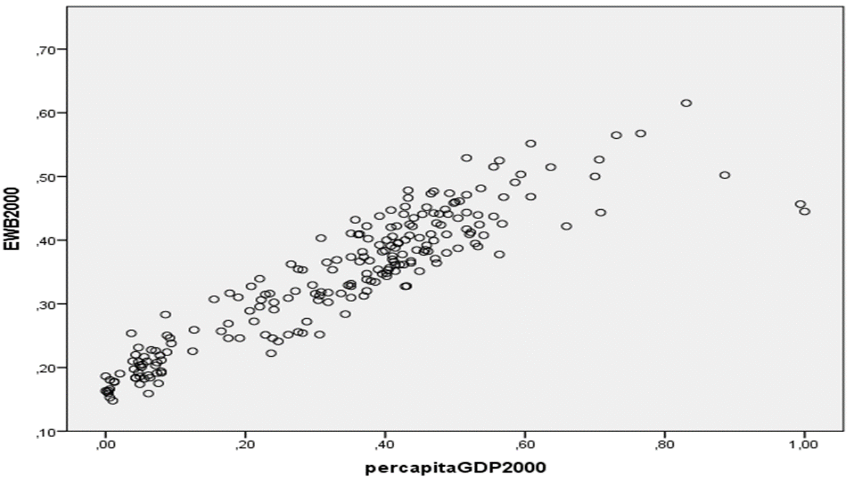
Source: our elaboration on Eurostat data

Figure 2-per-capita GDP (standardized) values (2010)

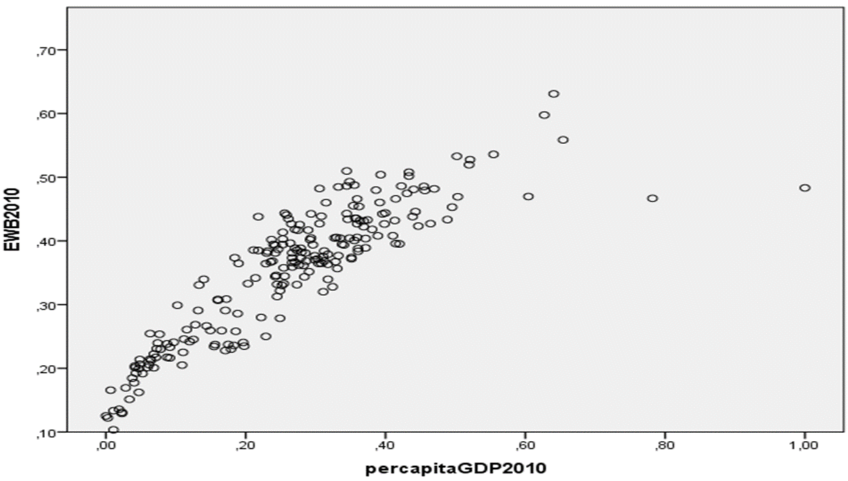


Source: our elaboration on Eurostat data

Figure 3- European NUTS 2 regions by per-capita GDP and well-being index (2004, 2010).



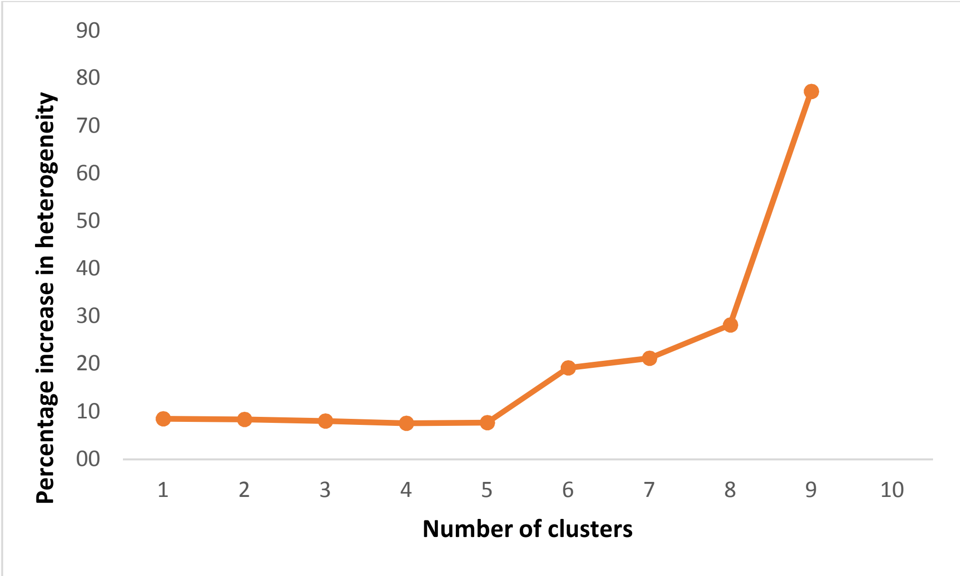
(a)



(b)

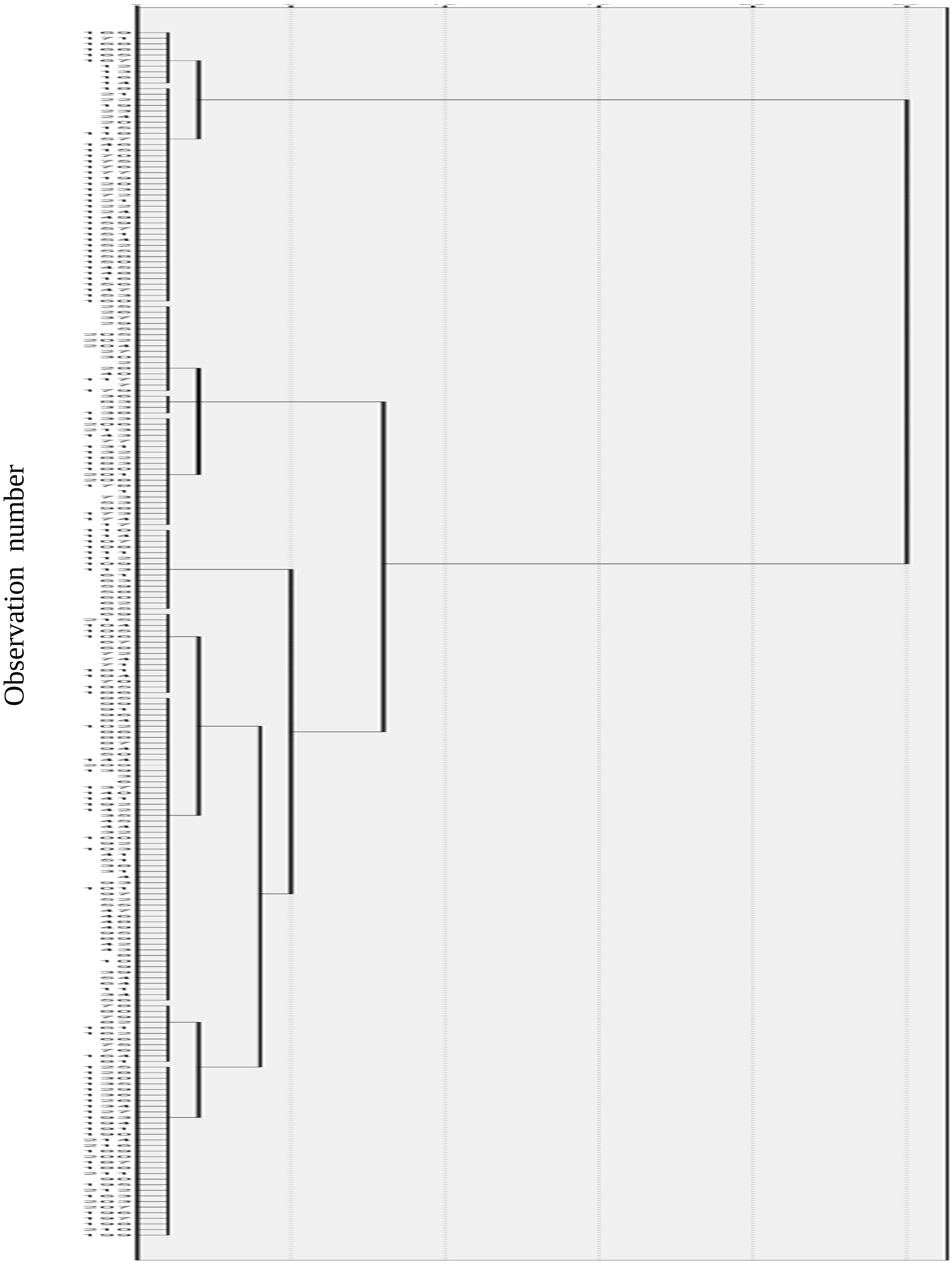
Source: our elaboration on Eurostat data

Figure 4- Percentage change in heterogeneity



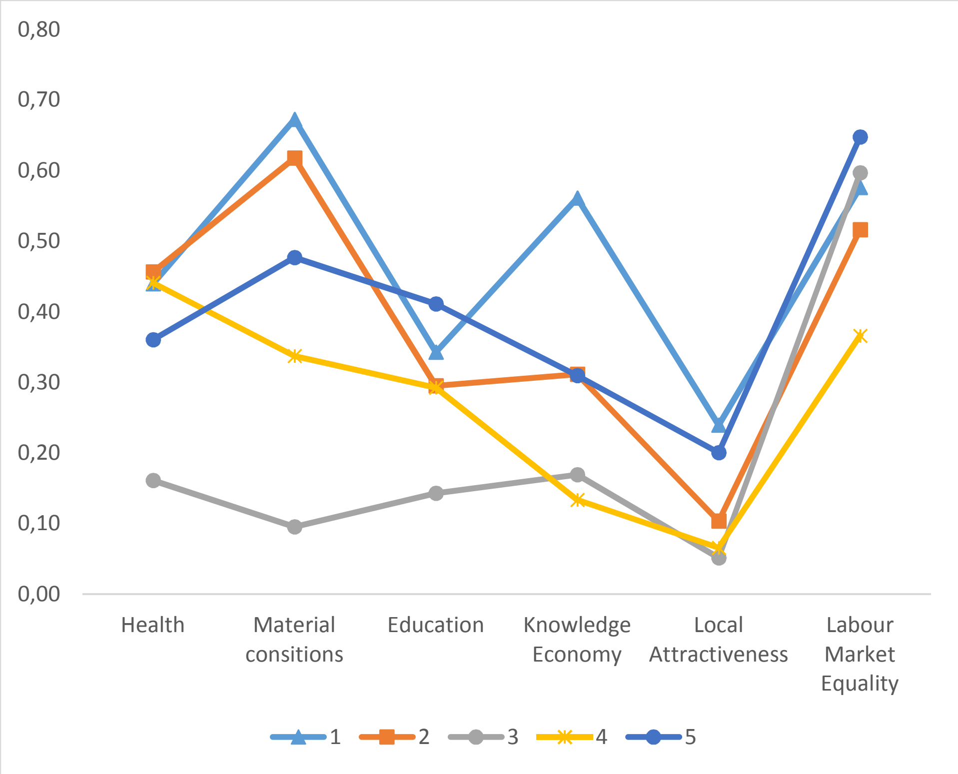
Source: our elaboration on Eurostat data

Figure 5- Dendogram



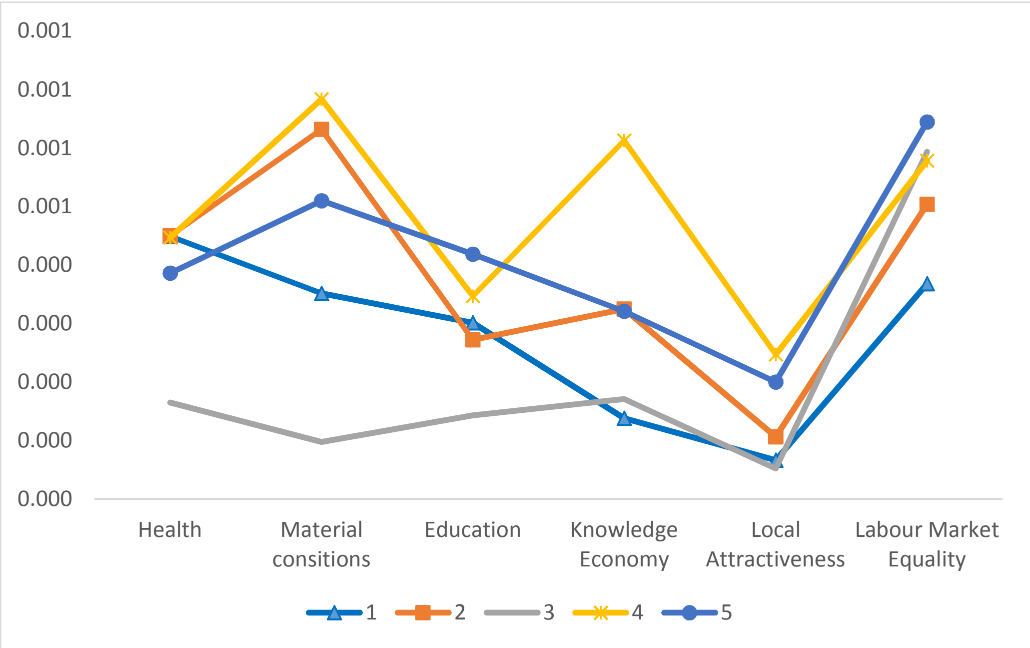
Source: our elaboration on Eurostat data

Figure 6- Hierarchical cluster Profile (Means)



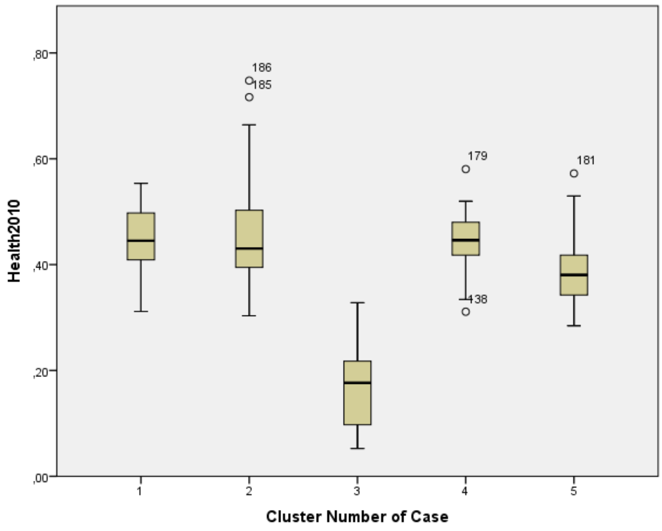
Source: our elaboration on Eurostat data

Figure 7-Non-hierarchical cluster Profile (Means)

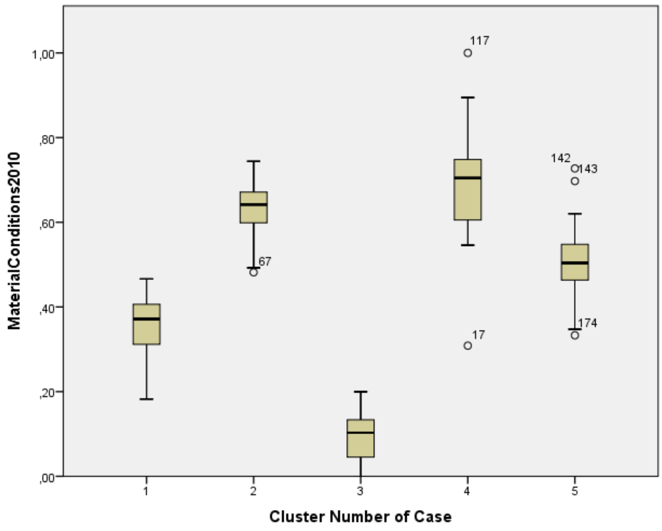


Source: our elaboration on Eurostat data

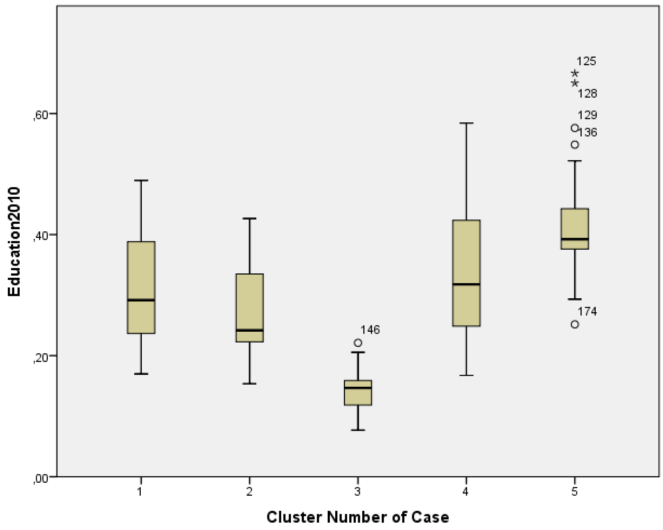
Figure 8 Box-plot K-means cluster solutions



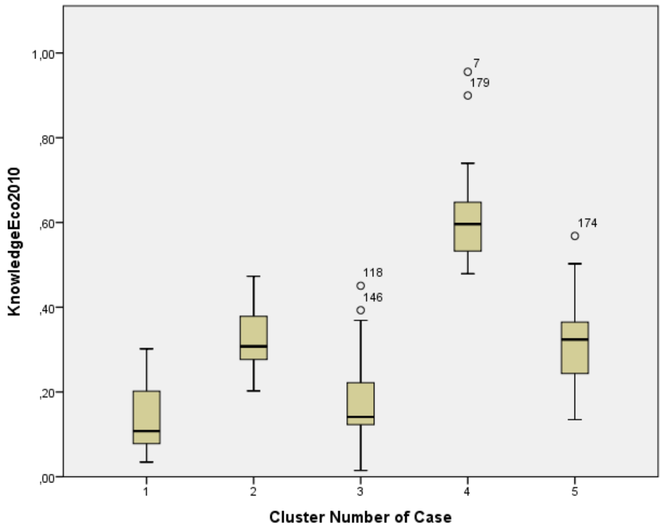
(a)



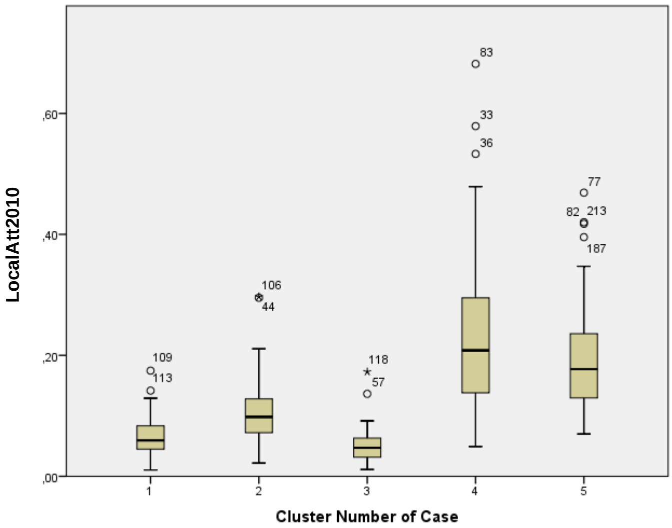
(b)



(c)



(d)



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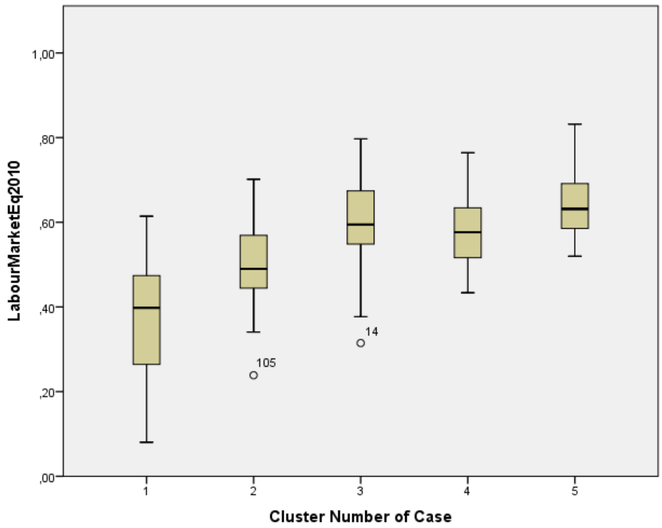
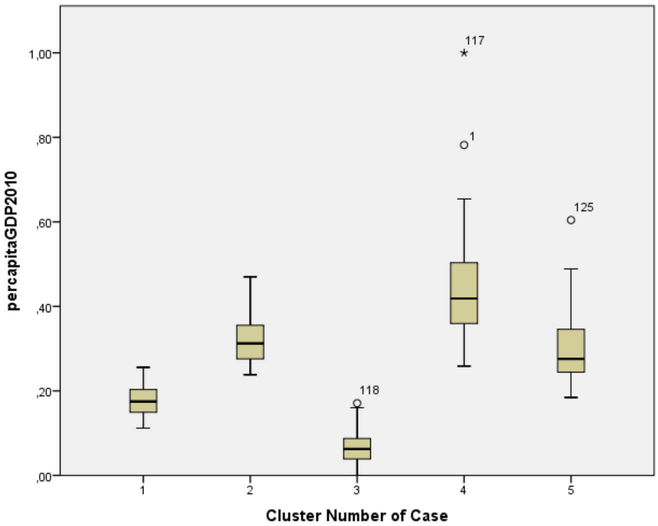


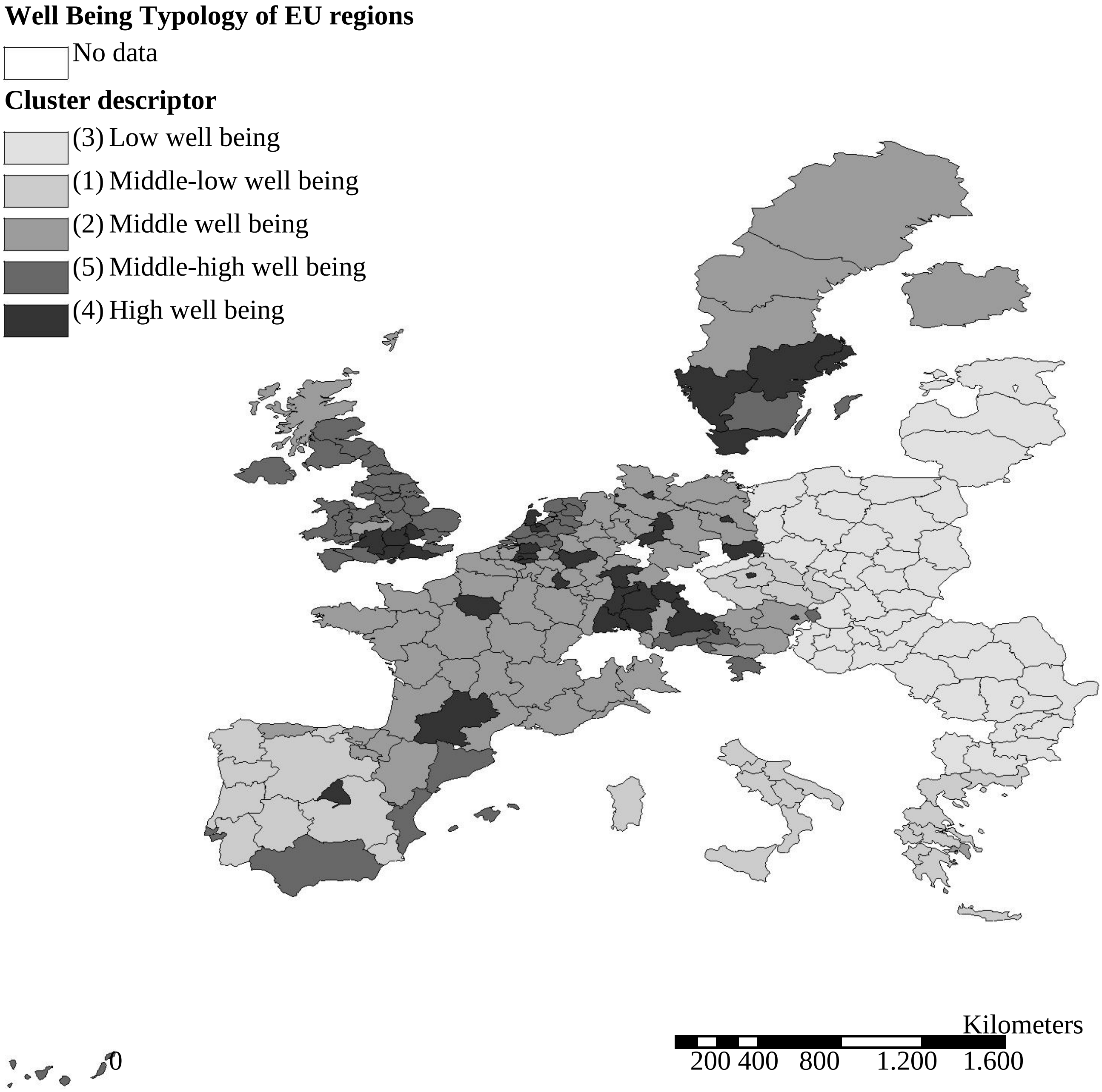
(f)



(g)

Source: our elaboration on Eurostat data

Figure 9- A taxonomy of European NUTS 2 in well-being dimensions



Source: our elaboration on Eurostat data

Figure 10- Inequality in the per-capita GPD and in the EWB and its components (2000=100)

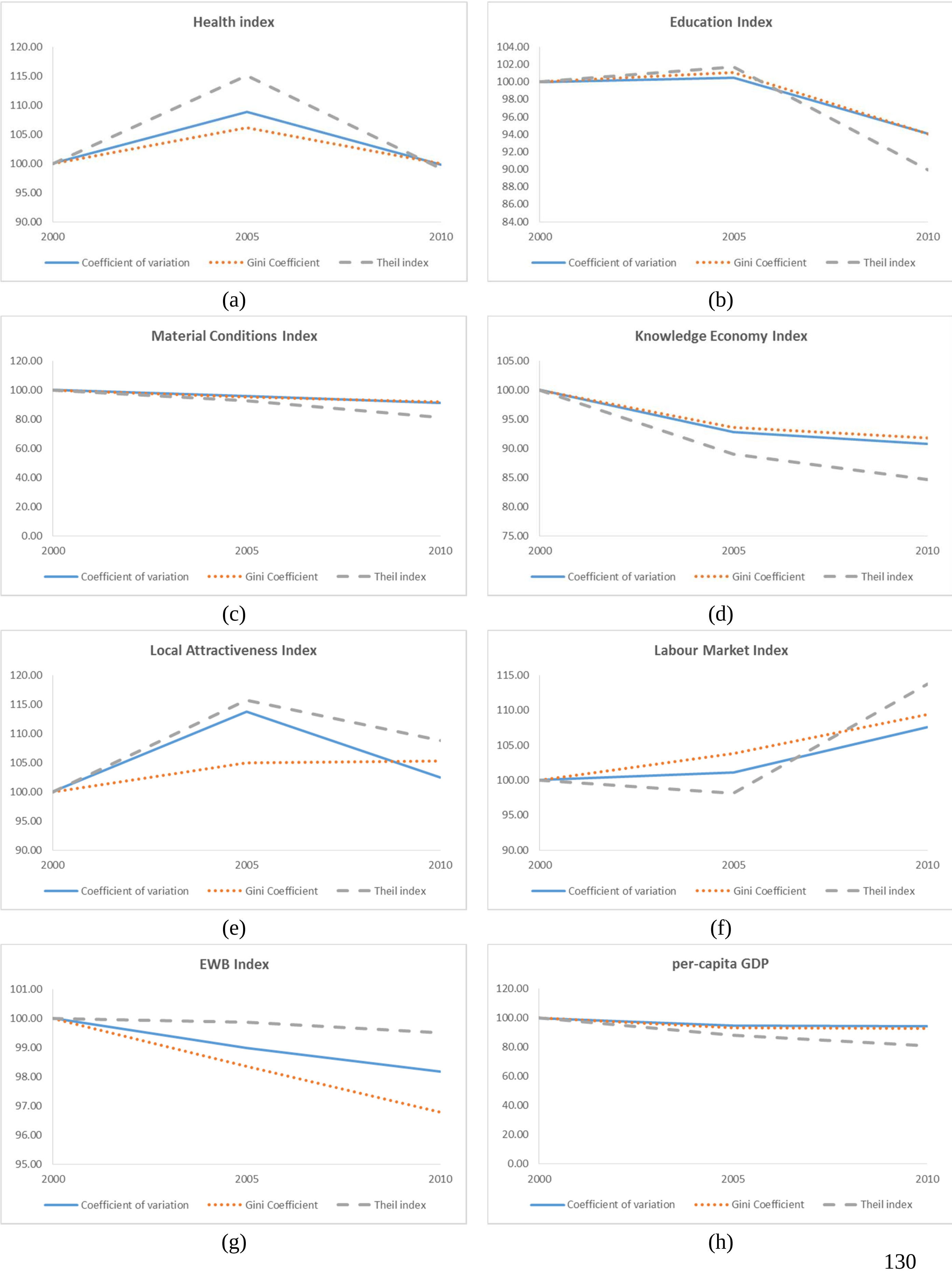
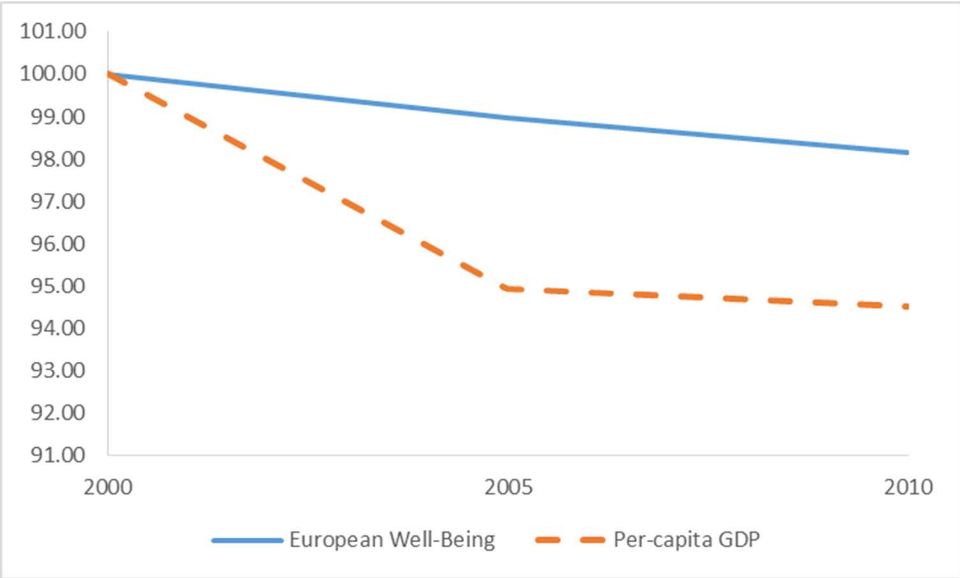


Figure 11- EWB and per-capita GDP coefficients of variation (2000-2010)



Source: our elaboration on Eurostat data

2.9.2 Tables

Table 1- Variables, definitions and polarities

PILLAR	CODE	TITLE	Polarity relative to EWB
HEALTH AND SOCIAL CONDITIONS	H1	Population density	-
	H2	Life expectancy at birth (ex)	+
	H3	Infant mortality rate at birth - ratio of the total number of deaths of children under one year of age during the year to the number of live births in that year. The value is expressed per 1000 live births.	-
MATERIAL CONDITIONS	M1	Household per-capita disposable income	+
EDUCATION AND TRAINING	E1	Persons aged 25-64 with lower secondary education attainment, %	+
	E2	Participation of adults aged 25-64 in education and training %	+
	E3	Young people aged 18-24 not in employment and not in any education or training, NEET rates level 0-2 ISCED %	-
KNOWLEDGE ECONOMY	K1	Total intramural R&D expenditure (GERD)	+
	K2	Human resources in Science and Tech; % active pop	+
	K3	Employment in technology and knowledge-intensive sectors	+
LOCAL ATTRACTIVENESS	LA1	Arrivals at tourist accommodation establishments	+
	LA2	Victims in road accidents (deaths per million inhabitants)	-
LABOUR MARKET	L1	Young employment index [Young Employment (15-34y)/Total employment]	+
	L2	Women employment index [Women Employment(15-64y) /Men Employment (15-64y)]	+
GDP		Gross domestic product (GDP) at current market prices	

Table 2-Coefficients of correlation among sub-indices (2010)

	Health	Material Conditions	Education	Knowledge Economy	Local Attractiveness	Labour Market Equality
Health	1.000	.723	.562	.390	.260	-.214
Material Conditions	.723	1.000	.479	.641	.424	-.034
Education	.562	.479	1.000	.343	.354	.170
Knowledge Economy	.390	.641	.343	1.000	.512	.251
Local Attractiveness	.260	.424	.354	.512	1.000	.266
Labour Market Equality	-.214	-.034	.170	.251	.266	1.000

Source: our elaboration on Eurostat data

Table 3-Agglomeration schedule for hierarchical cluster solution (first ten and last ten stages)

Stage	Cluster Combined		Coefficients	Number of clusters after combining	Increase in heterogeneity	Proportionate increase in heterogeneity to next stage	Stage Cluster First Appears		Next Stage
	Cluster 1	Cluster 2					Cluster 1	Cluster 2	
1	169	171	.000	215	0.00	254.0	0	0	2
2	168	169	.000	214	0.00	128.6	0	1	89
3	149	159	.001	213	0.00	75.1	0	0	7
4	84	102	.002	212	0.00	46.5	0	0	39
5	119	120	.003	211	0.00	39.4	0	0	133
6	49	95	.004	210	0.00	28.9	0	0	67
7	149	157	.005	209	0.00	23.4	3	0	14
8	111	112	.006	208	0.00	20.0	0	0	134
9	155	158	.008	207	0.00	17.0	0	0	52
10	85	99	.009	206	0.00	14.7	0	0	104
.	.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	.	.
205	3	4	5.974	11	0.42	7.0	193	199	208
206	15	18	6.391	10	0.54	8.4	202	171	207
207	12	15	6.930	9	0.58	8.3	191	206	215
208	3	67	7.508	8	0.60	8.0	205	194	212
209	66	90	8.105	7	0.61	7.5	200	204	212
210	1	33	8.713	6	0.67	7.7	203	182	211
211	1	2	9.381	5	1.80	19.2	210	201	214
212	3	66	11.178	4	2.36	21.1	208	209	213
213	3	58	13.542	3	3.82	28.2	212	192	214
214	1	3	17.357	2	13.40	77.2	211	213	215
215	1	12	30.752	1			214	207	0

Source: our elaboration on Eurostat data

Table 4- Means from hierarchical cluster analysis

Variable	Mean Values Cluster Number:						
	1	**2**	**3**	**4**	**5**	**F**	**Sig.**
Nr of observations	46	68	43	28	31		
Health	0.44	0.46	0.16	0.44	0.36	137.65	0.00
Material consitions	0.67	0.62	0.10	0.34	0.48	400.11	0.00
Education	0.34	0.30	0.14	0.29	0.41	50.46	0.00
Knowledge Economy	0.56	0.31	0.17	0.13	0.31	131.02	0.00
Local Attractiveness	0.24	0.10	0.05	0.07	0.20	41.70	0.00
Labour Market Equality	0.58	0.52	0.60	0.37	0.65	35.14	0.00

Source: our elaboration on Eurostat data

Table 5- Means from K-means cluster analysis

Variable	Mean Values Cluster Number:					Mean Values all regions	ANOVA	
	1	**2**	**3**	**4**	**5**	**EU**	**F**	**Sig.**
Nr of observations	29	65	44	34	44	216		
Health	0.449	0.450	0.165	0.447	0.386	0.38	122.36	0.000
Material consitions	0.352	0.632	0.097	0.684	0.510	0.47	384.86	0.000
Education	0.301	0.272	0.143	0.347	0.418	0.29	73.68	0.000
Knowledge Economy	0.138	0.325	0.171	0.613	0.321	0.31	156.34	0.000
Local Attractiveness	0.066	0.106	0.052	0.247	0.200	0.13	39.60	0.000
Labour Market Equality	0.368	0.504	0.594	0.578	0.644	0.54	41.75	0.000

Source: our elaboration on Eurostat data

Table 6- Clusters' composition

(a) Cluster 1- Middle-low well-being regions

NUTSCODE	NUTSLABEL
CZ02	Stedníechy
CZ03	Jihozápad
CZ05	Severovýchod
CZ06	Jihovýchod
CZ07	Stední Morava
EL11	Anatoliki Makedonia, Thraki)
EL12	Kentriki Makedonia)
EL14	Thessalia
EL23	Dytiki Ellada
EL24	Sterea Ellada
EL25	Peloponnisos
EL43	Kriti
ES11	Galicia
ES13	Cantabria
ES41	Castilla y León
ES42	Castilla-La Mancha
ES43	Extremadura
ES62	Región de Murcia
ITF1	Abruzzo
ITF2	Molise
ITF3	Campania
ITF4	Puglia
ITF5	Basilicata
ITF6	Calabria
ITG1	Sicilia
ITG2	Sardegna
PT11	Norte
PT16	Centro (PT)
PT18	Alentejo

(b) Cluster 2- Middle well-being regions

NUTSCODE	NUTSLABEL
BE22	Prov. Limburg (BE)
BE23	Prov. Oost-Vlaanderen
BE25	Prov. West-Vlaanderen
BE32	Prov. Hainaut
BE33	Prov. Liège
BE34	Prov. Luxembourg (BE)
BE35	Prov. Namur
DE26	Unterfranken
DE27	Schwaben
DE40	Brandenburg
DE72	Gießen
DE80	Mecklenburg-Vorpommern
DE92	Hannover
DE93	Lüneburg
DE94	Weser-Ems
DEA1	Düsseldorf
DEA3	Münster
DEA4	Detmold
DEA5	Arnsberg
DEB1	Koblenz
DEB2	Trier
DEB3	Rheinhessen-Pfalz
DEC0	Saarland
DEE0	Sachsen-Anhalt
DEF0	Schleswig-Holstein
DEG0	Thüringen
EL30	Attiki
ES12	Principado de Asturias
ES21	País Vasco
ES22	Comunidad Foral de Navarra
ES23	La Rioja
ES24	Aragón
FR21	Champagne-Ardenne
FR22	Picardie
FR23	Haute-Normandie
FR24	Centre
FR25	Basse-Normandie
FR26	Bourgogne
FR30	Nord - Pas-de-Calais
FR41	Lorraine
FR42	Alsace
FR43	Franche-Comté
FR51	Pays de la Loire
FR52	Bretagne
FR53	Poitou-Charentes
FR61	Aquitaine
FR63	Limousin
FR71	Rhône-Alpes
FR72	Auvergne
FR81	Languedoc-Roussillon
FR82	Provence-Alpes-Côte d'Azur
ITC1	Piemonte
ITC3	Liguria
ITC4	Lombardia
AT12	Niederösterreich
AT21	Kärnten
AT22	Steiermark
AT31	Oberösterreich
AT34	Vorarlberg
FI19	Länsi-Suomi
SE31	Norra Mellansverige
SE32	Mellersta Norrland
SE33	Övre Norrland
UKG1	Herefordshire, Worcestershire and Warwickshire
UKM6	Highlands and Islands

(c) Cluster 3- Low well-being regions

NUTSCODE	NUTSLABEL
BG32	Severen tsentralen)
BG33	Severoiztochen)
BG34	Yugoiztochen)
BG41	Yugozapaden)
BG42	Yuzhen tsentralen)
CZ04	Severozápad
CZ08	Moravskoslezsko
EE00	Eesti
LV00	Latvija
LT00	Lietuva
HU10	Közép-Magyarország
HU21	Közép-Dunántúl
HU22	Nyugat-Dunántúl
HU23	Dél-Dunántúl
HU31	Észak-Magyarország
HU32	Észak-Alföld
HU33	Dél-Alföld
PL11	ódzkie
PL12	Mazowieckie
PL21	Maopolskie
PL22	lskie
PL31	Lubelskie
PL32	Podkarpackie
PL33	witokrzyskie
PL34	Podlaskie
PL41	Wielkopolskie
PL42	Zachodniopomorskie
PL43	Lubuskie
PL51	Dolnolskie
PL52	Opolskie
PL61	Kujawsko-Pomorskie
PL62	Warmisko-Mazurskie
PL63	Pomorskie
RO11	Nord-Vest
RO12	Centru
RO21	Nord-Est
RO22	Sud-Est
RO31	Sud - Muntenia
RO32	Bucureti - Ilfov
RO41	Sud-Vest Oltenia
RO42	Vest
SK02	Západné Slovensko
SK03	Stredné Slovensko
SK04	Východné Slovensko

(d) Cluster 4-High well-being regions

NUTSCODE	NUTSLABEL
BE10	Région de Bruxelles-Capitale/Brussels Hoofdstedelijk Gewest
BE21	Prov. Antwerpen
BE24	Prov. Vlaams-Brabant
BE31	Prov. Brabant Wallon
CZ01	Praha
DE11	Stuttgart
DE12	Karlsruhe
DE13	Freiburg
DE14	Tübingen
DE21	Oberbayern
DE25	Mittelfranken
DE30	Berlin
DE50	Bremen
DE60	Hamburg
DE71	Darmstadt
DE91	Braunschweig
DEA2	Köln
DED2	Dresden
ES30	Comunidad de Madrid
FR10	Île de France
FR62	Midi-Pyrénées
LU00	Luxembourg
NL31	Utrecht
NL32	Noord-Holland
AT13	Wien
SE11	Stockholm
SE12	Östra Mellansverige
SE22	Sydsverige
SE23	Västsverige
UKH2	Bedfordshire and Hertfordshire
UKJ1	Berkshire, Buckinghamshire and Oxfordshire
UKJ2	Surrey, East and West Sussex
UKJ3	Hampshire and Isle of Wight
UKK1	Gloucestershire, Wiltshire and Bristol/Bath area

(e) Cluster 5- Middle-high well-being regions

NUTSCODE	NUTSLABEL
ES51	Cataluña
ES52	Comunidad Valenciana
ES53	Illes Balears
ES61	Andalucía
ES70	Canarias
NL11	Groningen
NL12	Friesland (NL)
NL13	Drenthe
NL21	Overijssel
NL22	Gelderland
NL23	Flevoland
NL33	Zuid-Holland
NL34	Zeeland
NL41	Noord-Brabant
NL42	Limburg (NL)
AT32	Salzburg
AT33	Tirol
PT17	Lisboa
SI02	Zahodna Slovenija
SK01	Bratislavský kraj
SE21	Småland med öarna
UKC1	Tees Valley and Durham
UKC2	Northumberland and Tyne and Wear
UKD3	Greater Manchester
UKD4	Lancashire
UKE1	East Yorkshire and Northern Lincolnshire
UKE2	North Yorkshire
UKE3	South Yorkshire
UKE4	West Yorkshire
UKF1	Derbyshire and Nottinghamshire
UKF2	Leicestershire, Rutland and Northamptonshire
UKF3	Lincolnshire
UKG2	Shropshire and Staffordshire
UKG3	West Midlands
UKH1	East Anglia
UKH3	Essex
UKJ4	Kent
UKK2	Dorset and Somerset
UKK4	Devon
UKL1	West Wales and The Valleys
UKL2	East Wales
UKM2	Eastern Scotland
UKM3	South Western Scotland
UKN0	Northern Ireland

Table 7- Cross-Classification to assess cluster stability

Cluster Number of Case First K-Means	Cluster Number of Case Second K-Means					Total
	1	2	3	4	5	
1	0	0	29	0	0	29
2	0	0	0	0	65	65
3	0	44	0	0	0	44
4	0	0	0	34	0	34
5	44	0	0	0	0	44
Total	44	44	29	34	65	216

Source: our elaboration on Eurostat data

Table 8- Multivariate F Results assessing Cluster solution Criterion Validity

Tests of Between-Subjects Effects

Source	Dependent Variable	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	EWB	1,953[a]	4	,488	291,312	,000
	Per-capita GDP	3,519[b]	4	,880	139,114	,000

Multivariate tests

Effect		Value	F	Hypothesis df	Error df	Sig.
	Pillai's Trace	,952	47,965	8,000	422,000	,000
	Wilks' Lambda	,134	91,139[c]	8,000	420,000	,000
	Hotelling's Trace	5,841	152,604	8,000	418,000	,000
	Roy's Largest Root	5,729	302,196[d]	4,000	211,000	,000

a) R Squared = ,847 (Adjusted R Squared = ,844

b) R Squared = ,725 (Adjusted R Squared = ,720

c) Exact statistic

d) The statistic is an upper bound on F that yields a lower bound on the significance level.

Source: our elaboration on Eurostat data

Table 9- σ-convergence for each of the indexes of overall well-being, for the overall index of well-being and for per-capita GDP

	Inequality measure	2000	2005	2010	σ-convergence rate 2000-2005	2005-2010	2000-2010
	Coefficient of variation	0.351	0.383	0.351	8.90	-8.34	-0.18
Health	Gini Coefficient	0.190	0.202	0.190	6.18	-5.82	-0.01
	Theil index (GE(a), a = 1)	0.073	0.084	0.072	15.12	-13.88	-0.86
	Coefficient of variation	0.438	0.440	0.412	0.47	-6.34	-5.90
Education	Gini Coefficient	0.247	0.249	0.232	1.05	-6.96	-5.99
	Theil index (GE(a), a = 1)	0.094	0.096	0.085	1.68	-11.55	-10.07
	Coefficient of variation	0.534	0.511	0.487	-4.22	-4.74	-8.77
Material Conditions	Gini Coefficient	0.295	0.280	0.271	-4.99	-3.40	-8.22
	Theil index (GE(a), a = 1)	0.187	0.173	0.152	-7.41	-12.28	-18.77
	Coefficient of variation	0.611	0.567	0.555	-7.25	-2.10	-9.20
Knowledge Economy	Gini Coefficient	0.334	0.313	0.307	-6.46	-1.94	-8.27
	Theil index (GE(a), a = 1)	0.184	0.164	0.156	-11.02	-4.89	-15.38
	Coefficient of variation	0.813	0.925	0.833	13.77	-9.93	2.47
Local Attractiveness	Gini Coefficient	0.390	0.410	0.411	4.92	0.34	5.27
	Theil index (GE(a), a = 1)	0.260	0.300	0.282	15.73	-6.00	8.79
	Coefficient of variation	0.221	0.224	0.238	1.06	6.43	7.56
Labour Market Equality	Gini Coefficient	0.118	0.123	0.130	3.77	5.44	9.41
	Theil index (GE(a), a = 1)	0.028	0.028	0.032	-1.87	15.86	13.69
	Coefficient of variation	0.298	0.295	0.292	-1.02	-0.82	-1.83
European Well-Being	Gini Coefficient	0.169	0.167	0.164	-1.64	-1.62	-3.23
	Theil index (GE(a), a = 1)	0.046	0.046	0.046	-0.13	-0.37	-0.50
	Coefficient of variation	0.597	0.566	0.564	-5.06	-0.46	-5.49
Per-Capita GDP	Gini Coefficient	0.331	0.309	0.307	-6.50	-0.79	-7.23
	Theil index (GE(a), a = 1)	0.214	0.189	0.173	-11.69	-8.39	-19.10

Source: our elaboration on Eurostat data

Table 10- Kendall's index - γ convergence

	2000	2005	p-value	2010	p-value
Health	1	0.9488	<0.005	0.9224	<0.005
Education	1	0.9650	<0.005	0.9558	<0.005
Material conditions	1	0.9865	<0.005	0.9418	<0.005
Knowledge Economy	1	0.9827	<0.005	0.9623	<0.005
Local Attractiveness	1	0.9503	<0.005	0.9396	<0.005
Labour market	1	0.8852	<0.005	0.8372	<0.005
Well Being	1	0.9850	<0.005	0.9695	<0.005
Per-capita GDP	1	0.9915	<0.005	0.9641	<0.005

Source: our elaboration on Eurostat data

ESSAY 3

MEASURING WELL-BEING IN A MULTIDIMENSIONAL PERSPECTIVE: A MULTIVARIATE STATISTICAL APPLICATION TO ITALIAN REGIONS

[Abstract]
The interest for measures of well-being, as opposed to more traditional economic indicators of wealth, has been rapidly increasing in recent years. This paper aims to contribute to the empirical literature on the measurement of well-being indicators. We consider ten dimensions of well-being and calculate, for each of them, a synthetic indicator, by applying principal component analysis. The focus is on the 20 Italian regions. The dimensions of well-being considered relate to: culture and free time; education; employment; the environment; availability of essential public services; health; material living conditions; personal security; research and innovation; and the strength of social relations. Overall, 57 variables are considered. We then use these indicators of different aspects of the well-being of an area to generate – again, by using principal component analysis - an index of overall well-being. The analysis is conducted for each of the seven years over the period 2004-2010. Rankings of the regions based on the indicators of well-being are compared with those based of the most traditional indicator of economic performance, per-capita GDP. Results clearly show that differences in well-being between regions do not necessarily reproduce those based on standard economic indicators. Regional differences in well-being are at least as relevant as those in terms of per capita GDP, suggesting the need to give more attention in public policy goals and design to quality-of-life features of economic progress. Further, the essay investigates well-being dispersion across regions and rank mobility over the same period. Italian regions tend to become more similar in terms of their well-being over time (σ-convergence), but no evidence emerges of significant intra-distributional mobility (γ-convergence).

Keywords: well-being indicators; σ-convergence; γ-convergence; principal component analysis; Italy; regions.
Jel Classification: D63; I31; O18; R11.

3.1 Introduction

The issue of measurement of well-being beyond its economic features has gained momentum both in academic research and in public debate.
An impulse to the intensification of studies in this field has recently been provided by the publication of the Report by the "Commission for the Measurement of Economic Performance and Social Progress" (Stiglitz *et al*., 2009), but also by a number of initiatives promoted by prestigious international organizations: the UNDP, since the beginning of the Nineties, has been carrying out the pioneering work of calculating a Human Development Index (HDI); the OECD starting from 2011 provides a bi-annual assessment of well-being in member countries and in selected emerging economies (OECD 2013); the European Union organized a number of international conferences with the aim of going "beyond GDP" in order to construct well-being indicators, on the assumption that environmental protection, biodiversity and social cohesion are essential factors for progress;

since 2011 the European Statistical System Committee (ESSC) has been working towards developing a set of Quality of Life indicators for EU countries.
At the same time, many countries have intensified their efforts to produce statistics for measuring well-being. The report of the "Stiglitz Commission" cited before was in fact commissioned by the French government to a group of experts, including Nobel laureates. In the United States, the 2010 Key national Indicators Act prescribes the creation of a system of indicators providing accurate information on well-being in a number of dimensions; in Canada, the *Canadian index of well-being* considers indicators of social and living conditions of the population; in Ireland the Central Statistics Office measures progress based on 109 indicators, more than half relating to the social domain, the others covering the economy, innovation and the environment. In the Netherlands, the Dutch Social and Cultural Planning Office provides the *Living Condition Index*, which combines eight indicators covering aspects such as housing, health, consumption of durables, leisure, sports, social participation, mobility and holidays. A task force on "Growth, well-being and quality of life" which includes a section on the "development of a comprehensive welfare and progress indicator" was launched by the German Parliament in 2010. In the United Kingdom the Office for National Statistics (ONS) launched in 2010 the "Measuring National Well-being Programme" and started to hold a consultation on proposed actions and indicators for the measurement of well-being. The National Statistical Office of Malta has recently improved the methodology and enriched the set of indicators included in its Survey Income and Living Conditions carried on since 2005 with statistics on the information society and sustainable development. In Italy, a recent project carried on by the Italian National Institute of Statistics (ISTAT) in conjunction with the National Council for Economy and Labour (CNEL) has given rise to a data base covering 12 dimensions of "Equitable and Sustainable Well-Being" (whose Italian acronym, used hereafter, is BES) consisting of a set of 134 outcome indicators[1]. They also provide a report in which well-being in Italy is examined from a multi-dimensional perspective in the spirit of the recommendations of the "Stiglitz Commission", with each chapter focusing on one specific issue. The BES report, however, does not attempt the final step of aggregating the data into a synthetic measure of well-being.
This paper aims to contribute to the empirical literature by investigating changes in ten different dimensions of well-being in Italian regions. From a strict economic standpoint, many indicators geographically group Italian regions into more developed areas clustered in the Centre-North of the country, while in the South, notwithstanding the existence of important entrepreneurial successes and high-tech clusters (see Cersosimo and Viesti 2013), areas of economic backwardness are still common (Figure 1)[2]: the eight Mezzogiorno regions as a whole produce 25% of the national GDP and export only 10% of the overall Italian exportations, the South contains one third of the overall population but two thirds of the country's poor and 45% of the unemployed; labour productivity in the South is 20% lower than the Centre-North and the employment rate is less than 30% (Franco 2010). Behind the (economic) dualism between the two macro-areas, Italian regions differ in a number of other structural aspects which influence well-being. To give a few examples, Valle d'Aosta and Basilicata have a population density eleven and seven times lower than Campania or Lombardia, respectively; Lazio, Umbria and Marche have the highest percentage of people aged 30-

[1] The Bes data-base is available at www.istat.it
[2] Sub-national areas in Italy include eight regions (Valle d'Aosta, Piemonte, Lombardia, Trentino Alto Adige, Friuli-Venezia Giulia, Liguria, Emilia Romagna and Veneto) for the North; four regions for the Centre (Toscana, Marche, Umbria and Lazio) and eight regions for the South, or Mezzogiorno (Abruzzo, Molise, Campania, Puglia, Basilicata, Calabria, Sicilia and Sardegna).

34 university graduated, more than twice that Sicilia and Campania; the highest percentage of children up to age 3 using child-care services is found to live in Emilia Romagna (29%) and in Umbria (28%) while the lowest percentage is that of Calabria (2.4%); sedentary lifestyle in Sicilia and Campania concerns 60% aged 14 and over, against 14% in Trentino-Alto Adige and so on. We can continue with a long list of examples which highlight important regional differences in many aspects of the multifaceted phenomenon of the quality of life.

By adopting a multidimensional perspective, we calculate one synthetic indicator for each domain of well-being considered, combining a set of 57 variables at the regional level, by means of the principal component analysis. We then use these partial synthetic indicators to construct an overall index of well-being. As our goal was, other than the measurement of current well-being, to assess the process of convergence/divergence, we focused on dimensions for which variables were available for the same time interval, i.e. the period 2004-2010.

Compared with the BES report (CNEL-ISTAT 2013) our analysis does not address the dimensions of "subjective well-being"; "politics and institutions", "landscape and cultural heritage" because not enough variables are available at regional level or because, in relation to these areas, data are accessible only for a too short period for the purpose of our analysis. However, in addition to the issues discussed in the BES report, we consider the "culture and free-time" dimension, another key aspect of well-being, on account of the intrinsic effects that culture and sport can have in terms of physical and psychological health, individual enjoyment and leisure, but also for the externalities they determine: cultural consumption has been shown to foster civic participation, social capital and social cohesion (Carlisle and Hanlon 2007; Diener 2002, 2009; Grossi *et al*. 2012; Peterson 2012)[3].

The goal of this essay, therefore, is threefold: a) to construct a synthetic indicator, by means of the principal component analysis, for each of the ten dimensions of well-being considered, for the period 2004-2010 for each of the Italian regions; b) to build an overall index of well-being derived from the indicators calculated in the previous step of the analysis; c) to assess the existence of processes of convergence across the Italian regions in terms of well-being using two non-parametric techniques, applied to both the partial and overall indicators which have been calculated. We also compare the dynamics of regional well-being with those of the traditional indicator of economic performance, per-capita GDP.

The contribution of our work to this area of research is, therefore, both conceptual and methodological. First, it expands the spectrum of domains and variables through which much of the empirical literature has measured well-being in Italy so far; further, it analyses convergence for both single-domain indexes and the overall well-being indicator, thus capturing the dynamics of well-being by assessing changes in progress and in various aspects of the quality of life over time. A number of important initiatives used to construct multidimensional indexes do so for one year only (i.e. Annoni and Weziak-Bialowolska 2012; OECD 2011, 2013). Secondly, to the best of our knowledge, this is the first paper that uses principal component analysis in a two-steps approach in order to calculate single domain sub-indexes, in the first step, and the overall well-being indicator in the second step, using as new variables the sub-indexes. Most of the empirical literature on measuring well-being, in fact, relies upon either composite indicators calculated as weighted averages of variables and sub–indexes (Berloffa and Modena 2012; Marchante *et al*. 2006; OECD 2013) or mixed statistical strategies that use principal component analysis to assess the internal

[3] As a matter of facts, some institutions, such as the Scottish Executive, have proposed to construct a specific index for measuring the benefit of culture and sport on quality of life and well-being (Scottish Executive 2005).

coherence of the different domains, whereas the final composite well-being indicator is calculated as a weighted average of the partial indexes (Annoni and Weziak-Bialowolska 2012).
The paper is structured as follows. Section 2 deals with related studies on measuring well-being. Section 3 presents the data and methodology used; section 4 shows the results for Italian regions regarding the different dimensions of well-being considered. In section 5 the results of the synthetic index of well-being are discussed. Section 6 presents the analysis of regional disparities trends in terms of both partial and overall well-being indicators. Finally, Section 7 concludes by discussing the results.

3.2 Related literature

Since its introduction, GDP is, at the same time, the most widely used indicator of the economic performance of a country, and the most criticized measure of well-being. Even those economists who contributed to defining national accounts, stated that the welfare of a nation could not be measured by the level of the Gross Domestic Product (see, for instance, Kuznets 1934). At the beginning of the Seventies, Nordhaus and Tobin (1973) wondered whether growth in terms of variation of the Gross National Product, is an obsolete concern of economic theory, proposing a primitive and experimental "measure of economic welfare (MEW), in which we attempt to allow for the more obvious discrepancies between GNP and economic welfare" (p. 512).
The literature dealing with well-being measurement holds that it is a multidimensional issue, thus it is necessary to capture information on different aspects which are relevant for people's quality of life. This poses two questions: the first one, on conceptual grounds, is to define which specific factors are relevant for individual well-being; the second, on empirical grounds, regards the collection and processing of information from very different ambits of human life. Both questions have not yet received an exhaustive or unanimous answer, but indeed, they are the two key research strands to which the recent literature has contributed. Fleurbaey (2009) proposes a critical review of the literature splitting up these two strands into four different approaches ("corrected GDP"; "sustainability and nonmarket factors"; measurement of the "gross national happiness" and the "capability approach" proposed by Sen 1985, 2000 and Nussbaum 2000; 2011; and the construction of "synthetic indicators")[4].
The Report of the "Stiglitz Commission" supports the idea that it is necessary to integrate the measurement of activities more closely related to the material standards of living (income, consumption, wealth) with elements regarding sustainability and social cohesion (health, education, social and natural environment, personal safety, the right to work and decent housing). Bleys (2012) proposes a scheme for classifying 23 of the indicators available in the literature.
With regard to the Italian case, few studies attempt to provide summary statistics alternative to GDP or an analysis of well-being at the regional level. Berloffa and Modena (2012) calculate for Italy as a whole and the Lombardia region in particular, a "revised version" of the Index of Economic Well-Being (IEBW) developed by the Centre for the Study of Living Standards (Osberg 1985; Osberg and Sharpe 2002, 2005). Their revised version adds two indicators: the proportion of temporary workers in the economic security dimension and the age wage gap in the equality dimension. The authors use composite indicators and a subjective weighting procedure to aggregate the partial indexes. They note that the inclusion of the two new variables lowers well-being both in Italy and in

[4] For a survey on the latter approach see Bandura (2008), Gadrey and Jany-Catrice (2006), Stiglitz *et al*. (2009); Annoni and Weziak-Bialowolska (2012); Costanza *et al.* (2009).

the Lombardia region, when compared to the "base IEWB", the index when the two variables are not included. Capriati (2011) builds a "real freedom index", given by the weighted average of seven variables, to analyse Italian regional disparities through the dynamics of the coefficient of variation of the index in three-year intervals from 1998 to 2007. For both Spanish and Italian regions, Murias *et al*. (2013) calculated a composite indicator of well-being by combining five variables (consumption per capita, research and development, higher education, the Gini index, unemployment rate) through a technique based on data envelopment analysis (DEA). Although limited to just one year and few variables, their results show that regional disparities in terms of economic well-being are less marked than those resulting from traditional per-capita income indicators. Two studies adopt an historical perspective: Felice (2007) considers seven social indicators, including the UN Human Development Index and an "improved" Human Development Index in ten-year intervals from 1871 to 2001, analysing the dynamics of regional disparities in each decade; Iuzzolino *et al*. (2011) analyse convergence of Italian regions from national unification in 1861 to 2009 focusing on the per-capita GDP flanked by indicators of human development, in particular education and health.

3.3 Data and Methods

The data used in this study are extracted from ISTAT databases: the BES statistics, the specific data set published in 2013 for monitoring equitable and sustainable well-being in Italy, and the ISTAT-DPS database, a set of territorial indicators for development and cohesion policies. The description of the variables used in the analysis, their definition and source are reported in Table A1 of the Appendix.

The methodological strategy is to use the principal component analysis (hereafter PCA) in order to obtain a synthetic indicator of well-being. Further, two non-parametric statistics are used to assess convergence across Italian regions.

PCA enables us to eliminate the exogenous arbitrariness which characterizes the weighting of variables in building composite indicators. We can also evaluate the internal consistency of the indicators for each well-being dimension by analysing the structure of correlations between variables and other specific related tests, such as the Measures of Sampling Adequacy and Bartlett test. PCA is a multivariate statistical method for extracting synthetic measures from a set of variables by transforming them into a smaller set of uncorrelated variables, the principal components, capturing most of the variation present in the original data. Although since many components such as v variables in the data set are required to reproduce the total variability, much of this variability can be accounted for by a small number of p principal components. If so, the p principal component can replace the v variables without much loss of information and with the advantage that the original data set is reduced in $p<v$ principal components. The principal components are given by the uncorrelated linear combination of the original variables whose variances are as large as possible. The first principal component is the normalized linear combination with maximum variance[5].

As our aim is to obtain a synthetic indicator for each dimension of well-being, we concentrate our attention only on the first principal component, after verifying that the results are satisfactory in

[5] This means that the sum of the squared coefficient of the linear combination is equal to 1.

terms of percentage of total variance explained and the structure of correlations between variables analysed (Table 1)[6].

The principal components are extracted by the variance-covariance matrix, after dividing the original variables by their average value, in order to eliminate differences in the unit of measurement, yet preserving differences in the variability within each variable.

Algebraically, consider the linear combinations

$$Y_{1,d}^{t} = a_{11,d}^{t} I_{1,d}^{t} + a_{12,d}^{t} I_{2,d}^{t} + \cdots + a_{1v,d}^{t} I_{v,d}^{t}$$
$$Y_{2,d}^{t} = a_{21,d}^{t} I_{1,d}^{t} + a_{22,d}^{t} I_{2,d}^{t} + \cdots + a_{2v,d}^{t} I_{v,d}^{t}$$
$$\vdots$$
$$Y_{v,d}^{t} = a_{v1,d}^{t} I_{1,d}^{t} + a_{v2,d}^{t} I_{2,d}^{t} + \cdots + a_{vv,d}^{t} I_{v,d}^{t}$$

where *v* is the number of the variables considered, different for each dimension $d_{=1}^{10}$ of well-being, t is the year, with $t_{=2004}^{2010}$; $I_{1,d}^{t}, I_{2,d}^{t}, \ldots\ldots, I_{v,d}^{t}$ are the values of the variables divided by the average.

$Y_{1,d}^{t}$ is the first principal component for the *d*-th dimension of well-being in year *t* which is obtained by maximizing Var($Y_{j,d}^{t}$) subject to $(a_{11,d}^{t})^2$ + $(a_{11,d}^{t})^2$ + …+ $(a_{1v,d}^{t})^2$ =1. Any successive principal component *i*, with $i_{=2}^{v}$ is given by the linear combination $Y_{i,d}^{t}$ which maximizes Var($Y_{j,d}^{t}$) subject to $(a_{i1,d}^{t})^2$ + $(a_{i2,d}^{t})^2$ + …+ $(a_{iv,d}^{t})^2$ =1 and orthogonal to all the previous components; in other terms, the covariance between all the principal components are equal to zero: Cov $(Y_{i,d}^{t}, Y_{p,d}^{t}) = 0$, ∀*s, i ,p; p=1,…v* .

The coefficients a_{1j}^{t}, are calculated by means of the component matrix, which provides the correlations between the variables $I_{j,d}^{t}$ and the first principal component $Y_{1,d}^{t}$, on the basis of the relation (Johnson and Wichern 2007):

$$r_{1j,d}^{t} = a_{1j,d}^{t}\left[\left(\lambda_{1,d}^{t} / \sigma^{2}{}_{j,d}^{t}\right)\right]^{1/2}$$

where $r_{1j,d}^{t}$ is the generic element of the component matrix, which gives the correlation between the first principal component and the variable *j* for the dimension *d* in the year *t*; $\lambda_{1,d}^{t}$ and $\sigma^{2}{}_{j,d}^{t}$ are, respectively, the eigenvalue of the first principal component and the variance of the variable *j* for the dimension *d* in year *t*[7].

We follow a two-step approach to build our well-being index. Although the literature on the construction of well-being indexes has recently used PCA as an intermediate tool for checking the internal consistency of variables within different dimensions in order to refine the original data set (see, for instance, Annoni and Weziak-Bialowolska 2012), this multivariate technique has not been applied to the construction of the overall synthetic indicator of well-being. In the first step, the original variables for all Italian regions, grouped in ten sets, are reduced by PCA to ten synthetic indicators, one for each well-being domain, for every year of the period 2004–2010. Thus, from the original database of 57 variables we generate a new series of variables, which represent, for every year, the synthetic indicators of the different dimensions of well-being in the Italian regions. In the second step, we apply the PCA in order to extract from the ten synthetic indexes, an overall indicator of regional well-being (RWBI). As in the first step, the principal component is extracted

[6] The correlation matrix for each well-being dimension and detailed information on the results of the principal component analysis are available on request from the authors.

[7] $a_{1j,d}^{t}$ are the eigenvectors of the covariance matrix; the eigenvalue $\lambda_{1,d}^{t}$ is the variance of the first principal component for the dimension *d* in the year *t*.

from the covariance matrix. On the whole, our results relies upon 77 applications of the principal component analysis.

Further, we use the synthetic indicators of each domain and the RWBI to assess dispersion across Italian regions during the seven years period considered in the analysis. As in Marchante *et al.* (2006), the paper investigates regional gaps in well-being by means of two non-parametric statistics, known as σ-convergence (Friedman 1992; Sala-i-Martin 1994), and γ-convergence (Boyle and McCarty 1997), the latter using Kendall's index of rank concordance (Siegel 1956). Adapting the Sala-i-Martin (1996) approach on GDP convergence across countries, we can say that the Italian regions are converging in the sense of σ if the dispersion of their well-being decreases over time. Following the literature (Giannias *et al.* 1999; Marchante *et al.* 2006; Jordà and Sarabia 2014), the measure of dispersion used in the paper is the coefficient of variation calculated on the scaled values of the first principal components:

$$sY_{1,d}^{t} = \frac{(Y_{1,d}^{t} - Y_{1,d\,min})}{(Y_{1,d\,max} - Y_{1,d\,min})},$$

Where $Y_{1,d}^{t}$ is the value of the first principal component for dimension *d* and year *t*; $Y_{1,d\,min}$ and $Y_{1,d\,max}$ are the minimum and the maximum value of the first principal component for dimension *d* in the period under consideration, respectively[8]. $sY_{1,d}^{t}$ assumes values between 0 and 1.

If the coefficient of variation in *T* is lower (higher) than the coefficient of variation in *t*, with $T_{=2005}^{2010}$ and *T*>*t*, then σ-convergence (divergence) is present. Following O'Leary (2001) we also calculate the rate of σ-convergence as the rate of change between the coefficient of variation at time *T* and *t*, where a negative (positive) value implies convergence (divergence). However, some authors assess convergence by referring to the mobility of unities (countries, regions) over time within the given distribution of the relevant variable, known as β-convergence: if the relevant variable in regions starting out in a less advantageous position has a faster growth than in those regions that at the beginning show higher values, there is absolute β-convergence. Although the concepts of σ and β-convergence are related, they do not always show up together[9]. Thus, we investigate β-convergence in well-being levels of Italian regions following the approach proposed by Boyle and McCarthy (1997) which assesses the extent of intra-distributional mobility over time by focusing on the change in the ranking of each region with respect to well-being by means of Kendall's index (Siegel 1956). The literature refers to this method of assessing β-convergence as γ-convergence. We consider the binary version of Kendall's index, which takes into account the concordance between the ranks in year *T* and the initial year (in our case 2004), for the different dimensions of well-being, as well as the RWBI:

$$k_T = \frac{Var\left[AR\left(sY_{1,d}^{T}\right)_z + AR\left(sY_{1,d}^{2004}\right)_z\right]}{Var\left[2 * AR\left(sY_{1,d}^{2004}\right)_z\right]}; \quad k_T = \frac{Var\left[AR\left(sRWBI^{T}\right)_z + AR\left(sRWBI^{2004}\right)_z\right]}{Var\left[2 * AR\left(sRWBI^{2004}\right)_z\right]}$$

where $AR\left(Y_{1,d}^{T}\right)_z$ is the rank of region *z*'s indicator of the well-being dimension *d* in year *T*; analogously $AR(RWBI^{T})_z$ is the rank of the synthetic indicator of well-being for region *z* in the

[8] We find similar results by considering the minimum and the maximum values of the first principal component in each year.

[9] As a matter of fact, the existence of β-convergence is a necessary, but not sufficient, condition for the existence of σ-convergence: mobility within the distribution (β-convergence) does not ensure that dispersion shrinks over time (σ-convergence); on the other hand, σ-convergence implies (is sufficient for) β-convergence, but it is not a necessary condition (Sala-i-Martin 1996).

year T. k_T ranges between 0 and 1: the closer k_T is to zero the greater is the mobility within the distribution and the stronger is γ-convergence.
As in Boyle and McCarthy (1997) we test the null hypothesis that no association exists between ranks in year T and in 2004. If the null hypothesis is rejected, we have no γ-convergence. In the binary version of Kendall's index, the test statistic is the following:

$$\chi^2 = 2 * (S - 1) * k_T$$

It is distributed as chi-squared with $(S - 1)$ degree of freedom, where S=20 is the number of Italian regions.
Finally, in order to compare the trend in well-being convergence with that of the traditional indicator of economic progress, we also calculate σ and γ-convergence for per-capita GDP.

3.4 Results: synthetic indicators of the different dimensions of well-being (step 1)

We consider ten dimensions of well-being: Culture and free time, Education, Employment, Environment, Essential Public Services, Health, Material Living Conditions, Personal Security, Research and Innovation, Social Relations. Below we offer a brief description of each dimension and the results of the principal component analysis.

3.4.1 Culture and free time

Consumption of cultural goods and other leisure and free time activities provide benefits both at the social and economic levels, influencing the growth of human capital, enhancing social capital and relationships, improving the individual's mental and physical status. Grossi *et al*. (2012) find that access to culture plays a primary role in determining psychological well-being; Koonlaan *et al*. (2000) show the existence of a negative correlation between the frequency of attending various kinds of cultural events (movies, concerts, museums, exhibitions) and mortality risk. Similar conclusions stem from Hyppa *et al*. (2006) and Bygren *et al*. (2009). Daykin *et al*. (2008) carry out a review of the literature on the impact of the performing arts on adolescents' behaviour, social skills and interactions.
In line with the influence of consumption of cultural goods, also sport influences well-being through its impact on physical and psychological health and the opportunity it offers for social interactions (Galloway 2006).
Seven variables are used for describing the culture and free time dimension of well-being (Table A1). Two indicators refer to reading: newspaper reading (C1) measured as the percentage of people aged 6 and over who read newspapers at least once a week, and book reading (C5) measured as the percentage of people aged 6 and over who have read books in the previous 12 months. Four indicators concern attendance at cultural or leisure events, measured as the percentage of persons aged 6 and over who have attended at least once in the last year: theatre exhibitions (C2), live classical music concerts (C3), sport events (C4), museums (C6). The last indicator is sport (C7) measured as the percentage of persons aged three and over who say they practice sports.
The first principal component accounts for 79% of the total variance contained in the seven original variables in 2004 and 2005, and 80% or over in the following years (Table 1). Table 2 shows the validation of the analysis assessed by means of Kaiser's measure of sampling adequacy (hereafter MSA) falling within the meritorious range (0.8 or above, except for 2004 when it was 0.7) for the overall set of variables; it also exceeds the threshold value for individual variables except for sports

events (which ranges between 0.3 and 0.4)[10]. As a further validation of the suitability of the correlation structure of the data, we use the Bartlett Test of Sphericity and find a small p-value for all years (<0.001); this means that our correlation matrix is significantly different from a zero correlations matrix, so we should continue with the analysis (Hair *et al.* 2014, p. 103).

Correlations with the first principal component (Table 3) are all positive, that is they show the expected sign. Communality values (Table 4) indicate that the amount of variance accounted for by the first principal component is, in each year, 0.8 or above in five variables (museum visits, book reading, newspaper reading, classical live music concerts, sport). Communality ranges between 0.6 and 0.7 for theatre attendance (C2), whereas small communalities (between 0.4 and 0.3) are found for the remaining variable (sports events). We can thus consider the value of the first principal component as the synthetic index of the cultural and free time dimension of well-being.

The highest index values are those for Trentino-Alto-Adige, at the top for every year considered, and Friuli-Venezia Giulia in second position, except for 2006 (Table 5). At the bottom of the ranking we find the Southern regions. Changes in regional rankings between 2004 and 2010 are not notable, except for Campania, who fell five positions. Among the seven regions who improved their ranking, we find four Mezzogiorno regions (Calabria, Sicilia, Sardegna and Basilicata); on the contrary, eight regions saw their relative rank lower, whilst in four cases it did not change.

3.4.2 Education

Starting from the works of Becker (1964) and Mincer (1974) a copious literature assesses the individual returns from education in terms of productivity and earnings (Harmon *et al*. 2003; Hanushek and Woessmann 2008). Moreover, education also entails externalities or spillover effects which affect the whole progress of society and many aspects of people's lives (Michalos 2008). A number of studies (Acemoglu and Angrist 2001; Lochner and Moretti 2004; Milligan et al. 2004; Moretti 2004, Miyamoto and Chevalier 2010, OECD 2010, Sianesi and Van Reenen 2003; Hanushek and Woessmann 2007; OECD 1998) investigate the external impacts of education both in terms of economic outcomes and benefits for collectivity. These studies find that more and higher-quality education are positively linked to better public health and environmental care, to greater respect for civil rights (lower crime and wider participation in political and community life), to greater social cohesion. Recent literature deals with private non-monetary returns of schooling (Yakovlev and Leguizamon 2012; Ooreopoulus and Salvanes 2009; Vila 2000; Wolfe and Zuvekas 1997): higher levels of education may entail improvements in decision making and, thus, in work satisfaction; further, they may lead to better individual prestige, health status and social relations, all of which are in turn likely to feed back into greater well-being.

For the construction of the education index we selected five variables (Table A1).

Considering that lower secondary school is compulsory in Italy, we have focused our attention on two indicators related to higher levels of educational attainment: the percentage of people aged 30-34 with tertiary education (E1) and the percentage of people aged 25-64 having completed secondary education (E5). The first indicator is included among the targets set by the Europe 2020 strategy with the goal of bringing the share of people aged 30-34 with a university degree to 40% by 2020; the latter indicator is usually employed in international comparisons for assessing the level of formal education of a country (CNEL-ISTAT 2013). The acquisition of higher education is

[10] Kaiser (1970) has classified the values of MSA ≥0.9 as marvelous; ≥0.8 as meritorious; ≥0.7 as middling; ≥0.6 as mediocre; ≥0.5 as miserable and below 0.5 as unacceptable (Hair *et al*. 2014).

indicative of people's aspirations based on both cognitive-cultural and professional-remunerative motivations.
Two indicators are included to capture the problem of school drops-out. The first is the rate of early leavers from education and training (E2), that is given by the percentage of people aged 18-24 with only the lower secondary school diploma and are not enrolled in a training program. This is also a target indicator of the Europe 2020 strategy, which aims to reduce the proportion of drops-out in European countries below 10% by 2020; the second is the rate of upper secondary school leavers (E3), which is given by the total school leavers within the first two years of upper secondary school as a percentage of the students enrolled in the second year of higher secondary school.
The final indicator used is the rate of participation in long-life learning (E4), given by the percentage of people aged 25-64 participating in formal, or informal, educational programs.
We obtain the synthetic indicator of the education dimension of well-being by calculating the value of the first principal component. It explains 79% of the total variance contained in the five original variables in 2010 and assumes higher values in previous years, ranging from 84% in 2004 and 2009 to 92% in 2006 and 2007 (Table 1). The correlations among the variables produce an overall MSA that is, according to Kaiser's classification (Table 6), middling (0.7 or above) for the years 2007-2008 and meritorious (0.8 or above) for the remaining years, supported also by a Bartlett test <0.0001; the MSA for each variable is meritorious in 68% of cases and middling for the others, except for just one variable (E3) only in 2008. A very high amount of the variance (0,9) in the rate of early leavers from education and training (E3) is accounted for by the first principal component whereas communalities (Table 8) are lower (up to 0.5) for the other variables.
The first principal component shows positive correlations (Table 7) with people with tertiary education (E1), participation in long-life learning (E4), people who completed their secondary education (E5), and negative for the remaining two variables, the rate of early leavers from education and training (E2) and the rate of upper secondary school leavers.
The education index describes a much more complex situation at regional level with respect to that observed for the dimensions previously analysed: although the first ten positions in the rankings are generally dominated by Northern regions, we also find Southern and Central regions, with their rankings changing year by year (Table 9). Looking at the changes between the beginning and the end of the period, it is worth noting that two Southern regions, Puglia and Calabria, show significant improvements in this dimension. On the whole, just two regions (Trentino-Alto Adige, Campania) do not change their position; Puglia makes spectacular progress gaining thirteen positions, with Calabria and Marche coming next, being four positions ahead with respect to seven years earlier. At the opposite end of the ranking, we observe that ten regions move backward: the biggest decline occurs for Friuli-Venezia Giulia, which moves back nine positions, followed by Umbria (-6) and Abruzzo (-5).

3.4.3 Employment

The employment dimension is crucial in defining well-being, both from the perspective of the opportunity for individuals to fulfil their job aspirations and from the perspective of earnings people must have to satisfy needs, personal ambitions and desires. Further, according to Solow (1990, p. 27), "we live in a society in which social status and self-esteem are strongly linked to employment and income [...] The way others look at us, and the way in which we see ourselves, depends on the income and, at a given level of income, from work." Having a job enables people to develop new competencies and relationships, giving them the opportunity to enrich their social capital (OECD 2013). On the contrary, the lack of employment is, according to Sylos Labini (1990, p. 265), a reason of "civil mortification: it generates frustration, confusion and sometimes anguish of living". Although the standard neoclassical theory assumes the existence of a "disutility of work", a number of studies show the negative impact of unemployment on individual satisfaction and well-being, not caused just by the loss of income (Ratzel 2012; Clark and Oswald 1994; Gerlach and Stephan 1996; Winkelmann and Winkelmann, 1998; Frey and Stutzer 2002, Clark 2003, 2006). In Italy, there are marked regional disparities in the real possibility of finding employment. Moreover, with regard to job opportunities, age and gender discrimination varies considerably across regions (Cersosimo and Nisticò 2013). In the South of Italy unemployment currently affects 40% of the people aged between 15 and 24 (45% if we consider just girls), a percentage more than twice that of the North-East of Italy. One-fifth of young Southern people between 25 and 34 years are unemployed (almost a quarter if women only are considered) in comparison with a much lower percentage in the North (just 7%). In the South less than three young people in ten are employed, about one in two in the North.

We selected eight indicators for describing the employment dimension of well-being (Table A1). The first is the commonly used indicator for measuring the availability of jobs: the employment rate (L1). However, following CNEL-ISTAT (2013) we calculated the employment rate for people aged 20-64 years, with the aim of considering the percentage of population of employed among those that are thought to have completed secondary school, avoiding considering younger people who, because of economic hardship or other reasons leave school at the compulsory level (lower secondary school in Italy). On the opposite ground of the lack of work, instead of the usual unemployment rate we use the non-partecipation rate (L2) which is measured as the sum of the unemployed and the "potential" labour force aged 15-74, that is people not searching for a job during the previous four weeks, but available for work, divided by the sum of the labour force aged 15-74 and the "potential" labour force aged 15-74. This indicator is a suitable measure of the job market, once the peculiarities of the Italian welfare system have been taken into account (CNEL-ISTAT report 2013). The share of currently employed persons with temporary jobs for at least 5 years (L3) aims to capture job (in)security. It is given by the share of temporary employees and short term-contract workers who started their current job 5 years previously as a percentage of the total temporary employees and short term contract workers.

Another important feature of employment affecting individual well-being is the incidence of the irregular jobs, which undermines the principle of equity that should guide labour relations (Solow 1990). The share of persons employed not in a regular occupation (L4), is given by the percentage of workers not in compliance with labour, fiscal and retirement laws on total in work.

Gender inequality in job opportunities and difficulties faced by women in balancing life and work are captured, respectively, by the ratio of female to male employment rate (L6), and the ratio between the employment rate of women aged 25-49 with at least one child of compulsory school age (6-13), and the employment rate of women aged 25-49 without children (L5). One of the variables used focuses on the problem of the incidence of long-term unemployment (L7) that discourages job searching and deteriorates human capital, making it more difficult for people to find a job. The final variable is the youth unemployment rate (L8), a hot issue in the agenda of Italian policy makers and a major societal concern.

The share of the variance present in the seven variables explained by the first principal component is quite high: 91% for years 2004-2006; 89% in 2007-2008; 87% in 2009 and 86% in 2010 (Table 1). Bartlett's test finds that correlations, when taken collectively, are significant at 0.0001 level, whereas the MSA for all the data set (Table 10), as well as for each variable in 91% of cases, fall in the meritorious (0.8 or above) range. In the remaining cases, it is never below 0.7. Table 11 shows the component matrix. Correlations with the first principal component are positive for three variables (the employment rate (L1); the relative employment rate for women with children (L5); the ratio of female employment to male employment rate (L6)) and negative for the remaining indicators. Higher communality values (0.9 or above) regard the youth unemployment rate (L8), the non-participation rate (L2), the employment rate (L1), the share of irregular workers (L3) and the ratio of female to male employment rate suggesting the strong influence of these variables in characterizing the index value (Table 12).
The national divide in the labour dimension is even more marked than those analysed so far: for each year, all the Southern regions fall in the lower positions. In terms of the ranking of the employment index, it is worth noting that most regions (55%) do not vary position over the period 2004-2010, while just five Center-North regions move upwards: three by one position (Veneto, Toscana and Lazio) and two by two positions (Marche and Umbria), (Table 13).

3.4.4 Environment

Environment is an essential aspect of well-being, above all for its impact on human health. For example, air and noise pollution, hazardous substances and contaminants, have been shown to be linked to hill health (Zivin and Neidell 2013). Further, people derive pleasure directly from the natural beauty and liveability of places, since the biophysical context affects our daily lives (Dodds 1997). Moreover many derive satisfaction from the possibility of limiting the degradation of the planet and the over exploitation of natural resources (OECD 2013). Zivin and Neidell (2013) highlight three strands of the recent economic literature on the relationship between the environment and individual well-being: the effects of pollution on the optimizing behaviour in residential sorting (Chay and Greenstone 2005); the costs of avoidance behaviour consisting in activities aimed at averting toxic exposure (Courant and Porter 1981; Harrington and Portney 1987; Bartik 1988); a number of studies on the effects of environmental pollution on human capital, productivity, cognitive development and performance (Strauss and Duncan 1998; Cunha and Heckman 2007; Currie and Hyson 1999; Currie and Stabile 2006; Zivin and Neidell 2012; Hanna and Oliva 2011; Lavy, Ebstein and Roth 2012). Stiglitz *et al*. (2009) link environmental quality to the issue of sustainability, through the "magnitude of exhaustible resources that we leave to future generations" (p. 61). This perspective moves the analysis from the question of measuring the present to the prediction of the well-being of future generations.
Our environmental index refers to those aspects of well-being involving environmental quality and local liveability. We consider six variables to describe important aspects of this dimension of well-being (Table A1): three variables capture the first aspect and reflect the idea that environmental quality is better the lower the fertilizers per hectare used in agriculture (A1), the greater the number of air quality monitoring stations in relation to the number of city dwellers (A2), the percentage of energy consumption provided by renewable sources (A4); three variables refer to the dimension of local liveability, which rises when air pollution (A3) and population density (A6) are lower and when a wider percentage of land is under a special protection (A5).

The structure of correlations meets the necessary threshold with values falling in the acceptable range (above 0.50) for each year, both for the overall set of variables and individual variables, and the Bartlett test shows that non zero correlations exist at the significance level of 0.05 (Table 14).
The first principal component explains a quota of the total variance ranging from 63% in 2004 to 72% in 2008 and 2009. Table 15 displays that it is positively correlated with the monitoring of air quality, energy consumption covered by renewable sources, special protection areas, while it has negative correlations with fertilizers used in agriculture, air pollution and population density. Communalities (Table 16) are large for energy consumption covered by renewable sources (0.9 every year) and monitoring of air quality (0.7 or above in four out of seven years).
Over the period 2004-2006 the maximum values for the Environment index were reached by Valle d'Aosta and Trentino-Alto Adige, two Northern regions at the foot of the Alps, where care for the environment is a major concern not just because the local economic system relies heavily upon tourism, but also for the society in general for reasons linked to the cultural and historical values of small mountain towns (Table 17). The following positions are occupied by some Centre-South regions characterized by low levels of air pollution, population density and relatively high percentage of land protected as special areas: Abruzzo was in third position until 2006, replaced by Calabria in 2007 and Molise in the last three years. More mobility is found at the opposite end of the scale. In the first half of the period the worst performances were recorded by three Northern regions (Lombardia in 2004 and 2005; Veneto in 2006 and Emilia Romagna in 2007) replaced later by Campania, that from 2008 shows a sharp decline in the environmental index ranking. Looking at the whole period of the analysis, we observe a clear deterioration of the ranking for Friuli-Venezia Giulia, which moves from the fourth to the ninth position, Campania (from 16th in 2004 to 20th in 2010), Veneto, Marche and Piemonte (which all fall by three positions), whereas Toscana, Lazio and Umbria, besides Valle d'Aosta and Trentino Alto Adige, do not see their rank change. On the contrary, seven regions improve their position; in particular five Mezzogiorno regions (Sicilia, Puglia, Sardegna, Basilicata and Molise, the latter reaching the third position in 2010).

3.4.5 Essential public services

A key role in determining people's well-being is played by the possibility to access essential services, such as the provision and quality of child and elderly care, water and electricity and waste management. These services are *ipso facto* important for social and civic progress; further, they involve spillovers into other quality of life dimensions: for example, increasing the availability of child and elderly care would favour women's participation in the labour market; analogously, urban waste management protects and improve the quality of the environment. Striking regional disparities in the provision of these essential services are found in Italy. Notwithstanding the improvements after the unification of Italy, citizens who live in the Mezzogiorno still have to contend with central and local government services of much lower quantity, quality, accessibility and efficiency than those in the North (Cersosimo and Nisticò 2013).
We select six variables for assessing the quality of essential services provided to citizens (Table A1). The first one regards the health services and, in particular, the problem of long waiting lists for treatment (Q1), calculated as the percentage of population who renounced medical care because of the length of the waiting lists. The differentiated urban waste collection (Q2), is given by the percentage of urban waste handled through separate (recyclable vs non-recyclable) waste collection out of total urban waste collected, is aimed at capturing the progress in recycling urban waste. Two

indicators refer to care for children and the elderly: the percentage of children up to age 3 in child-care provision out of the total population aged up to 3 years (Q3) and the percentage of elderly receiving home assistance out of total elderly population aged 65 years and over (Q4); the last two variables look at the inefficiency in the provision of electricity and water: the percentage of households who report irregularities in water supply (Q6) and the frequency of long lasting power cuts (Q5).

The variance of the original variables explained by the first principal component ranges between 45% in 2004 and 66% in 2009. The overall MSA (0.6 or above) and Bartlett's test (sig. <0.0001) confirm the existence of a good correlation among variables (Table 18); analogously, the MSA for each variable falls above the acceptable range except for one variable (elderly assisted at home- Q4) and for two years (2004, 2005). The first principal component is positively correlated (Table 19) with differentiated urban waste collection (Q2), child care services (Q3) and elderly assisted at home (Q4); conversely, the elements of the component matrix are negative for the variables: waiting lists for treatment (Q1), break downs in electric power provision (Q5), and, finally, irregularities in water supply (Q6).

The amount of variance accounted for by the first principal component is higher for waiting lists for treatment and irregularities in water supply (for which communality values are 0.6 or above) and for irregularities in electric power provision (with communality values of 0.5 or above). Communalities (Table 20) are lower for the elderly assisted at home (0.3 or below).

The synthetic index reproduces the historical divide between Northern and Southern Italy, with the latter at the foot of the rankings (Table 21). This confirms that the civic divide in Italy, in terms of the provision of essential public services, is at least as important as the economic and productive divide. Notwithstanding this, among the ten regions that gained positions between 2004 and 2010 we find five Southern regions (Campania, Sardegna, Calabria, Abruzzo, Basilicata). It is worth noting the big jump by Umbria and Friuli-Venezia Giulia, who occupy in 2010 the first and the second position in the regional ranking after moving up by ten and nine positions, respectively.

3.4.6 Health

Health is among the most important factors people indicate as influencing their well-being (ONS 2011, WHO 2013, OECD 2013) and has been the most common dimension in the construction of composite well-being indicators since the pioneering initiative of the UNDP Human Development Index. Many studies state a two way relationship between health and well-being: mental and physical health influence professional and personal relationships as they free people from medical or other care needs, increase their probability of finding a job, and of participating in social activities; conversely, good quality of life increases the individual's attention on prevention and medical check-ups, enhance immune systems, increase longevity and reproductive health, and, in the case of disease, provide access to adequate care (Diener and Chan 2011; Dolan et al. 2008; Shields and Wheatley Price 2005; Howell et al. 2007).

The health index is calculated from five basic indicators (Table A1). The first one (H1) is the life expectancy at birth (UNDP 1990, 2010). The infant mortality rate (H2) is given by deaths during the first years of life per 10,000 live births. The remaining three variables refer to habits or lifestyles that present health risks. Overweight or obesity constitute a danger for health: they are major risk factors for a number of chronic diseases, including diabetes, cardiovascular diseases and cancer (WHO 2014; Darnton-Hill *et al.* 2004). Overweight or obesity (H3) is given by the average body mass index of the population (BMI), an index used by WHO to classify people as “normal weight” (BMI of 18.5 to less than 25), overweight (BMI of 25 to less than 30) or obese (BMI of 30 or more). A sedentary lifestyle (H4), can damage physical and psychological health: there is evidence that physical activity reduces anxiety and depression (World Health Organization 2010), while a sedentary lifestyle, by contributing to obesity, causes the same risks as chronic diseases. Analogously, a balanced diet is important for good health (Swinburn *et al.* 2004): we consider as indicator the percentage of people aged 3 years or more who consume at least four portions of fruit and vegetables a day (H5).

Our synthetic indicator of the health dimension, the first principal component, explains a quota of the total variance present in the five variables used to compute it ranging from 61% in 2007 to 88% in 2004 (Table 1). Bartlett’s test finds that the correlations, when taken jointly, are significant at the 0.0001 level, whereas the overall measure of sampling adequacy assumes middling values (0.7) or above (Table 22). Examination of the values of each variable identifies middling or meritorious (0.8 or above) measures of sampling adequacy. Communalities (Table 24) are large for nutrition, sedentary lifestyle, infant mortality rate (0.8 or above), and overweight or obesity (0.7), whereas they are quite small (up to 0.3) for life expectancy.

Table 23 shows that the first principal component is positively linked to life expectancy at birth (H1) and nutrition (H5) and has a negative association with the infant mortality rate (H2), overweight or obesity (H3), sedentariness (H4); as a consequence, it appears as a reliable synthetic indicator of health dimension of well-being.

Despite the health index reports at the top and at the bottom of the rankings the usual divide between the North and the South of Italy, characterized by the backwardness of the Mezzogiorno regions, the changes in the ranking over the seven years show that a Central region (Marche) and four Northern regions (Valle d’Aosta, Friuli Venezia Giulia, Piemonte and Veneto) experienced the largest fall (Table 25). At the opposite end, there is an improvement for three Southern regions (Sardegna, Calabria, Puglia). The largest improvements were found in Emilia-Romagna and Toscana which gained five and eight positions, respectively. Only one region (Lombardia) did not change its rank.

3.4.7 Material living conditions

Material living conditions, determining people’s ability to satisfy their needs and aspirations, are an essential component of well-being (OECD 2013). The index of material conditions is based on five variables (Table A1). We consider dimensions that can be summed up in monetary units and dimensions related to aspects of daily life, such as housing. Among the first group of variables, we include not only the disposable household income per person (M1), but also indicators of inequalities (disposable income inequality-M2), poverty (people at risk of relative poverty-M3) and social distress (jobless households-M4). Further, the percentage of people living in houses with “structural problems” (M5) reflects social and economic disadvantage in material living standards, affecting essential needs such as personal security, privacy, health, the quality of family relationships and the possibility to receive visits (OECD 2008).

Applying the PCA technique, we get good results in terms of synthesizing the information contained in the original variables. In fact, the first principal component always explains over 90% of the variability present in the 5 variables considered: it reaches 96% in 2004, whereas the lowest value is 91% in 2009 (Table 1). The measure of sampling adequacy falls in 91% of the cases in the meritorious (0.80 or above) or middling (0.70 or above) range and never below 0.50; analogously, the Bartlett test and the overall MSA (0.6 or above) confirm the significance of the correlations (Table 26). The component matrix (Table 27) shows a positive correlation between the first principal component and disposable household income per inhabitant (M1), whereas correlations are negative for the other variables, confirming the interpretation of the first component as an index of good living conditions.

People at risk of relative poverty (M3) and people living in jobless households (M4) are the variables with the highest communality values (Table 28), which indicate that a large amount of the variance in these variables is accounted for by the first principal component.

The values assumed by the synthetic index of material living conditions reproduces the North-South divide in Italy: the Northern and Central regions are firmly at the top of the rankings, while the bottom positions are always occupied by the Southern regions (Table 29). During the last four years, Trentino-Alto-Adige was the best performer moving up 5 places. In the two initial years Emilia Romagna occupies the top position, but it then moves to third (2006-2008) and second position (2010). At the bottom of the ranking, we find Sicilia (2004-2007) and Campania (2008-2010).

However, the regional dynamics in the 2004-2010 period highlight that along with Trentino-Alto Adige four other regions (Liguria, Valle d'Aosta, Sicilia and Sardegna) experience improvements in the ranking of the material living condition index. For 30% of Italian regions the position in the ranking remains unchanged at the beginning and at the end of the period but the relative performance worsens for 40%.

3.4.8 Personal security

The security dimension of well-being reflects the perceived threat to people's lives and personal freedom. The fear of being a crime victim has impact on individual well-being, determining anxiety and limiting personal freedom (OECD 2013). In Italy, there are still remarkable regional disparities as regards law enforcement and security: citizens who live in Southern regions have a twice higher chance than those in the North-East of the country of being a victim of murder, extortion or robbery. Young people in Southern regions are much more likely to be involved in crimes against persons or private property than their peers in the North-West of the country (ISTAT 2011, 2013; Cersosimo and Nisticò 2013).

We selected five variables for describing the personal security dimension of well-being (Table A1). Four indicators are objective measures of the incidence of crimes: the burglary rate (T1) measures the number of burglaries per 1,000 households; the pick-pocketing rate (T2) measures the number of pick-pocketing per 1.000 people; the robbery rate (T3) measures the number of robberies per 1000 people and the homicide rate (T4) measures the number of homicides per 100,000 people. The fifth indicator is a subjective measure of people's feelings about personal insecurity: the perception of the crime risk in the area (T5) given by the percentage of households who are very much concerned by the crime risk in the area where they live.

The first principal component explains a percentage of the total variance ranging between 52% for years 2004-2005 to 59% in 2008 (Table 1). The overall MSA is above the threshold of acceptance (0.5 or above) and the Bartlett test confirms the significance of correlations at the level of 0.0001 (Table 30). The MSA for each variable also falls within the acceptable range except for one variable (burglary rate) in just one year (2006). Table 32 shows that all the communalities are sufficiently

high (0.5 or above), but they show larger values for the robbery rate (0.9), homicide rate and pick-pocketing rate (0.8 or above), household perception of crime risk (0.7). The first principal component is negatively correlated with all the variables considered in the analysis, suggesting that it is, indeed, a reliable index of the personal security dimension of well-being (Table 31).
The security index shows differentiated regional performances, not reproducing the recurrent divide from North and South Italy (Table 33). In fact, in each year we find in the first ten positions both Northern and Mezzogiorno regions. Among the latter, Basilicata is, in four out of seven years, at the top of the ranking, but a good performance is showed also by Abruzzo, Sardegna and Molise. Best performing Central region is Marche, whereas, among the Northern regions, Valle d'Aosta has the highest value of the index in three years (2005, 2008 and 2010), Friuli-Venezia Giulia, Veneto and Trentino-Alto Adige are always among the top ten. During the seven year period, the best improvement in the ranking is experienced by Valle d'Aosta, who gains five positions; five regions show smaller positive changes. Nine regions went backward, especially Trentino-Alto Adige who lost three positions between 2004 and 2010, whereas five regions did not alter their rank.

3.4.9 Research and innovation

Research and innovation represent basic components of social and economic progress. Many aspects of quality of life are improved by research and innovation through the development of technologies across different sectors which interact with other well-being dimensions: for example, innovations in energy (e.g. energies from renewable sources, such as bio-fuel, solar energy), transport (e.g. lighter, safer and more energy efficient transport) and chemistry (e.g. green processing) influence environmental quality; new technologies enhance medical care (e.g. gene therapy and genetic testing) and people's health; innovations in information and communications (e.g. mobile phones, tablets, cloud computing) foster people's connections and improve education methods, and so on. Research and innovation also influence professional life and work satisfaction when they are used to produce changes in the organization of business. The direct impact of innovation on subjective well-being remains, however, quite an unexplored field of study (Dolan and Metcalfe 2012), while the influence of research and innovation on economic well-being and competitiveness has received more attention (Dijkstra et al. 2011, Annoni and Kozovska 2010; Hong *et al*. 2012; Huggins and Davies 2006; IMD 2008; McCann and Oxley 2012; Schwab and Porter 2007).
We selected five variables for describing this domain of well-being (Table A1). We consider the region's potential to innovate by means of the R&D expenditure by public administration, universities and public and private enterprises as percentage of GDP (R1), and the patents registered by the European Patent Office per million of inhabitants (R3). Two indicators describe research and innovation by looking at the region's potential to adapt to changing demand through the availability of human capital with technological skills: the R&D workers (R4), measured as the number of researchers, technicians and other personnel involved in R&D in the public administration, universities, public and private enterprises per 1,000 inhabitants; finally, as a proxy of the innovative potential of human capital, we consider graduates in Science and Technology (R5), the number of science graduates per 1,000 inhabitants aged 20-29.
The share of total variance explained by the first principal component ranges between 72% in 2005 and 81% in 2010 (Table 1). Good correlations are reported by the MSA (Table 34) both when it is calculated for all the variables, and for each variable individually, falling in the middling range (0.7

or above), and by the Bartlett test (sig. <0.0001). Communality figures (Table 36) are sufficiently high for all variables (greater than 0.5), but they are larger for patents (0.9) and capacity to exports (0.7 or above). The first principal component shows positive correlations with all the variables (Table 35); it can be considered a suitable synthetic indicator of the research and innovation domain of well-being.
As regards Research and innovation, the best performers are five Northern regions (Piemonte, Emilia-Romagna, Lombardia, Friuli-Venezia Giulia and Veneto), (table 37). The Southern regions are at the bottom of the ranking, except for Abruzzo, which is in the middle. The worst performing regions are Calabria and Molise, which occupy the last two positions. During the seven year period, six regions did not change their rank, whereas seven regions experienced an improvement; particularly noteworthy is the positive move by Trentino-Alto-Adige and Liguria which gained five and three positions, respectively. At the opposite end Piemonte, Lazio, Abruzzo and Sicilia lost out the most.

3.4.10 Social Relations

The importance of social relations at individual and community level has been extensively investigated by social scientists (Cersosimo and Nisticò 2008). Coleman (1990) defines social capital as a network of relations between agents. Social capital is a resource that can generate trust in economic and social relations. In Coleman's words (1990, p. 302), it is a resource "lodged neither in individuals nor in physical implements of production, (but inherent) in the structure of relations between persons and among persons". Social capital influences transaction costs and thereby efficiency, by enhancing the level of trust between agents (Guiso, Sapienza, and Zingales 2004; Trigilia 2001) or generating shared values and community norms which support cooperative outcomes (Aoki 2001, Spagnolo 1999). Developing the original ideas of Bourdieu (1986) and Coleman (1990), Aoki (2001, p. 209) defines social capital as "the present value sum of future benefits, including intangible goods such as status, social approval, and emotional stability, that individual agents expect to derive from cooperative association with the community in the social exchange game. In order to derive returns from it, individuals must invest in it and maintain it through social exchange."
We describe the social relations domain of well-being by means of five variables, two of which measure the quality of personal connections in terms of the subjective satisfaction with family (S1) and friends (S2), respectively (Table A1). Two further indicators rely instead on objective measures: the share of population who have funded associations (S5) and the percentage of the population who performed volunteer work (S4) for associations or volunteer groups. The final indicator is a composite measure calculated by ISTAT by synthetizing people's participation in social and cultural meetings, professional associations, trade unions, clubs or religious groups (S3).
The first principal component explains over 90% of the variance contained in the five original variables (Table 1). The overall measure of sampling adequacy (Table 38), as well as that referred to each variable, fall in each year in the meritorious range (0.8 or above) and Bartlett's test finds that correlations are significant at the 0.0001 level. All variables show high figures of communalities (0.7 or above): they reach values of 0.9 or above for three variables (the synthetic indicator of social participation, volunteer work and the share of population who funded associations), suggesting that a great amount of the variance in these variables is accounted for by the first principal component (Table 40). The component matrix in Table 39 shows all positive

correlations with the first principal component, thus we can interpret the latter as an index of the social relations dimension of well-being.
For this dimension the divide North-South of Italy is less pronounced. In fact, not all the Southern regions are positioned at the lower end of the table (for example Sicilia and Sardegna), and, conversely, some Central and Northern regions are not found among the top twelve: this is the case of Liguria and Lazio. Emilia Romagna at the beginning of the period occupied the third rank, but thereafter dropped to the middle of the ranking or below. Emilia Romagna had the worst dynamics, falling eight places between 2004 and 2010, followed by Trentino-Alto-Adige (-7) and Veneto (-5) (table 41). Conversely, regions who improved the most their ranking are Sicilia, who gained 11 positions, Umbria and Toscana who, at the end of the period, moved up five places with respect to 2004.

3.5 Results: well-being in Italian regions (step 2)

Following the same methodology, we derive the synthetic regional well-being indicator (RWBI) considering as variables the values of the indexes obtained by means of the principal component analysis for each individual dimension of well-being considered. Thus, we have ten variables, represented by the indexes of Culture and free time, Education, Employment, Environment, Essential public services, Health, Material living conditions, Personal security, Research and innovation and Social relations.
The first principal component explains a percentage of the total variance in these ten variables ranging between 46% in 2007 and 53% in 2004 (Table 1)[11]. The overall MSA value (Table 42) falls within the acceptable range, assuming values of 0.7 or above and Bartlett’s test shows that none zero correlations exist at the significance level of 0.0001. Examination of the values for each variable, however, indicates that the Environment index has MSA values under 0.50 in all years and should therefore be deleted from the analysis; however, because of the importance given to environmental factors in the literature, we decided, in first approximation, to keep this indicator. The amount of variance accounted for by the first principal component is higher (0.5 or above) for six of the indexes considered in the analysis (Table 44): culture and free time (ranging from 0.5 to 0.7), employment (from 0.6 to 0.9), essential public services (from 0.6 to 0.9), health (from 0.5 to 0.8 except for 2008 when the communality value is 0.4), material living conditions (from 0.6 to 0.9), social relations (from 0.5 to 0.7). On the contrary, a small amount of the variance in four sub-indexes (education, environment, personal security and research and innovation) has been extracted by the first principal component. Therefore, the latter is a good synthesis of the major part of the different dimensions selected in the analysis as essential aspects for describing well-being. The first principal component is positively correlated with all the indexes of the different domains, thus confirming that it can indeed be considered a suitable overall indicator of regional well-being (Table 43).
Results show a sharp demarcation between the North and the South of the country: every year the first ten positions are all occupied by Centre-North regions and the last ten by the eight Mezzogiorno regions along with Liguria and Lazio (Figure 2).
The most evident feature of the dynamics of the well-being index over time is the absence of changes at the five top and bottom positions of the rankings (Table 45). At the beginning of the

[11] Detailed information on the results of the principal component analysis are available on request from the authors.

period 2004-2010, the first five positions are occupied by Valle d'Aosta, Trentino-Alto Adige, Friuli-Venezia Giulia, Emilia Romagna and Veneto and this remains unchanged throughout the whole period. Similarly, the same five regions occupy the bottom five positions at the beginning and at the end of the period. The region that suffers the lack of well-being the most is Campania, which occupies the bottom rank in five years out of seven, whereas the best performance in terms of well-being is observed throughout the whole period in Valle d'Aosta.
As for the analysis for the individual indicators, the final column of Table 45 gives, for each region, the absolute variation of the rank between 2004 and 2010. By looking at the position determined according to the changes in the rank of the Italian regions at the beginning and at the end of the period we can definitively confirm the relatively marked level of inertia of well-being in Italy, as shown by the long list of regions whose variation in rank is equal to zero. Notwithstanding this prevailing trend, five regions improve their relative position in the ranking, and six regions are worse off. Umbria, which initially occupied the tenth position in the overall well-being ranking, records the highest improvement (of three positions), followed by Basilicata and Marche with two positions onwards and Liguria and Sardegna who move ahead by just one place. Toscana, which was in sixth position in 2004, shows the worst change in terms of its well-being ranking, slipping down by three positions.
Figure 3 plots Italian regions considering the well-being index, on y-axis, and per capita-GDP divided by average GDP, on x-axis, in 2004 (Figure 3a) and in 2010 (Figure 3b). It is worth noting the positive linear relation between the two indexes, as confirmed by the fairly high coefficient of correlation (0.8 in 2004 and 0.9 in 2010). This is not really surprising since per-capita GDP and RWBI indeed synthetize regional progress, albeit from different perspectives: the first from a productive standpoint and the latter from the multifaceted dimension of quality of life. The results are consistent with the literature on regional comparisons of well-being indicators and GDP (Berloffa and Modena 2012; Marchante *et al*. 2006). Moreover, Figure 3 illustrates the substantially unchanged position of regions at the beginning and at the end of the period: regions who in 2004 were positioned below the x-axis on the left, as well as regions who occupied in 2004 the upper-right side of the figure, still remain there in 2010.

3.6 Well-being Dispersion across Regions

In order to assess regional disparities trends in terms of both partial and overall well-being indicators we calculated the coefficient of variation and the rate of σ-convergence of Italian regions both for the RWBI index and the per-capita GDP for the whole period and for two sub-periods: from 2004 to 2007 and from 2008 to 2010 (Table 46).
During the seven years 2004-2010 disparities among Italian regions decreased. As regards per-capita GDP the coefficient of variation decreased by 2% over the entire period. The even stronger change (-18%) for the RWBI confirms the existence of σ-convergence: regions became more similar in terms of well-being and at a much higher rate than in terms of per-capita GDP, as shown by the trend lines in Figure 4. However, if we look at the two sub-periods we can see that the rates of σ-convergence are negative for both indicators in years 2004-2007, but they had different signs in the following period (2007-2010). After 2007, disparities in per-capita GDP increase slightly. A similar dynamic characterized all European regions, which showed a progressive narrowing of economic disparities until 2007 and an opposite trend thereafter, as a consequence of the economic and financial crises (European Commission, 2013). On the contrary, in terms of well-being, the

immediate effect of the crisis on Italian regions disparities seems to be a marked, albeit brief, rise of the coefficient of variation followed, however, by a new convergence process, although, possibly, less intense than in the first sub-period (2004-2007).
Despite all this, if we compare the values of the σ convergence between 2007 and 2010, both indicators exhibit the same rate of divergence (1%), whereas in the sub-period before the advent of crisis (2004-2007) Italian regions converge more in terms of RWBI (-19%) than in per-capita GDP (-3%).
It is worth noting that both indicators have, at the beginning of the period, the same value of the coefficient of variation, that is also the highest dispersion showed by the Italian regions over the whole period. Similarly, they reached the minimum coefficient of variation in the same year (2007), coinciding with the advent of the global economic crisis, but at different levels: the minimum dispersion as regards overall well-being is significantly lower than for per-capita GDP.
Considering the results of σ-convergence for each of the ten partial indicators, we find that some of them exhibit a smooth increasing trend until 2007 (Personal Security, Material Conditions and Research and Innovation) with upward intervals in the following years (Personal Security and Material Conditions), while Research and Innovation remain quite flat. As regard the other sub-indicators (Culture and Free Time, Health, Essential Public Services, Education, Environment, Social Relations), we can observe fluctuations over the entire period (Figure 5). This implies that there has been no continuous trend towards σ-convergence in all the ambits of well-being; on the contrary, in some important dimensions, such as security and culture and free time, significant divergences persist. A slight divergence exists over the whole period also for Material Living Conditions. The Health Index dispersion, instead, increases in the first sub-period, but slows down sharply afterwards, which determines convergence.
Conversely, for the six remaining dimensions of well-being (Environment, Employment, Education, Essential Public Services, Social Relations and Research and Innovation) we find a reduction of the disparities throughout the seven years.
However, two sub-indicators that did not show an overall negative σ-convergence rate (Material Conditions and Health) experienced convergence in the second sub-period.
The Environment Index showed the highest σ-convergence rate (26%) with a decreasing trend throughout the period except for one upward adjustment in 2007. This indicator, however, exhibits the highest coefficient of variation in each year. This means that regional dispersion in environmental performance is higher than in other dimensions of well-being.
As regards the mobility of regions over time within the cross-regional distribution of each dimension (γ-convergence), we consider Kendall's index of rank concordance (Table 47). For the index of each dimension of well-being as well as for the two indicators, RWBI and per-capita GDP, Kendall's index tends to one. Thus, there is no evidence of rank mobility within the distribution. This means that, although the gaps between regions in terms of the indicators considered were reduced over time, the process of σ-convergence did not affect their relative position. Basically, the regions with lower levels of well-being at the beginning have not been able to improve their conditions sufficiently to gain positions in the table. The results of the test of the hypothesis clearly confirm the absence of rank mobility: the null hypothesis of no association among the ranks in different years (which means convergence is happening) is always rejected with a significance level of at least 5%. In fact, in many cases, we find that the result of non-convergence is even stronger, being statistically significant at 1%. This happens for the environment indicator just in 2009, for the

education indicator in 2005 and 2007, and every year for the other indicators (Employment, Material Living Conditions, Social Relations, Research and Innovation, Personal Security, Culture and Free Time, RWBI and per-capita GDP) except for Health, just in 2010, and Essential Public Services. In conclusion, neither significant improvements nor worsening occurred for the overall well-being indicator, the per-capita GDP and each dimension index in regional intra-distributional mobility over the studied period.

3.7 Conclusions

Recent years have witnessed an explosion of studies on measuring well-being beyond its productive and economic features. Scholars shared the awareness that well-being is a multidimensional concept. This has given rise to the necessity to dispose of indicators and data-bases on the wide number of factors that researchers consider crucial in affecting progress and quality of life. Many institutions and national governments are at work to define suitable measures of well-being domains. In Italy the BES project made available in 2013 a database of 134 outcome indicators regarding 12 dimensions for an “equitable and sustainable well-being”.

Focusing on the Italian regions, the aim of this paper was threefold: to construct synthetic indexes for 10 different dimensions of well-being, combining 57 different variables; to then use these partial synthetic indexes to construct an overall indicator of well-being; finally, to assess well-being and per-capita GDP convergence/divergence processes across regions over the period 2004-2010. With these goals in mind, we implemented a two-step principal component analysis in order to calculate single domain indexes, in the first step, and the overall regional well-being indicator, in the second step, using as input the ten indicators previously generated. Regional dispersion on single domain and overall well-being indexes was investigated by means of the growth rate of the coefficient of variation (or σ-convergence); finally, the regional ranking mobility over time was assessed by means of a non-parametric technique based on the Kendall index of rank concordance (or γ-convergence).

Results clearly show that differences in well-being between regions do not necessarily reproduce those based on standard economic indicators. As a consequence, these results highlight the fact that the regional well-being divide in Italy is at least as significant as the economic divide, suggesting the importance of paying much more attention in public policies and academic debates, still mostly focused on the economic gaps, to the quality-of-life features of the development. However, the analysis in terms of σ-convergence shows that Italian regions tend to became more similar over time, both in terms of per-capita GDP and overall well-being, even a gradual slowing-down of this process can be observed in recent years, after the global economic crisis. Moreover, convergence in terms of well-being occurs at a much faster rate than in terms of per-capita GDP. After the crisis the two indicators, RWBI and per-capita GDP, have different convergence trends: disparities in GDP increase slightly; on the contrary, in terms of RWBI the effect of the crisis seems to be a rise of the coefficient of variation, followed, however, by a new convergence process, albeit less intense than in the first sub-period (2004-2007).

Moreover, our results show different convergence patterns for each different dimension of well-being, highlighting the persistence of disparities across regions in important quality-of-life aspects. In fact, significant divergences still characterize the Personal Security and Culture and Free Time domains. Analogously, if we look at the entire time interval, the divergence across Italian regions slightly increases for the Health and Material Living Conditions indices, even if they experienced a substantial recovery in the period 2007-2010. Further, in four dimensions -Education, Environment, Essential Public Services and Research and Innovation-, convergence is not a continuous process, though at the end of the period Italian regions are found to be more similar than at the beginning. Finally, for two dimensions of well-being, Employment and Social Relations, we find that dispersion across regions has fallen both over the entire study period and the two sub-periods considered.

The analysis of mobility among ranks within the distribution (γ-convergence) showed that for each partial indicator, for the RWBI and for per-capita GDP, the value of Kendall’s index tends to one. This implies that the null hypothesis of no association among ranks is always firmly rejected: the relative positions of the regions did not change substantially, even if our results indicate that a process of σ-convergence has been at work.

The analysis points out the importance of considering a synthetic well-being index along with GDP statistics: notwithstanding the two indicators show a high correlation, they presents different trends in terms of regional convergence over time confirming that public policies targeted just on enhancing production levels or aimed mainly to reduce regional disparities in terms of GDP, could not necessarily entail the same results in terms of quality of life improvements, as suggested by the recent literature on economic and social progress (Sen 2000; Stiglitz, Sen and Fitoussi 2009). Nevertheless, some productive factors could be significantly affected by public policies designed relying upon well-being indicators, as it happens for the fields of intervention of education, essential public services, environment, employment, health, research and innovation (Salvemini 2014). Moreover, improvements in most of well–being dimensions, in reason of their structural nature, need medium-long run policies and a coordination effort between different development institutions and agents, as well as across different levels of governance (central/local), as remarked by the “Well-Being 2030” research project recently launched by the European Policy Centre and the European Commission (Theodoropoulou and Zuleeg 2009). Thus, well-being indicators could help policy makers in designing public interventions for progress entailing wider ambits than production, medium-long run programming periods and the institutional coordination in a multilevel governance perspective.

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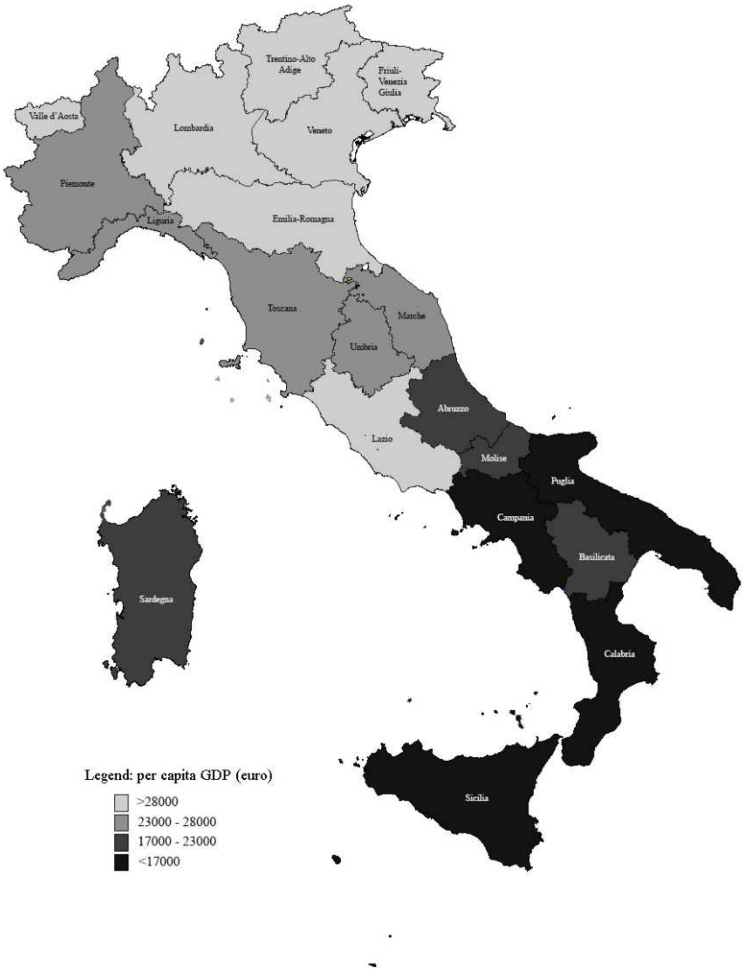
3.8 Appendices

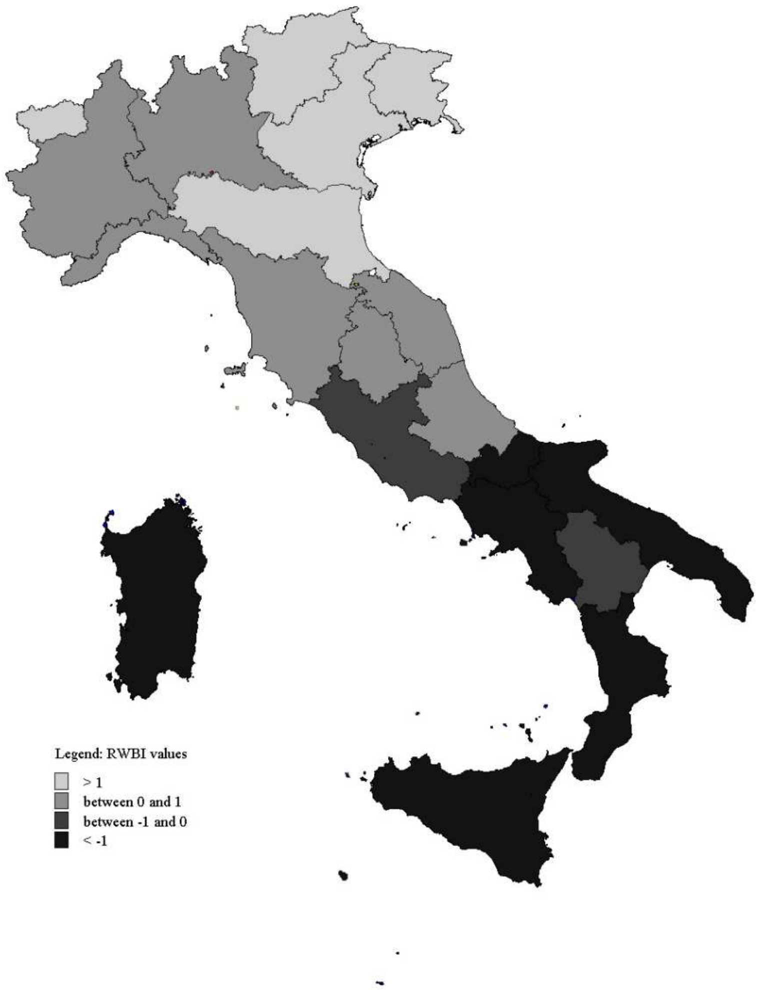
3.8.1 Figures

Figure 1. Italian regions by per-capita GDP (2010)



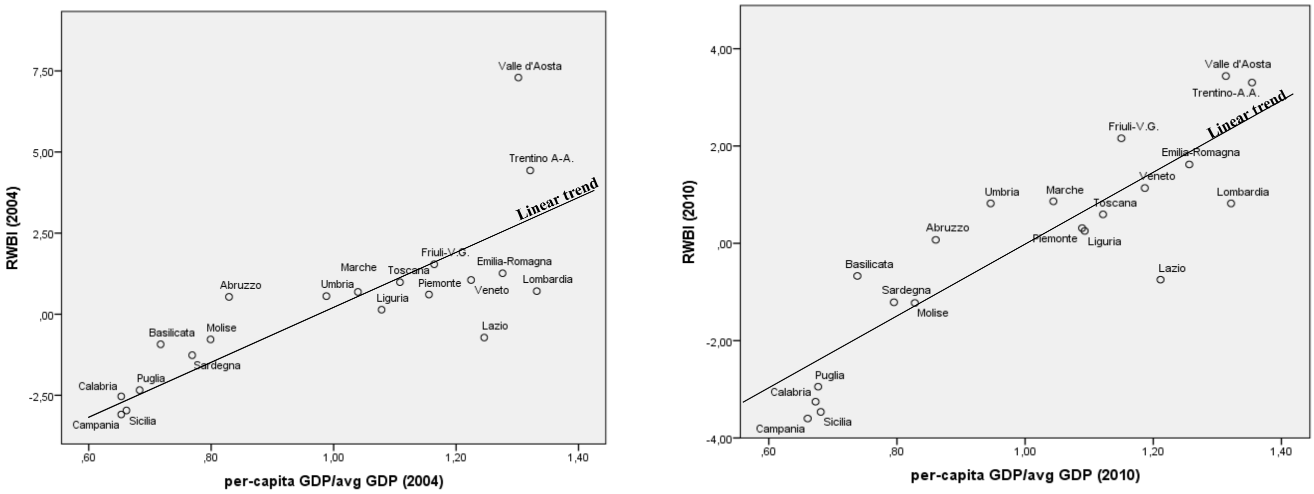
Source: our elaboration on ISTAT data

Figure 2. Regional Well-Being Index (RWBI) in the Italian regions (2010)



Source: our elaboration on ISTAT data

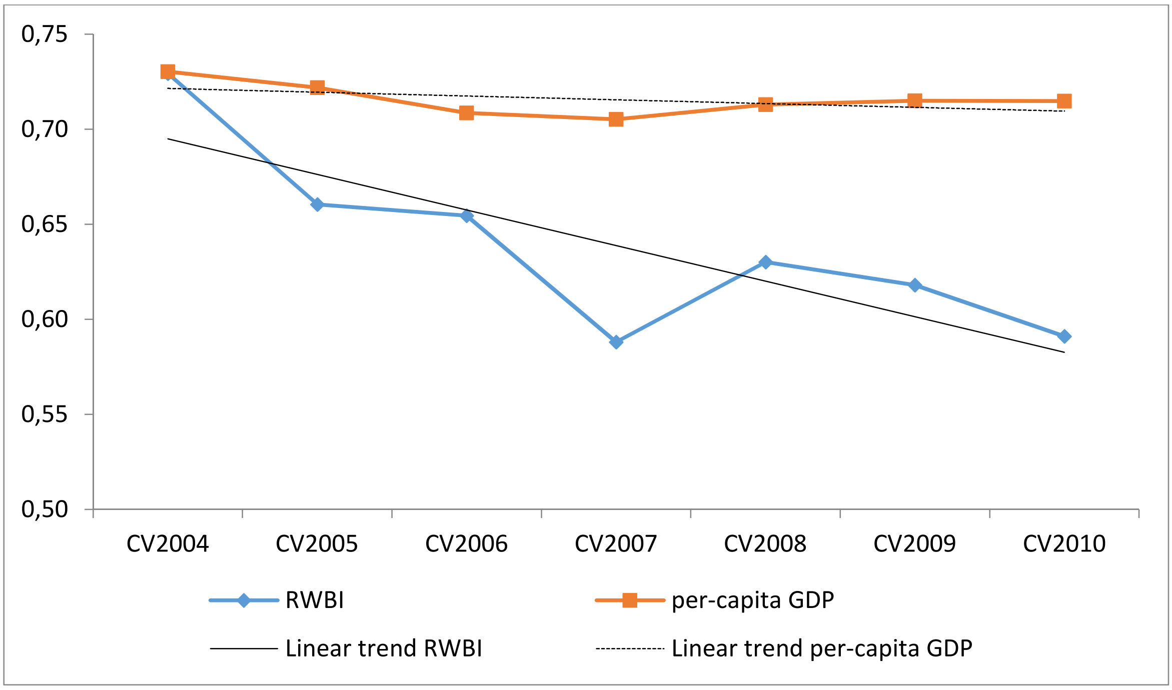
Figure 3 – Italian regions by per-capita GDP and well-being index (2004, 2010)



(a) (b)

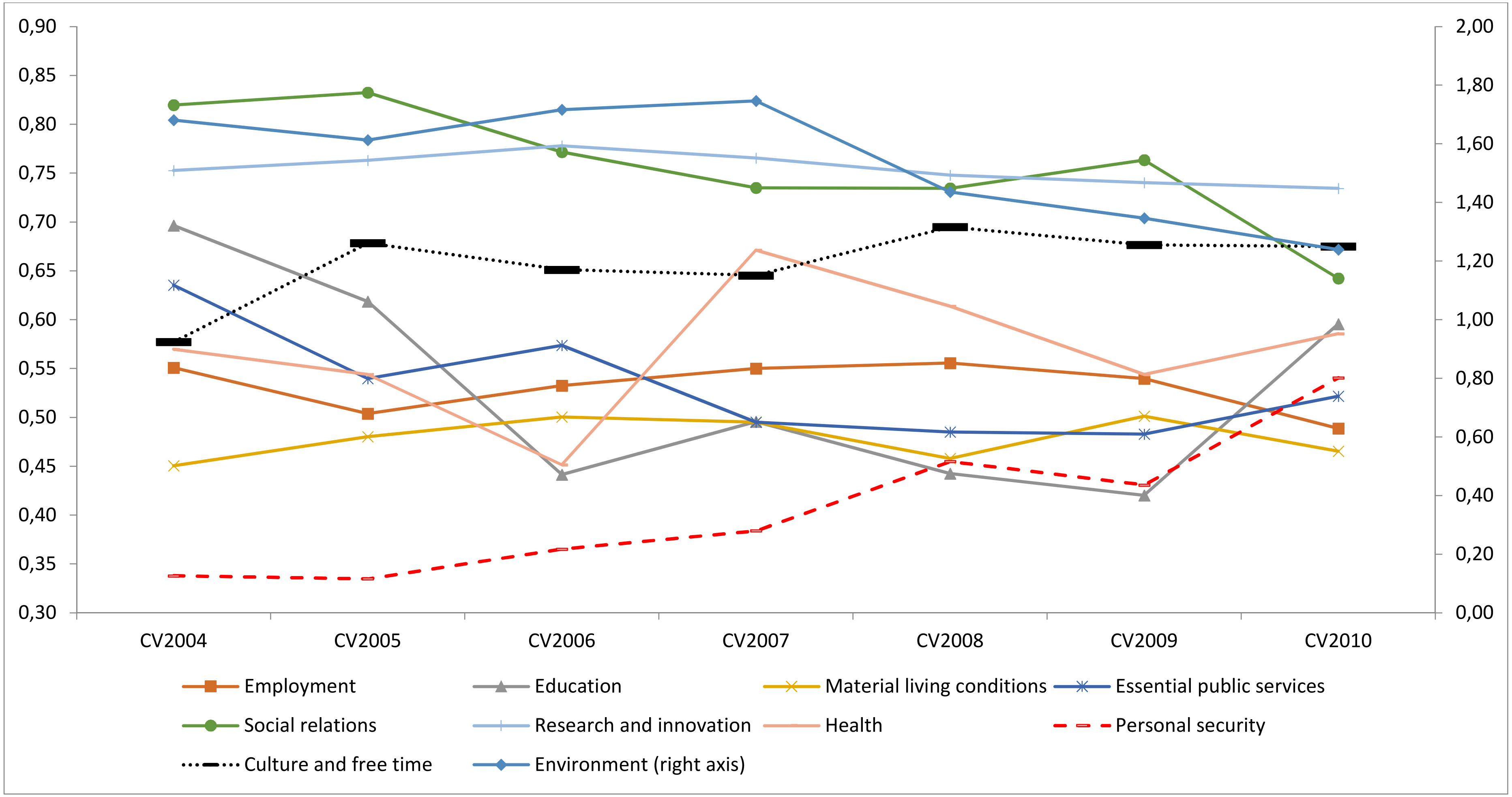
Source: our elaboration on ISTAT data

Figure 4- RWBI and per-capita GDP - Coefficients of variation (2004-2010)



Source: our elaboration on ISTAT data

Figure 5-Partial Indicators - Coefficients of Variation (2004 -2010)



Source: our elaboration on ISTAT data

3.8.2 Tables

Table A1 – Well-being dimensions: indicators, definitions and sources (database subsections in parenthesis)

	Indicators	Definitions	Source
	Culture and free time		
C1	Newspaper reading	Persons aged 6 and over who read newspapers at least once a week per 100 people with the same characteristics.	i.stat (Culture, leisure and time use)
C2	Theater attendance	Percentage of persons aged 6 and over who have attended theater at least once in the last year.	i.stat (Culture, leisure and time use)
C3	Live classical music concerts	Percentage of persons aged 6 and over who have attended classical live music concerts at least once in the last year.	i.stat (Culture, leisure and time use)
C4	Sport events	Percentage of persons aged 6 and over who have attended sport events at least once in the last year.	i.stat (Culture, leisure and time use)
C5	Books reading	Persons aged 6 and over who read books in the previous 12 months per 100 people with the same characteristics.	i.stat (Culture, leisure and time use)
C6	Museums visits	Percentage of persons aged 6 and over who have visited museums at least once in the last year.	i.stat (Culture, leisure and time use)
C7	Sport	Percentage of persons aged 3 and over who practise sports.	i.stat (Culture, leisure and time use)
	Education		
E1	People with tertiary education	Percentage of people aged 30-34 with tertiary education (ISCED 5 or 6).	BES (Education)
E2	Rate of early leavers from education and training	Percentage of people aged 18-24 with only lower secondary school diploma (ISCED 2) and are not enrolled in a training program.	BES (Education)
E3	Rate of upper secondary school leavers	Total school leavers within the first two years of upper secondary school as a percentage of the students enrolled in the second year of higher secondary school.	ISTAT-DPS (Education)
E4	Participation in long-life learning	Percentage of people aged 25-64 participating in formal or non-formal educational programs.	BES (Education)
E5	People with at least upper secondary education	Percentage of people aged 25-64 having completed secondary education (ISCED level not below 3a, 3b or 3c).	BES (Education)

	Employment		
L1	Employment rate	Percentage of employed persons aged 20-64.	BES (Work and life balance)
L2	Non-participation rate	Unemployed and potential labour force aged 15-74 (people not searching for a job during the previous 4 weeks but available for work) as percentage of labour force aged 15-74 and potential labour force aged 15-74.	BES (Work and life balance)
L3	Share of employed persons with temporary jobs for at least 5 years	Share of currently employed persons with temporary jobs for at least 5 years.	BES (Work and life balance)
L4	Share of workers not in regular occupation	Percentage of workers not in compliance with labour, fiscal and pension laws.	BES (Work and life balance)
L5	Ratio between the employment rate of women aged 25-49 with at least one child of compulsory school age (6-13), and the employment rate of women aged 25-49 without children	Employment rate of women aged 25-49 with at least one child under compulsory school age (6-13) divided by the employment rate of women aged 25-49 without children.	BES (Work and life balance)
L6	Ratio of female employment rate to male employment rate	Ratio of female to male employment rate (%).	ISTAT-DPS (Labour)
L7	Incidence of long term unemployment	Persons looking for employment for more than 12 months as percentage of the total of persons seeking employment.	ISTAT-DPS (Labour)
L8	Youth unemployment rate	Persons aged 15-24 looking for employment as percentage of the labour force aged 15-24.	ISTAT-DPS (Labour)
	Environment		
A1	Fertilizers used in agriculture	Simple fertilizers (Nitrogen, Phosphorus, Potassium) used per hectare of Utilized Agriculture Area (in quintals).	ISTAT-DPS (Environment)
A2	Monitoring of air quality	Number of air monitoring stations, per 100.000 inhabitants.	ISTAT-DPS (Cities)
A3	Air pollution	Number of days during which the level of PM10 was higher than the limit of 50 μg/m3 in regional capital cities [(days/365)*100].	BES (Environment)
A4	Energy consumption provided by renewable sources	Electricity produced by renewable sources (GWh) as percentage of electricity internal gross consumption.	BES (Environment)
A5	Special Protection Areas	Percentage of regional land (ha) designed as Special Protection Areas.	ISTAT-DPS (Environment)
A6	Population density	Population per square kilometre of land area.	I.Stat (Population)

	Essential public services		
Q1	Waiting lists for treatments	Individuals who give up the chance to see a specialist or undergo therapeutic treatment (not dental) because of the length of waiting lists as percentage of residents.	BES (Quality of services)
Q2	Differentiated urban waste collection	Percentage of differentiated (recyclable vs non-recyclable) urban waste collection out of total urban waste.	BES (Quality of services)
Q3	Child care services	Percentage of children up to age 3 using child-care services - day-care centers, mini day-care facilities or supplementary and innovative services - of which 70% in day-care centres, out of the total population aged up to 3 years.	BES (Quality of services)
Q4	Elderly assisted at home	Percentage of elderly people who benefited from integrated home assistance service (Adi) out of the total elderly population (aged 65 and over).	BES (Quality of services)
Q5	Irregularities in electric power provision	Frequency of accidental long lasting power cuts (cuts without notice longer than 3 minutes), (average number per consumer).	BES (Quality of services)
Q6	Irregularities in water supply	Percentage of households who report irregularities in water supply.	BES (Quality of services)
	Gross domestic product		
GDP	Per-capita GDP	Gross domestic product (GDP) at current market prices by NUTS 2 regions, euro per inhabitants.	Eurostat (Regional economic statistics)
	Health		
H1	Life expectancy	Average number of years that a child born in a given calendar year can expect to live if exposed throughout life to the risks of death observed in the same year at different ages.	BES (Health)
H2	Infant mortality rate	Deaths in the first year of life per 10.000 live births.	BES (Health)
H3	Overweight or obesity	Standardized percentage of people aged 18 years and over who are overweight or obese: the indicator refers to the Body Mass Index (BMI).	BES (Health)
H4	Sedentary lifestyle	Standardized percentage of people aged 14 years and over who do not practice any physical activity.	BES (Health)
H5	Nutrition	Standardized percentage of people aged 3	BES (Health)

		years and over who consume at least 4 portions of fruit and vegetables a day.	
	Material living conditions		
M1	Disposable household income per inhabitant	Disposable household income on the total number of inhabitants.	ISTAT (Regional economic accounts)
M2	Disposable income inequality	Ratio of total equivalised income received by 20% of the population with the highest income to that received by 20% of the population with the lowest income.	BES (Economic Well-Being)
M3	People at risk of relative poverty	Percentage of persons at risk of poverty, with an equivalised income less than or equal to 60% of the median equivalised income.	BES (Economic Well-Being)
M4	People living in jobless households	Percentage of individuals living in households with at least one component aged 18-59 years (with the exception of households where all members are full time students under 25 years) where nobody works or receives an occupational pension.	BES (Economic Well-Being)
M5	People suffering poor housing conditions	Percentage of people in overcrowded dwellings without basic facilities or with structural defects.	BES (Economic Well-Being)
	Personal Security		
T1	Burglary rate	Number of burglaries per 1.000 households.	BES (Security)
T2	Pick-pocketing rate	Number of pick-pocketing per 1.000 people.	BES (security)
T3	Robbery rate	Number of robberies per 1.000 people.	BES (Security)
T4	Homicide rate	Number of homicide per 100.000 people.	BES (Security)
T5	Perception of crime risk	Percentage of households who are very much worried by the crime risk in the area where they live.	ISTAT DPS (Legality and safety)
	Research and Innovation		
R1	R&D expenditure	R&D expenditure by Public Administration, Universities and public and private companies as percentage of GDP.	BES (Research and Innovation)
R2	Capacity to export	Percentage of the value of the goods' exports on GDP.	ISTAT-DPS (Internationalization)
R3	Patents	Number of patents registered by the European Patent Office per million inhabitants.	BES-ISTAT - DPS (Research and Innovation)

R4	R&D workers	Researchers, technicians and other personnel involved in R&D in the Public Administrations, University, public and private companies, per 1.000 inhabitants.	ISTAT - DPS (Research and Innovation)
R5	Graduates in Science and Technology	People aged 20-29 with degree in scientific and technological disciplines, per 1.000 inhabitants.	ISTAT - DPS (Research and Innovation)
	Social Relations		
S1	Satisfaction with family relations	Share of population aged 14 and over who are very satisfied with their family relationships.	BES (Social relationships)
S2	Satisfaction with friendship relation	Share of population aged 14 and over who are very satisfied with the relationship with friends.	BES (Social relationships)
S3	Synthetic indicator of social participation	Based on the aggregation of the following indicators: People aged 14 and over who during the past 12 months have participated in meetings of associations, trade unions and professional associations or in activities (cultural, sporting, recreational, spiritual), organized or promoted by religious or spiritual groups; have attended meetings of political parties and/or have worked free for a party.	BES (Social relationships)
S4	Volunteer work	Percentage of the population aged 14 and over who in the past 12 months performed non-paid volunteer work for associations or volunteer groups.	BES (Social relationships)
S5	Share of population who funded associations	Share of population aged 14 and over who in the past 12 months have funded associations.	BES (Social relationships)

Table 1 – Variance explained by the first principal component (%) for each well-being dimension and for the well-being synthetic index by year

	Nr. of variables	2004	2005	2006	2007	2008	2009	2010
Culture and free time	7	79	79	80	83	81	80	80
Education	5	84	88	92	92	85	84	76
Employment	8	91	91	91	89	89	87	86
Environment	6	63	65	71	71	72	72	71
Essential public services	6	45	57	56	60	59	66	64
Health	5	88	75	73	61	67	80	82
Material living conditions	5	96	93	94	92	93	91	92
Personal security	5	52	52	57	57	59	56	53
Research and innovation	5	76	72	76	79	79	79	81
Social relations	5	92	91	92	91	93	91	92
Regional Well-Being Index	10	53	51	47	46	50	50	47

Source: our elaboration on ISTAT data

Table 2 - Culture and free time: Measure of sampling adequacy and Bartlett test

	2004	2005	2006	2007	2008	2009	2010
Newspaper reading	0.799	0.791	0.847	0.762	0.769	0.709	0.774
Theater attendance	0.582	0.785	0.804	0.802	0.783	0.77	0.725
Live classic music concerts	0.735	0.868	0.85	0.895	0.848	0.836	0.917
Sport events	0.524	0.738	0.841	0.647	0.656	0.695	0.826
Books reading	0.685	0.706	0.804	0.791	0.841	0.85	0.864
Museums visits	0.756	0.768	0.906	0.899	0.803	0.789	0.835
Sport	0.928	0.746	0.896	0.831	0.816	0.854	0.939
				overall MSA			
KMO MSA	.718	.769	.853	.809	.795	.788	.845
Bartlett test (sig.)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

Source: our elaboration on ISTAT data

Table 3- Culture and free time: Component matrix (correlation with the first principal component)

	2004	2005	2006	2007	2008	2009	2010
Newspaper reading	.912	.851	.863	.932	.901	.874	.905
Theater attendance	.818	.806	.771	.785	.772	.793	.740
Live classic music concerts	.889	.873	.873	.912	.896	.887	.887
Sport events	.636	.567	.644	.629	.621	.665	.532
Books reading	.915	.921	.927	.949	.952	.946	.954
Museums visits	.964	.979	.974	.980	.979	.983	.986
Sport	.904	.953	.960	.946	.958	.910	.942

Source: our elaboration on ISTAT data

Table 4- Culture and free time: Communalities

	2004	2005	2006	2007	2008	2009	2010
Newspaper reading	.831	.725	.744	.868	.812	.764	.820
Theater attendance	.668	.650	.595	.617	.596	.629	.547
Live classic music concerts	.791	.763	.762	.832	.804	.786	.786
Sport events	.404	.322	.415	.395	.385	.442	.283
Books reading	.837	.848	.859	.900	.906	.894	.910
Museums visits	.929	.959	.949	.960	.959	.967	.971
Sport	.817	.908	.921	.894	.917	.829	.887

Source: our elaboration on ISTAT data

Table 5- Culture and free time Index by region and year

	2004		2005		2006		2007		2008		2009		2010		Δ (2010-2004)	
Position	Regions	Index value	Regions	Index value	Regions	Index value	Regions	Index value	Regions	Index value	Regions	Index value	Regions	Index value	Regions	Ranks
1	Trentino-A.A.	3.61	Trentino-A.A.	3.63	Trentino-A.A.	3.70	Trentino-A.A.	3.72	Trentino-A.A.	3.72	Trentino-A.A.	3.65	Trentino-A.A.	3.52	Campania	5
2	Friuli-V.G.	3.08	Friuli-V.G.	3.06	Lombardia	3.02	Friuli-V.G.	3.05	Friuli-V.G.	3.16	Friuli-V.G.	3.14	Friuli-V.G.	3.08	Emilia-Romagna	2
3	Veneto	3.04	Lombardia	3.05	Emilia-Romagna	3.01	Lombardia	3.03	Valle d'Aosta	3.03	Lombardia	2.89	Lombardia	3.02	Toscana	2
4	Lombardia	2.98	Lazio	3.02	Veneto	3.00	Piemonte	2.99	Veneto	3.02	Lazio	2.87	Veneto	2.95	Puglia	2
5	Emilia-Romagna	2.89	Veneto	2.90	Toscana	2.86	Veneto	2.96	Lombardia	2.96	Emilia-Romagna	2.85	Lazio	2.93	Veneto	1
6	Toscana	2.85	Piemonte	2.79	Valle d'Aosta	2.78	Emilia-Romagna	2.90	Lazio	2.94	Veneto	2.84	Valle d'Aosta	2.90	Piemonte	1
7	Lazio	2.80	Emilia-Romagna	2.76	Friuli-V.G.	2.75	Valle d'Aosta	2.89	Emilia-Romagna	2.82	Piemonte	2.79	Emilia-Romagna	2.77	Umbria	1
8	Piemonte	2.78	Toscana	2.72	Piemonte	2.74	Lazio	2.86	Toscana	2.74	Valle d'Aosta	2.78	Toscana	2.76	Abruzzo	1
9	Valle d'Aosta	2.71	Valle d'Aosta	2.70	Lazio	2.70	Liguria	2.74	Piemonte	2.74	Toscana	2.69	Piemonte	2.71	Trentino-A.A.	0
10	Liguria	2.67	Marche	2.64	Umbria	2.62	Toscana	2.60	Liguria	2.64	Marche	2.67	Liguria	2.70	Friuli-V.G.	0
11	Marche	2.60	Umbria	2.48	Marche	2.61	Umbria	2.45	Umbria	2.45	Liguria	2.59	Marche	2.51	Liguria	0
12	Umbria	2.42	Liguria	2.41	Liguria	2.59	Sardegna	2.43	Marche	2.44	Umbria	2.48	Sardegna	2.49	Marche	0
13	Abruzzo	2.41	Abruzzo	2.39	Sardegna	2.36	Marche	2.37	Sardegna	2.44	Sardegna	2.37	Umbria	2.44	Lombardia	-1
14	Sardegna	2.31	Sardegna	2.39	Abruzzo	2.34	Abruzzo	2.30	Abruzzo	2.28	Abruzzo	2.29	Abruzzo	2.37	Basilicata	-1
15	Campania	2.01	Basilicata	2.02	Basilicata	2.14	Basilicata	2.11	Basilicata	2.10	Basilicata	2.08	Basilicata	1.95	Lazio	-2
16	Basilicata	1.97	Calabria	1.94	Puglia	1.97	Molise	1.92	Campania	1.88	Sicilia	1.99	Molise	1.95	Sardegna	-2
17	Puglia	1.91	Puglia	1.93	Molise	1.94	Campania	1.88	Molise	1.87	Campania	1.98	Sicilia	1.94	Molise	-2
18	Molise	1.88	Campania	1.91	Campania	1.90	Sicilia	1.86	Sicilia	1.83	Molise	1.93	Calabria	1.94	Sicilia	-2
19	Sicilia	1.85	Molise	1.87	Sicilia	1.82	Puglia	1.82	Calabria	1.82	Calabria	1.80	Puglia	1.83	Calabria	-2
20	Calabria	1.62	Sicilia	1.78	Calabria	1.77	Calabria	1.70	Puglia	1.75	Puglia	1.80	Campania	1.80	Valle d'Aosta	-3

Source: our elaboration on ISTAT data

Table 6- Education: Measure of sampling adequacy and Bartlett test

	2004	2005	2006	2007	2008	2009	2010
				for each variable			
People with tertiary education	0.73	0.824	0.734	0.658	0.753	0.797	0.78
Rate of early leavers from education and training	0.856	0.824	0.87	0.821	0.668	0.777	0.849
Rate of upper secondary school leavers	0.738	0.831	0.855	0.864	0.407	0.675	0.835
Participation in long-life learning	0.843	0.889	0.779	0.673	0.89	0.906	0.876
People with at least upper secondary education	0.723	0.775	0.702	0.74	0.818	0.851	0.755
				overall MSA			
KMO MSA	.771	.821	.775	.741	.721	.812	.803
Bartlett test (sig.)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

Source: our elaboration on ISTAT data

Table 7- Education: Component matrix (correlation with the first principal component)

	2004	2005	2006	2007	2008	2009	2010
People with tertiary education	.505	.471	.567	.495	.148	.285	.293
Rate of early leavers from education and training	-.690	-.679	-.569	-.648	-.581	-.440	-.372
Rate of upper secondary school leavers	-.991	-.996	-.999	-.999	-.997	-.997	-.996
Participation in long-life learning	.673	.580	.654	.490	.257	.475	.145
People with at least upper secondary education	.644	.603	.612	.616	.374	.380	.329

Source: our elaboration on ISTAT data

Table 8-Education: Communalities

	2004	2005	2006	2007	2008	2009	2010
People with tertiary education	.255	.222	.321	.245	.022	.081	.086
Rate of early leavers from education and training	.477	.462	.323	.420	.337	.194	.139
Rate of upper secondary school leavers	.983	.993	.997	.997	.994	.994	.993
Participation in long-life learning	.453	.337	.428	.240	.066	.225	.021
People with at least upper secondary education	.415	.363	.374	.379	.140	.144	.108

Source: our elaboration on ISTAT data

Table 9- Education Index by region and year

	2004		2005		2006		2007		2008		2009		2010		Δ (2010-2004)	
Position	Regions	Index value	Regions	Index value	Regions	Index value	Regions	Index value	Regions	Index value	Regions	Index value	Regions	Index value	Regions	Ranks
1	Trentino-A.A.	0.32	Trentino-A.A.	0.51	Umbria	0.68	Umbria	1.14	Trentino-A.A.	0.34	Trentino-A.A.	0.54	Trentino-A.A.	0.68	Friuli-V.G.	9
2	Friuli-V.G.	0.18	Veneto	0.18	Trentino-A.A.	0.48	Friuli-V.G.	0.18	Marche	0.14	Puglia	-0.13	Marche	-0.11	Umbria	6
3	Umbria	0.08	Marche	0.10	Emilia-Romagna	0.40	Emilia-Romagna	0.14	Veneto	-0.48	Veneto	-0.14	Veneto	-0.15	Abruzzo	5
4	Veneto	-0.17	Friuli-V.G.	0.04	Marche	0.08	Veneto	0.10	Calabria	-0.49	Basilicata	-0.24	Calabria	-0.20	Lombardia	3
5	Emilia-Romagna	-0.17	Emilia-Romagna	0.03	Veneto	0.06	Marche	-0.07	Basilicata	-0.51	Emilia-Romagna	-0.30	Puglia	-0.53	Toscana	2
6	Marche	-0.17	Umbria	-0.44	Friuli-V.G.	-0.08	Calabria	-0.16	Umbria	-0.55	Calabria	-0.31	Emilia-Romagna	-0.60	Emilia-Romagna	1
7	Lazio	-0.37	Basilicata	-0.46	Molise	-0.24	Trentino-A.A.	-0.27	Friuli-V.G.	-0.73	Friuli-V.G.	-0.32	Piemonte	-0.73	Lazio	1
8	Calabria	-0.64	Lazio	-0.55	Abruzzo	-0.47	Abruzzo	-0.38	Puglia	-0.77	Umbria	-0.34	Lazio	-1.01	Molise	1
9	Piemonte	-0.68	Toscana	-0.68	Lazio	-0.62	Piemonte	-0.52	Emilia-Romagna	-0.85	Lazio	-0.79	Umbria	-1.03	Valle d'Aosta	1
10	Abruzzo	-0.79	Calabria	-0.69	Toscana	-0.91	Basilicata	-0.56	Lazio	-0.94	Piemonte	-0.86	Basilicata	-1.08	Sicilia	1
11	Toscana	-0.81	Piemonte	-0.84	Piemonte	-0.95	Lazio	-0.65	Piemonte	-0.94	Marche	-0.91	Friuli-V.G.	-1.12	Trentino-A.A.	0
12	Basilicata	-0.84	Abruzzo	-0.86	Puglia	-1.04	Molise	-1.19	Molise	-1.02	Toscana	-0.97	Liguria	-1.14	Campania	0
13	Molise	-1.14	Liguria	-1.16	Basilicata	-1.27	Puglia	-1.36	Toscana	-1.03	Abruzzo	-1.04	Toscana	-1.17	Veneto	-1
14	Lombardia	-1.29	Molise	-1.18	Calabria	-1.35	Toscana	-1.51	Abruzzo	-1.13	Molise	-1.15	Molise	-1.17	Sardegna	-1
15	Liguria	-1.34	Lombardia	-1.35	Liguria	-1.52	Campania	-1.58	Campania	-1.30	Campania	-1.21	Abruzzo	-1.23	Piemonte	-2
16	Campania	-1.53	Puglia	-1.51	Lombardia	-1.62	Liguria	-1.78	Liguria	-1.41	Liguria	-1.34	Campania	-1.36	Basilicata	-2
17	Valle d'Aosta	-1.62	Sardegna	-1.96	Campania	-1.67	Lombardia	-2.04	Lombardia	-1.81	Lombardia	-1.34	Lombardia	-1.39	Liguria	-3
18	Puglia	-1.73	Valle d'Aosta	-2.19	Sardegna	-1.93	Valle d'Aosta	-2.18	Sicilia	-1.98	Sicilia	-1.78	Valle d'Aosta	-1.54	Marche	-4
19	Sicilia	-1.78	Campania	-2.23	Sicilia	-2.17	Sicilia	-2.65	Valle d'Aosta	-2.30	Sardegna	-2.39	Sardegna	-1.79	Calabria	-4
20	Sardegna	-1.81	Sicilia	-2.24	Valle d'Aosta	-3.11	Sardegna	-3.12	Sardegna	-2.73	Valle d'Aosta	-2.80	Sicilia	-2.00	Puglia	-13

Source: our elaboration on ISTAT data

Table 10- Employment: Measure of sampling adequacy and Bartlett test

	2004	2005	2006	2007	2008	2009	2010
				for each variable			
Employment rate	0.884	0.898	0.85	0.823	0.815	0.787	0.78
Non-participation rate	0.772	0.859	0.859	0.885	0.854	0.86	0.889
Share of employed persons with temporary jobs for at least 5 years	0.828	0.71	0.792	0.798	0.893	0.806	0.899
Share of workers not in regular occupation	0.861	0.872	0.931	0.808	0.893	0.792	0.79
Ratio between the employment rate of women aged 25-49 with at least one children of compulsory school age (6-13), and the employment rate of women aged 25-49 without children	0.66	0.838	0.833	0.745	0.79	0.805	0.778
Ratio of the female employment rate to male employment rate	0.731	0.792	0.818	0.866	0.886	0.807	0.824
Incidence of long term unemployment	0.822	0.834	0.803	0.967	0.927	0.875	0.852
Youth unemployment rate	0.758	0.876	0.841	0.848	0.928	0.818	0.878
				overall MSA			
KMO MSA	.790	.842	.843	.846	.875	.819	.836
Bartlett test (sig.)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

Source: our elaboration on ISTAT data

Table 11- Employment: Component matrix (correlation with the first principal component)

	2004	2005	2006	2007	2008	2009	2010
Employment rate	.977	.978	.982	.984	.982	.976	.979
Non-participation rate	-.994	-.992	-.994	-.991	-.989	-.982	-.983
Share of employed persons with temporary jobs for at least 5 years	-.747	-.731	-.704	-.700	-.744	-.778	-.798
Share of workers not in regular occupation	-.962	-.972	-.954	-.931	-.941	-.945	-.934
Ratio between the employment rate of women aged 25-49 with at least one children of compulsory school age (6-13), and the employment rate of women aged 25-49 without children	.620	.510	.690	.679	.558	.675	.539
Ratio of the female employment rate to male employment rate	.949	.934	.939	.940	.942	.915	.902
Incidence of long term unemployment	-.890	-.926	-.912	-.912	-.929	-.911	-.840
Youth unemployment rate	-.989	-.994	-.985	-.965	-.969	-.897	-.939

Source: our elaboration on ISTAT data

Table 12- Employment: Communalities

	2004	2005	2006	2007	2008	2009	2010
Employment rate	.955	.956	.965	.969	.965	.952	.958
Non-participation rate	.987	.985	.987	.982	.978	.965	.966
Share of employed persons with temporary jobs for at least 5 years	.557	.535	.495	.490	.554	.605	.637
Share of workers not in regular occupation	.926	.944	.911	.867	.886	.894	.872
Ratio between the employment rate of women aged 25-49 with at least one children of compulsory school age (6-13), and the employment rate of women aged 25-49 without children	.384	.260	.476	.460	.311	.455	.291
Ratio of the female employment rate to male employment rate	.901	.873	.881	.884	.887	.838	.814
Incidence of long term unemployment	.791	.858	.832	.831	.863	.829	.705
Youth unemployment rate	.979	.988	.971	.930	.939	.805	.883

Source: our elaboration on ISTAT data

Table 13- Employment Index by region and year

	2004		2005		2006		2007		2008		2009		2010		Δ (2010-2004)	
Position	**Regions**	**Index value**	**Regions**	**Index value**	**Regions**	**Index value**	**Regions**	**Index value**	**Regions**	**Index value**	**Regions**	**Index value**	**Regions**	**Index value**	**Regions**	**Ranks**
1	Trentino-A.A.	-0.53	Trentino-A.A.	-0.59	Trentino-A.A.	-0.57	Trentino-A.A.	-0.50	Trentino-A.A.	-0.56	Trentino-A.A.	-0.52	Trentino-A.A.	-0.56	Piemonte	4
2	Valle d'Aosta	-0.56	Valle d'Aosta	-0.69	Valle d'Aosta	-0.65	Emilia-Romagna	-0.63	Emilia-Romagna	-0.70	Veneto	-0.72	Valle d'Aosta	-0.70	Emilia-Romagna	1
3	Emilia-Romagna	-0.72	Emilia-Romagna	-0.70	Emilia-Romagna	-0.71	Veneto	-0.68	Veneto	-0.72	Emilia-Romagna	-0.76	Veneto	-0.80	Friuli-V.G.	1
4	Veneto	-0.79	Lombardia	-0.79	Veneto	-0.78	Valle d'Aosta	-0.74	Valle d'Aosta	-0.79	Valle d'Aosta	-0.79	Emilia-Romagna	-0.85	Abruzzo	1
5	Lombardia	-0.83	Veneto	-0.80	Lombardia	-0.83	Marche	-0.78	Lombardia	-0.84	Lombardia	-0.89	Lombardia	-0.86	Trentino-A.A.	0
6	Friuli-V.G.	-0.91	Friuli-V.G.	-0.82	Marche	-0.87	Lombardia	-0.80	Marche	-0.86	Friuli-V.G.	-0.92	Marche	-0.88	Valle d'Aosta	0
7	Piemonte	-1.07	Marche	-0.99	Friuli-V.G.	-0.93	Friuli-V.G.	-0.94	Friuli-V.G.	-0.94	Toscana	-0.96	Friuli-V.G.	-0.89	Lombardia	0
8	Marche	-1.08	Toscana	-1.00	Piemonte	-0.98	Piemonte	-0.94	Toscana	-0.95	Marche	-1.03	Toscana	-1.05	Liguria	0
9	Toscana	-1.09	Piemonte	-1.03	Toscana	-1.03	Toscana	-0.95	Piemonte	-1.05	Liguria	-1.10	Umbria	-1.13	Molise	0
10	Liguria	-1.32	Liguria	-1.26	Liguria	-1.22	Umbria	-1.19	Umbria	-1.13	Umbria	-1.18	Liguria	-1.14	Sardegna	0
11	Umbria	-1.35	Umbria	-1.44	Umbria	-1.32	Liguria	-1.24	Liguria	-1.30	Piemonte	-1.19	Piemonte	-1.17	Puglia	0
12	Abruzzo	-1.70	Abruzzo	-1.65	Abruzzo	-1.58	Abruzzo	-1.55	Abruzzo	-1.52	Abruzzo	-1.54	Lazio	-1.57	Basilicata	0
13	Lazio	-1.92	Lazio	-1.83	Lazio	-1.83	Lazio	-1.76	Lazio	-1.73	Lazio	-1.69	Abruzzo	-1.65	Campania	0
14	Molise	-2.38	Molise	-2.41	Molise	-2.42	Molise	-2.23	Molise	-2.47	Molise	-2.40	Molise	-2.27	Sicilia	0
15	Sardegna	-2.63	Sardegna	-2.55	Sardegna	-2.53	Sardegna	-2.51	Sardegna	-2.64	Sardegna	-2.51	Sardegna	-2.38	Calabria	0
16	Puglia	-2.78	Puglia	-2.77	Basilicata	-2.73	Puglia	-2.67	Puglia	-2.69	Puglia	-2.53	Puglia	-2.47	Veneto	-1
17	Basilicata	-2.80	Basilicata	-2.79	Puglia	-2.75	Basilicata	-2.72	Basilicata	-2.91	Basilicata	-2.81	Basilicata	-2.74	Toscana	-1
18	Campania	-3.17	Campania	-3.18	Campania	-3.15	Campania	-3.06	Campania	-3.11	Campania	-2.96	Campania	-2.93	Lazio	-1
19	Sicilia	-3.41	Sicilia	-3.42	Sicilia	-3.27	Sicilia	-3.25	Sicilia	-3.34	Sicilia	-3.06	Sicilia	-3.04	Marche	-2
20	Calabria	-3.58	Calabria	-3.78	Calabria	-3.57	Calabria	-3.42	Calabria	-3.51	Calabria	-3.37	Calabria	-3.52	Umbria	-2

Source: our elaboration on ISTAT data

Table 14- Environment: Measure of sampling adequacy by year and Bartlett test

	2004	2005	2006	2007	2008	2009	2010
				for each variable			
Fertilizers used in agriculture	0.635	0.652	0.807	0.694	0.736	0.676	0.783
Monitoring of air quality	0.573	0.621	0.618	0.574	0.589	0.638	0.645
Air pollution	0.53	0.653	0.663	0.692	0.573	0.681	0.91
Energy consumption provided by renewable sources	0.531	0.567	0.606	0.576	0.527	0.623	0.655
Special Protection Areas	0.404	0.453	0.486	0.514	0.511	0.615	0.568
Population density	0.711	0.723	0.744	0.789	0.803	0.673	0.804
				overall MSA			
KMO MSA	.562	.612	.648	.627	.606	.647	.706
Bartlett test (sig.)	<0.013	<0.042	<0.002	<0.001	<0.001	<0.001	<0.001

Source: our elaboration on ISTAT data

Table 15- Environment: Component matrix (correlation with the first principal component)

	2004	2005	2006	2007	2008	2009	2010
Fertilizers used in agriculture	-.434	-.459	-.474	-.472	-.488	-.494	-.570
Monitoring of air quality	.733	.620	.895	.708	.838	.862	.846
Air pollution	-.241	-.277	-.252	-.314	-.390	-.490	-.502
Energy consumption provided by renewable sources	.988	.989	.985	.990	.985	.983	.968
Special Protection Areas	.541	.502	.396	.631	.629	.660	.453
Population density	-.489	-.507	-.502	-.517	-.542	-.571	-.626

Source: our elaboration on ISTAT data

Table 16- Environment: Communalities

	2004	2005	2006	2007	2008	2009	2010
Fertilizers used in agriculture	.188	.210	.225	.222	.238	.244	.324
Monitoring of air quality	.538	.385	.801	.502	.702	.742	.716
Air pollution	.058	.077	.064	.099	.152	.240	.252
Energy consumption provided by renewable sources	.977	.978	.970	.980	.970	.967	.937
Special Protection Areas	.292	.252	.157	.399	.396	.436	.205
Population density	.240	.257	.252	.267	.293	.327	.392

Source: our elaboration on ISTAT data

Table 17- Environment Index by region and year

	2004		2005		2006		2007		2008		2009		2010		Δ (2010-2004)	
Position	Regions	Index value	Regions	Index value	Regions	Index value	Regions	Index value	Regions	Index value	Regions	Index value	Regions	Index value	Regions	Ranks
1	Valle d'Aosta	8.54	Valle d'Aosta	8.43	Valle d'Aosta	9.32	Valle d'Aosta	8.87	Valle d'Aosta	8.28	Valle d'Aosta	8.23	Valle d'Aosta	6.69	Friuli-V. G.	5
2	Trentino-A.A.	4.49	Trentino-A.A.	3.68	Trentino-A.A.	3.85	Trentino-A.A.	4.37	Trentino-A.A.	4.34	Trentino-A.A.	3.63	Trentino-A.A.	3.25	Campania	4
3	Abruzzo	1.39	Abruzzo	1.34	Abruzzo	1.16	Calabria	1.64	Molise	1.25	Molise	1.43	Molise	1.69	Marche	3
4	Friuli-V. G.	0.90	Molise	0.91	Friuli-V. G.	1.01	Toscana	1.58	Abruzzo	0.82	Abruzzo	1.09	Basilicata	1.03	Piemonte	3
5	Calabria	0.80	Calabria	0.82	Sardegna	0.95	Abruzzo	1.50	Basilicata	0.82	Basilicata	1.02	Abruzzo	0.83	Veneto	3
6	Basilicata	0.76	Friuli-V.G.	0.68	Umbria	0.93	Molise	1.50	Toscana	0.73	Calabria	0.80	Calabria	0.82	Abruzzo	2
7	Umbria	0.74	Toscana	0.67	Basilicata	0.90	Basilicata	1.39	Sardegna	0.71	Sardegna	0.70	Umbria	0.67	Liguria	2
8	Molise	0.73	Basilicata	0.66	Calabria	0.82	Umbria	1.15	Friuli-V. G.	0.62	Friuli-V. G.	0.60	Sardegna	0.58	Calabria	1
9	Liguria	0.58	Umbria	0.62	Toscana	0.72	Piemonte	1.12	Calabria	0.61	Toscana	0.56	Friuli-V. G.	0.42	Lazio	0
10	Toscana	0.53	Sardegna	0.52	Molise	0.58	Sardegna	1.10	Umbria	0.45	Umbria	0.46	Toscana	0.37	Toscana	0
11	Sardegna	0.50	Liguria	0.21	Liguria	0.46	Friuli-V. G.	0.89	Liguria	0.28	Sicilia	0.16	Liguria	0.12	Trentino-A.A.	0
12	Piemonte	0.25	Piemonte	0.18	Sicilia	0.30	Sicilia	0.86	Marche	0.16	Piemonte	0.09	Sicilia	-0.03	Umbria	0
13	Marche	0.22	Sicilia	0.18	Piemonte	0.28	Lazio	0.86	Sicilia	0.13	Puglia	0.00	Puglia	-0.06	Valle d'Aosta	0
14	Lazio	0.18	Marche	0.03	Marche	0.13	Campania	0.85	Piemonte	0.12	Liguria	-0.02	Lazio	-0.27	Emilia-Romagna	-1
15	Veneto	0.11	Lazio	0.01	Lazio	0.12	Liguria	0.85	Puglia	-0.10	Marche	-0.03	Piemonte	-0.35	Lombardia	-1
16	Campania	0.04	Campania	0.00	Puglia	0.08	Puglia	0.80	Emilia-Romagna	-0.11	Emilia-Romagna	-0.09	Marche	-0.38	Basilicata	-2
17	Puglia	0.03	Puglia	-0.06	Emilia-Romagna	0.05	Lombardia	0.73	Lazio	-0.12	Lazio	-0.12	Emilia-Romagna	-0.51	Sardegna	-3
18	Emilia-Romagna	0.01	Emilia-Romagna	-0.07	Lombardia	-0.10	Veneto	0.67	Veneto	-0.16	Veneto	-0.21	Veneto	-0.69	Puglia	-4
19	Sicilia	-0.07	Veneto	-0.19	Campania	-0.14	Marche	0.60	Lombardia	-0.24	Lombardia	-0.40	Lombardia	-0.73	Molise	-5
20	Lombardia	-0.18	Lombardia	-0.30	Veneto	-0.18	Emilia-Romagna	0.50	Campania	-0.49	Campania	-0.59	Campania	-0.75	Sicilia	-7

Source: our elaboration on ISTAT data

Table 18- Essential public services: Measure of sampling adequacy and Bartlett test

	2004	2005	2006	2007	2008	2009	2010
	for each variable						
Waiting lists for treatments	0.813	0.671	0.77	0.847	0.814	0.646	0.894
Differentiated urban waste collection	0.654	0.65	0.805	0.8	0.578	0.902	0.786
Child care services	0.547	0.543	0.733	0.8	0.775	0.891	0.831
Elderly assisted at home	0.349	0.321	0.543	0.736	0.615	0.604	0.839
Irregularities in electric power provision	0.609	0.672	0.691	0.763	0.625	0.658	0.791
Irregularities in water supply	0.684	0.796	0.861	0.834	0.705	0.65	0.773
	overall MSA						
KMO MSA	.608	.641	.743	.802	.679	.711	.811
Bartlett test (sig.)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

Source: our elaboration on ISTAT data

Table 19- Essential public services: Component matrix (correlation with the first principal component)

	2004	2005	2006	2007	2008	2009	2010
Waiting lists for treatments	-.410	-.846	-.884	-.817	-.889	-.905	-.904
Differentiated urban waste collection	.706	.713	.601	.759	.580	.716	.648
Child care services	.870	.648	.572	.769	.638	.750	.752
Elderly assisted at home	.061	.371	.527	.453	.508	.474	.509
Irregularities in electric power provision	-.783	-.914	-.876	-.875	-.726	-.787	-.759
Irregularities in water supply	-.817	-.933	-.795	-.906	-.862	-.939	-.854

Source: our elaboration on ISTAT data

Table 20- Essential public services: Communalities

	2004	2005	2006	2007	2008	2009	2010
Waiting lists for treatments	.168	.716	.781	.667	.791	.820	.818
Differentiated urban waste collection	.499	.508	.362	.576	.337	.513	.420
Child care services	.758	.420	.328	.592	.406	.562	.566
Elderly assisted at home	.004	.138	.278	.206	.258	.224	.259
Irregularities in electric power provision	.613	.835	.767	.765	.527	.619	.577
Irregularities in water supply	.668	.870	.633	.820	.742	.881	.729

Source: our elaboration on ISTAT data

Table 21- Essential Public Services Index by region and year

	2004		2005		2006		2007		2008		2009		2010		Δ (2010-2004)	
Position	Regions	Index value	Regions	Index value	Regions	Index value	Regions	Index value	Regions	Index value	Regions	Index value	Regions	Index value	Regions	Ranks
1	Valle d'Aosta	3.23	Valle d'Aosta	1.51	Friuli-V.G.	1.09	Friuli-V.G.	1.23	Friuli-V.G.	0.99	Emilia-Romagna	1.17	Umbria	1.05	Toscana	8
2	Emilia-Romagna	1.49	Trentino-A.A.	0.90	Trentino-A.A.	0.66	Emilia-Romagna	1.21	Emilia-Romagna	0.66	Friuli-V.G.	1.07	Friuli-V.G.	1.04	Lombardia	5
3	Lombardia	1.09	Friuli-V.G.	0.67	Valle d'Aosta	0.65	Valle d'Aosta	0.81	Umbria	0.61	Trentino-A.A.	0.55	Emilia-Romagna	1.01	Veneto	5
4	Trentino-A.A.	1.06	Liguria	0.45	Emilia-Romagna	0.45	Trentino-A.A.	0.78	Valle d'Aosta	0.57	Valle d'Aosta	0.48	Valle d'Aosta	0.71	Piemonte	4
5	Toscana	0.94	Lombardia	0.43	Veneto	0.43	Veneto	0.71	Liguria	0.39	Veneto	0.47	Trentino-A.A.	0.69	Molise	4
6	Veneto	0.82	Emilia-Romagna	0.40	Liguria	0.38	Lombardia	0.52	Trentino-A.A.	0.38	Liguria	0.40	Marche	0.58	Valle d'Aosta	3
7	Marche	0.75	Umbria	0.20	Umbria	0.30	Piemonte	0.07	Veneto	0.20	Lombardia	0.37	Liguria	0.48	Puglia	3
8	Piemonte	0.61	Veneto	0.17	Lombardia	0.13	Liguria	0.00	Lombardia	0.18	Basilicata	-0.01	Lombardia	0.39	Emilia-Romagna	1
9	Liguria	0.60	Piemonte	-0.07	Abruzzo	-0.04	Umbria	-0.10	Basilicata	0.07	Umbria	-0.02	Abruzzo	0.39	Trentino-A.A.	1
10	Friuli-V.G.	0.54	Marche	-0.10	Molise	-0.12	Marche	-0.18	Abruzzo	-0.18	Marche	-0.04	Basilicata	0.35	Sicilia	1
11	Umbria	0.32	Abruzzo	-0.40	Basilicata	-0.20	Molise	-0.19	Molise	-0.46	Piemonte	-0.25	Veneto	0.25	Marche	-1
12	Abruzzo	0.01	Molise	-0.50	Marche	-0.20	Abruzzo	-0.24	Piemonte	-0.71	Lazio	-0.92	Piemonte	-0.27	Lazio	-1
13	Molise	-0.32	Toscana	-0.69	Piemonte	-0.28	Toscana	-0.28	Marche	-0.87	Toscana	-1.13	Toscana	-0.60	Liguria	-2
14	Basilicata	-0.37	Lazio	-1.29	Lazio	-1.05	Lazio	-0.86	Lazio	-1.26	Sardegna	-1.20	Lazio	-0.63	Campania	-2
15	Lazio	-0.42	Campania	-1.53	Toscana	-1.12	Basilicata	-0.93	Toscana	-1.36	Campania	-1.57	Campania	-1.20	Sardegna	-2
16	Puglia	-0.72	Puglia	-1.60	Puglia	-2.17	Sardegna	-1.06	Sardegna	-1.46	Puglia	-1.84	Sardegna	-1.49	Calabria	-2
17	Campania	-0.95	Basilicata	-2.05	Campania	-2.26	Puglia	-1.66	Campania	-1.51	Abruzzo	-1.87	Molise	-1.61	Abruzzo	-3
18	Sardegna	-0.99	Sardegna	-2.09	Calabria	-2.44	Campania	-2.00	Puglia	-2.31	Molise	-2.17	Calabria	-1.68	Basilicata	-4
19	Sicilia	-1.33	Sicilia	-2.75	Sardegna	-2.55	Calabria	-2.58	Sicilia	-3.15	Sicilia	-3.00	Puglia	-1.76	Friuli-V.G.	-8
20	Calabria	-1.52	Calabria	-2.88	Sicilia	-2.69	Sicilia	-2.74	Calabria	-3.20	Calabria	-3.39	Sicilia	-2.32	Umbria	-10

Source: our elaboration on ISTAT data

Table 22- Health: Measure of sampling adequacy and Bartlett test

	2004	2005	2006	2007	2008	2009	2010
				for each variable			
Life expectancy	0.81	0.696	0.886	0.937	0.725	0.735	0.624
Infant mortality rate	0.805	0.83	0.905	0.692	0.804	0.796	0.676
Overweight or obesity	0.908	0.85	0.817	0.726	0.747	0.798	0.678
Sedentary lifestyle	0.874	0.747	0.808	0.824	0.762	0.779	0.743
Nutrition	0.783	0.743	0.75	0.77	0.681	0.825	0.641
				overall MSA			
KMO MSA	.835	.771	.809	.788	.737	.792	.679
Bartlett test (sig.)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

Source: our elaboration on ISTAT data

Table 23- Health: Component matrix by year (correlation with the first principal component)

	2004	2005	2006	2007	2008	2009	2010
Life expectancy	.361	.583	.424	.603	.522	.516	.504
Infant mortality rate	-.947	-.777	-.771	-.697	-.769	-.907	-.891
Overweight or obesity	-.846	-.770	-.803	-.824	-.788	-.873	-.798
Sedentary lifestyle	-.931	-.923	-.924	-.898	-.891	-.911	-.942
Nutrition	.965	.907	.879	.750	.786	.864	.865

Source: our elaboration on ISTAT data

Table 24- Health: Communalities

	2004	2005	2006	2007	2008	2009	2010
Life expectancy	.131	.340	.180	.363	.273	.266	.254
Infant mortality rate	.897	.603	.594	.486	.592	.822	.794
Overweight or obesity	.716	.593	.646	.679	.622	.762	.637
Sedentary lifestyle	.868	.853	.855	.806	.794	.831	.886
Nutrition	.930	.823	.773	.562	.618	.747	.749

Source: our elaboration on ISTAT data

Table 25- Health Index by region and year

	2004		2005		2006		2007		2008		2009		2010		Δ (2010-2004)	
Position	Regions	Index value	Regions	Index value	Regions	Index value	Regions	Index value	Regions	Index value	Regions	Index value	Regions	Index value	Regions	Ranks
1	Friuli-V.G.	-0.23	Trentino-A.A.	-0.29	Valle d'Aosta	-0.28	Piemonte	-0.50	Piemonte	-0.55	Trentino-A.A.	-0.14	Trentino-A.A.	-0.20	Marche	6
2	Trentino-A.A.	-0.41	Veneto	-0.34	Friuli-V.G.	-0.47	Trentino-A.A.	-0.93	Valle d'Aosta	-1.11	Valle d'Aosta	-0.29	Toscana	-0.34	Valle d'Aosta	5
3	Piemonte	-0.43	Friuli-V.G.	-0.36	Trentino-A.A.	-0.49	Friuli-V.G.	-0.94	Liguria	-0.75	Piemonte	-0.40	Friuli-V.G.	-0.37	Friuli-V.G.	2
4	Veneto	-0.44	Piemonte	-0.45	Lombardia	-0.56	Basilicata	-1.03	Lombardia	-0.66	Liguria	-0.41	Emilia-Romagna	-0.42	Piemonte	2
5	Valle d'Aosta	-0.47	Toscana	-0.47	Veneto	-0.59	Veneto	-1.12	Trentino-A.A.	-0.37	Friuli-V.G.	-0.44	Piemonte	-0.42	Veneto	2
6	Marche	-0.54	Emilia-Romagna	-0.48	Liguria	-0.60	Emilia-Romagna	-1.17	Veneto	-0.59	Emilia-Romagna	-0.49	Veneto	-0.45	Campania	2
7	Lombardia	-0.56	Marche	-0.57	Emilia-Romagna	-0.60	Toscana	-1.20	Friuli-V.G.	-0.43	Veneto	-0.51	Lombardia	-0.54	Liguria	1
8	Liguria	-0.57	Liguria	-0.59	Piemonte	-0.64	Valle d'Aosta	-1.24	Emilia-Romagna	-0.68	Toscana	-0.54	Umbria	-0.61	Lazio	1
9	Emilia-Romagna	-0.63	Lombardia	-0.59	Toscana	-0.66	Lombardia	-1.25	Toscana	-0.72	Lombardia	-0.55	Liguria	-0.69	Abruzzo	1
10	Toscana	-0.76	Umbria	-0.67	Marche	-0.82	Marche	-1.29	Umbria	-0.82	Umbria	-0.56	Valle d'Aosta	-0.73	Molise	1
11	Umbria	-0.80	Valle d'Aosta	-0.70	Umbria	-0.86	Sardegna	-1.37	Marche	-0.70	Marche	-0.70	Sardegna	-0.79	Basilicata	1
12	Lazio	-0.86	Sardegna	-0.75	Sardegna	-0.92	Umbria	-1.38	Lazio	-0.99	Sardegna	-0.73	Marche	-0.85	Sicilia	1
13	Sardegna	-0.96	Molise	-0.82	Lazio	-1.04	Liguria	-1.48	Abruzzo	-1.40	Lazio	-0.88	Lazio	-0.87	Lombardia	0
14	Abruzzo	-1.22	Lazio	-0.85	Molise	-1.04	Lazio	-1.49	Molise	-1.28	Abruzzo	-1.00	Puglia	-1.21	Trentino-A.A.	-1
15	Molise	-1.24	Abruzzo	-0.99	Abruzzo	-1.10	Molise	-1.58	Campania	-1.44	Molise	-1.19	Abruzzo	-1.22	Sardegna	-2
16	Basilicata	-1.41	Campania	-1.29	Basilicata	-1.28	Abruzzo	-1.80	Puglia	-1.32	Campania	-1.26	Molise	-1.22	Calabria	-2
17	Campania	-1.42	Puglia	-1.36	Puglia	-1.33	Puglia	-1.82	Basilicata	-1.54	Puglia	-1.27	Basilicata	-1.25	Umbria	-3
18	Puglia	-1.43	Basilicata	-1.40	Campania	-1.47	Campania	-1.87	Calabria	-1.48	Calabria	-1.31	Calabria	-1.30	Puglia	-4
19	Sicilia	-1.55	Sicilia	-1.50	Sicilia	-1.50	Calabria	-1.93	Sicilia	-1.62	Basilicata	-1.33	Campania	-1.37	Emilia-Romagna	-5
20	Calabria	-1.66	Calabria	-1.55	Calabria	-1.81	Sicilia	-1.93	Sardegna	-0.96	Sicilia	-1.53	Sicilia	-1.51	Toscana	-8

Source: our elaboration on ISTAT data

Table 26- - Material living condition : Measure of sampling adequacy and Bartlett test

	2004	2005	2006	2007	2008	2009	2010
				for each variable			
Disposable household income per inhabitant	0.767	0.78	0.806	0.826	0.757	0.638	0.651
Disposable income inequality	0.814	0.797	0.814	0.847	0.889	0.482	0.654
People at risk of relative poverty	0.697	0.738	0.815	0.754	0.716	0.66	0.675
People living in jobless households	0.813	0.797	0.887	0.864	0.844	0.858	0.923
People suffering poor housing conditions	0.859	0.883	0.914	0.846	0.851	0.666	0.965
				overall MSA			
KMO MSA	.782	.795	.846	.823	.802	.666	.735
Bartlett test (sig.)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

Source: our elaboration on ISTAT data

Table 27- Material living conditions: Component matrix (correlation with the first principal component)

	2004	2005	2006	2007	2008	2009	2010
Disposable household income per inhabitant	.895	.900	.902	.906	.895	.922	.905
Disposable income inequality	-.782	-.798	-.863	-.803	-.849	-.654	-.873
People at risk of relative poverty	-.995	-.979	-.978	-.973	-.975	-.977	-.988
People living in jobless households	-.992	-.991	-.984	-.989	-.987	-.978	-.991
People suffering poor housing conditions	-.930	-.875	-.917	-.771	-.845	-.759	-.570

Source: our elaboration on ISTAT data

Table 28- Material living conditions: Communalities

	2004	2005	2006	2007	2008	2009	2010
Disposable household income per inhabitant	.800	.810	.814	.820	.800	.851	.819
Disposable income inequality	.612	.636	.744	.644	.721	.428	.762
People at risk of relative poverty	.991	.959	.956	.946	.950	.955	.975
People living in jobless households	.985	.981	.969	.977	.974	.957	.983
People suffering poor housing conditions	.866	.765	.842	.594	.714	.575	.325

Source: our elaboration on ISTAT data

Table 29- Material Living Conditions Index by region and year

	2004		2005		2006		2007		2008		2009		2010		Δ (2010-2004)	
Position	Regions	Index value	Regions	Index value	Regions	Index value	Regions	Index value	Regions	Index value	Regions	Index value	Regions	Index value	Regions	Ranks
1	Emilia-Romagna	-0.71	Emilia-Romagna	-0.68	Valle d'Aosta	-0.62	Trentino-A.A.	-0.56	Trentino-A.A.	-0.60	Trentino-A.A.	-0.62	Trentino-A.A.	-0.55	Lombardia	2
2	Lombardia	-0.75	Veneto	-0.71	Trentino-A.A.	-0.73	Friuli-V.G.	-0.64	Veneto	-0.70	Lombardia	-0.70	Emilia-Romagna	-0.72	Friuli-V.G.	2
3	Veneto	-0.76	Toscana	-0.72	Emilia-Romagna	-0.76	Emilia-Romagna	-0.66	Emilia-Romagna	-0.73	Veneto	-0.71	Veneto	-0.74	Toscana	2
4	Friuli-V.G.	-0.77	Valle d'Aosta	-0.74	Veneto	-0.77	Valle d'Aosta	-0.70	Lombardia	-0.73	Emilia-Romagna	-0.72	Lombardia	-0.78	Marche	2
5	Toscana	-0.79	Trentino-A.A.	-0.76	Toscana	-0.77	Veneto	-0.72	Friuli-V.G.	-0.74	Valle d'Aosta	-0.75	Valle d'Aosta	-0.79	Emilia-Romagna	1
6	Trentino-A.A.	-0.83	Lombardia	-0.78	Friuli-V.G.	-0.82	Lombardia	-0.81	Toscana	-0.79	Friuli-V.G.	-0.77	Friuli-V.G.	-0.86	Abruzzo	1
7	Valle d'Aosta	-0.94	Friuli-V.G.	-0.81	Lombardia	-0.86	Toscana	-0.83	Valle d'Aosta	-0.83	Toscana	-0.78	Toscana	-0.87	Molise	1
8	Marche	-0.99	Umbria	-0.99	Marche	-0.94	Piemonte	-0.83	Marche	-0.85	Piemonte	-0.88	Liguria	-0.87	Campania	1
9	Umbria	-1.05	Marche	-0.99	Piemonte	-0.98	Marche	-0.84	Piemonte	-0.93	Liguria	-0.89	Umbria	-0.92	Veneto	0
10	Liguria	-1.06	Piemonte	-1.00	Umbria	-1.20	Umbria	-0.99	Umbria	-0.99	Marche	-0.90	Marche	-0.94	Umbria	0
11	Piemonte	-1.12	Abruzzo	-1.26	Abruzzo	-1.23	Liguria	-1.19	Liguria	-1.10	Umbria	-1.03	Piemonte	-1.06	Piemonte	0
12	Abruzzo	-1.37	Liguria	-1.29	Liguria	-1.26	Abruzzo	-1.32	Abruzzo	-1.27	Lazio	-1.31	Lazio	-1.20	Basilicata	0
13	Lazio	-1.47	Lazio	-1.42	Lazio	-1.50	Lazio	-1.36	Lazio	-1.29	Abruzzo	-1.45	Abruzzo	-1.47	Puglia	0
14	Molise	-1.93	Molise	-1.89	Sardegna	-2.02	Sardegna	-2.00	Molise	-1.90	Sardegna	-1.78	Sardegna	-1.58	Calabria	0
15	Sardegna	-2.04	Sardegna	-1.96	Basilicata	-2.07	Molise	-2.00	Sardegna	-2.04	Molise	-2.01	Molise	-1.80	Lazio	-1
16	Basilicata	-2.42	Basilicata	-2.28	Molise	-2.20	Basilicata	-2.17	Puglia	-2.13	Puglia	-2.22	Basilicata	-2.20	Sardegna	-1
17	Puglia	-2.60	Puglia	-2.62	Puglia	-2.72	Puglia	-2.32	Basilicata	-2.37	Basilicata	-2.43	Puglia	-2.25	Sicilia	-1
18	Calabria	-3.31	Calabria	-3.21	Calabria	-3.35	Calabria	-3.24	Sicilia	-3.32	Calabria	-3.15	Calabria	-3.15	Valle d'Aosta	-2
19	Campania	-3.34	Campania	-3.22	Campania	-3.45	Campania	-3.49	Calabria	-3.35	Sicilia	-3.21	Sicilia	-3.20	Liguria	-2
20	Sicilia	-3.80	Sicilia	-3.51	Sicilia	-3.57	Sicilia	-3.49	Campania	-3.67	Campania	-3.34	Campania	-3.42	Trentino-A.A.	-5

Source: our elaboration on ISTAT data

Table 30- Personal security: Measure of sampling adequacy and Bartlett test

	2004	2005	2006	2007	2008	2009	2010
Burglary rate	0.605	0.612	0.421	0.711	0.563	0.517	0.556
Pick-pocketing rate	0.571	0.661	0.554	0.583	0.676	0.567	0.677
Robbery rate	0.541	0.519	0.469	0.618	0.552	0.499	0.485
Homicide rate	0.623	0.585	0.5	0.429	0.583	0.485	0.524
Perception of crime risk	0.539	0.621	0.611	0.686	0.695	0.714	0.641
				overall MSA			
KMO MSA	.565	.597	.516	.604	.619	.561	.580
Bartlett test (sig.)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

Source: our elaboration on ISTAT data

Table 31- Personal security: Component matrix (correlation with the first principal component)

	2004	2005	2006	2007	2008	2009	2010
Burglary rate	-.074	-.006	-.126	-.167	-.060	-.118	-.109
Pick-pocketing rate	-.368	-.322	-.583	-.455	-.325	-.429	-.482
Robbery rate	-.976	-.970	-.964	-.974	-.914	-.963	-.962
Homicide rate	-.422	-.581	-.397	-.618	-.823	-.668	-.575
Perception of crime risk	-.800	-.709	-.815	-.772	-.623	-.722	-.702

Source: our elaboration on ISTAT data

Table 32-Personal security: Communalities

	2004	2005	2006	2007	2008	2009	2010
Burglary rate	.005	3.9E-05	.016	.028	.012	.014	.012
Pick-pocketing rate	.136	.104	.340	.207	.104	.184	.233
Robbery rate	.952	.941	.930	.949	.836	.927	.926
Homicide rate	.178	.338	.157	.382	.672	.447	.331
Perception of crime risk	.640	.503	.664	.596	.386	.521	.493

Source: our elaboration on ISTAT data

Table 33- Personal security Index by region and year

	2004		2005		2006		2007		2008		2009		2010		Δ (2010-2004)	
Position	Regions	Index value	Regions	Index value	Regions	Index value	Regions	Index value	Regions	Index value	Regions	Index value	Regions	Index value	Regions	Ranks
1	Basilicata	-0.47	Valle d'Aosta	-0.39	Basilicata	-0.38	Basilicata	-0.51	Valle d'Aosta	-0.29	Basilicata	-0.25	Valle d'Aosta	-0.53	Trentino-A.A.	3
2	Molise	-0.56	Marche	-0.58	Molise	-0.53	Molise	-0.55	Basilicata	-0.38	Molise	-0.60	Basilicata	-0.58	Abruzzo	2
3	Marche	-0.58	Basilicata	-0.60	Marche	-0.82	Marche	-0.85	Molise	-0.63	Marche	-0.77	Molise	-0.73	Basilicata	1
4	Abruzzo	-0.85	Friuli-V.G.	-0.87	Friuli-V.G.	-0.83	Valle d'Aosta	-0.86	Marche	-0.64	Friuli-V.G.	-0.81	Marche	-0.88	Molise	1
5	Friuli-V.G.	-1.01	Molise	-0.90	Abruzzo	-0.83	Friuli-V.G.	-0.90	Abruzzo	-0.76	Valle d'Aosta	-0.84	Friuli-V.G.	-0.95	Marche	1
6	Valle d'Aosta	-1.18	Abruzzo	-0.91	Valle d'Aosta	-0.89	Abruzzo	-1.09	Friuli-V.G.	-0.77	Abruzzo	-0.97	Abruzzo	-1.07	Toscana	1
7	Sardegna	-1.19	Sardegna	-1.27	Sardegna	-1.06	Sardegna	-1.24	Trentino-A.A.	-1.05	Sardegna	-1.15	Sardegna	-1.12	Sicilia	1
8	Trentino-A.A.	-1.23	Veneto	-1.27	Veneto	-1.36	Trentino-A.A.	-1.27	Veneto	-1.14	Veneto	-1.29	Veneto	-1.25	Lazio	1
9	Toscana	-1.26	Toscana	-1.35	Trentino-A.A.	-1.39	Veneto	-1.32	Toscana	-1.50	Toscana	-1.41	Umbria	-1.50	Puglia	1
10	Veneto	-1.27	Trentino-A.A.	-1.36	Toscana	-1.48	Toscana	-1.36	Umbria	-1.56	Umbria	-1.62	Toscana	-1.58	Friuli-V.G.	0
11	Umbria	-1.28	Umbria	-1.58	Sicilia	-1.60	Umbria	-1.56	Emilia-Romagna	-1.63	Sicilia	-1.85	Trentino-A.A.	-1.63	Sardegna	0
12	Sicilia	-1.63	Emilia-Romagna	-1.63	Umbria	-1.72	Emilia-Romagna	-1.79	Sicilia	-1.73	Emilia-Romagna	-1.86	Emilia-Romagna	-1.70	Lombardia	0
13	Emilia-Romagna	-1.81	Sicilia	-1.72	Emilia-Romagna	-1.81	Sicilia	-1.97	Sardegna	-1.85	Trentino-A.A.	-1.92	Sicilia	-1.83	Calabria	0
14	Lombardia	-2.15	Lombardia	-1.99	Calabria	-2.30	Piemonte	-2.36	Piemonte	-1.95	Piemonte	-2.32	Lombardia	-2.32	Liguria	0
15	Lazio	-2.41	Piemonte	-2.08	Lombardia	-2.37	Lombardia	-2.43	Lombardia	-2.13	Lombardia	-2.45	Piemonte	-2.43	Emilia-Romagna	-1
16	Piemonte	-2.41	Lazio	-2.46	Piemonte	-2.53	Puglia	-2.90	Lazio	-2.39	Lazio	-2.56	Lazio	-2.89	Piemonte	-1
17	Calabria	-2.42	Puglia	-2.88	Puglia	-2.60	Calabria	-2.92	Puglia	-2.96	Liguria	-3.22	Calabria	-3.18	Campania	-1
18	Liguria	-2.89	Liguria	-2.92	Lazio	-3.06	Lazio	-2.98	Liguria	-3.18	Calabria	-3.27	Liguria	-3.46	Veneto	-2
19	Puglia	-3.36	Calabria	-3.08	Liguria	-3.60	Liguria	-3.48	Calabria	-4.15	Puglia	-3.33	Campania	-3.56	Umbria	-2
20	Campania	-5.05	Campania	-5.08	Campania	-4.93	Campania	-4.75	Campania	-4.31	Campania	-4.39	Puglia	-3.78	Valle d'Aosta	-5

Source: our elaboration on ISTAT data

Table 34- Research and innovation: Measure of sampling adequacy and Bartlett test

	2004	2005	2006	2007	2008	2009	2010
R&D expenditure	0.669	0.654	0.689	0.78	0.701	0.701	0.714
Capacity to Export	0.682	0.652	0.688	0.665	0.719	0.724	0.785
Patents	0.677	0.643	0.696	0.722	0.753	0.624	0.737
R&D workers	0.72	0.668	0.729	0.802	0.748	0.679	0.743
Graduates in Science and Technology	0.861	0.937	0.922	0.886	0.909	0.884	0.899
				overall MSA			
KMO MSA	.721	.700	.741	.770	.760	.708	.766
Bartlett test (sig.)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

Source: our elaboration on ISTAT data

Table 35- Research and innovation: Component matrix (correlation with the first principal component)

	2004	2005	2006	2007	2008	2009	2010
R&D expenditure	.644	.623	.601	.727	.718	.721	.762
Capacity to Export	.840	.850	.847	.819	.831	.905	.875
Patents	.968	.950	.971	.977	.974	.961	.970
R&D workers	.741	.764	.800	.858	.901	.883	.902
Graduates in Science and Technology	.852	.782	.785	.777	.751	.695	.737

Source: our elaboration on ISTAT data

Table 36- Research and innovation: Communalities

	2004	2005	2006	2007	2008	2009	2010
R&D expenditure	.414	.388	.361	.529	.515	.520	.581
Capacity to Export	.706	.722	.717	.670	.690	.819	.765
Patents	.937	.902	.943	.954	.949	.924	.941
R&D workers	.549	.583	.640	.736	.812	.779	.814
Graduates in Science and Technology	.725	.611	.617	.603	.564	.483	.544

Source: our elaboration on ISTAT data

Table 37- Research and innovation Index by region and year

	2004		2005		2006		2007		2008		2009		2010		Δ (2010-2004)	
Position	**Regions**	**Index value**	**Regions**	**Index value**	**Regions**	**Index value**	**Regions**	**Index value**	**Regions**	**Index value**	**Regions**	**Index value**	**Regions**	**Index value**	**Regions**	**Ranks**
1	Piemonte	3,92	Emilia-Romagna	4,26	Emilia-Romagna	4,22	Emilia-Romagna	4,28	Emilia-Romagna	4,07	Friuli-V.G.	3,96	Emilia-Romagna	4,00	Piemonte	3
2	Emilia-Romagna	3,57	Piemonte	3,76	Friuli-V.G.	3,71	Piemonte	3,61	Friuli-V.G.	3,78	Emilia-Romagna	3,91	Friuli-V.G.	3,91	Lazio	3
3	Lombardia	3,28	Lombardia	3,62	Lombardia	3,59	Lombardia	3,52	Piemonte	3,70	Lombardia	3,53	Lombardia	3,38	Abruzzo	3
4	Friuli-V.G.	3,00	Friuli-V.G.	3,36	Piemonte	3,59	Friuli-V.G.	3,52	Lombardia	3,51	Piemonte	3,36	Piemonte	3,36	Sicilia	3
5	Veneto	2,70	Veneto	3,11	Veneto	3,08	Veneto	3,22	Veneto	3,23	Veneto	3,19	Veneto	3,17	Toscana	2
6	Toscana	2,23	Toscana	2,70	Toscana	2,58	Toscana	2,58	Toscana	2,64	Trentino-A.A.	2,80	Trentino-A.A.	2,89	Valle d'Aosta	1
7	Lazio	1,91	Lazio	2,46	Marche	2,29	Marche	2,44	Trentino-A.A.	2,36	Toscana	2,59	Liguria	2,63	Puglia	1
8	Abruzzo	1,79	Marche	2,22	Liguria	2,20	Liguria	2,28	Liguria	2,34	Liguria	2,37	Toscana	2,58	Lombardia	0
9	Marche	1,66	Liguria	2,05	Lazio	2,15	Trentino-A.A.	2,23	Lazio	2,30	Marche	2,37	Marche	2,46	Veneto	0
10	Liguria	1,66	Trentino-A.A.	2,02	Trentino-A.A.	1,93	Lazio	2,21	Marche	2,29	Lazio	2,01	Lazio	2,09	Marche	0
11	Trentino-A.A.	1,60	Abruzzo	1,95	Abruzzo	1,86	Umbria	1,92	Umbria	1,71	Valle d'Aosta	1,68	Abruzzo	1,61	Umbria	0
12	Umbria	1,58	Umbria	1,91	Umbria	1,81	Abruzzo	1,91	Abruzzo	1,70	Abruzzo	1,64	Umbria	1,58	Molise	0
13	Valle d'Aosta	1,16	Valle d'Aosta	1,52	Valle d'Aosta	1,30	Campania	1,24	Campania	1,33	Umbria	1,54	Campania	1,24	Calabria	0
14	Campania	0,94	Campania	1,28	Campania	1,23	Valle d'Aosta	1,07	Valle d'Aosta	1,12	Campania	1,27	Valle d'Aosta	1,21	Emilia-Romagna	-1
15	Sicilia	0,82	Sicilia	1,09	Basilicata	1,02	Basilicata	1,06	Sardegna	1,12	Sardegna	1,04	Sardegna	1,14	Campania	-1
16	Puglia	0,77	Sardegna	1,04	Sicilia	0,98	Sardegna	1,01	Basilicata	1,06	Basilicata	1,02	Basilicata	1,07	Friuli-V.G.	-2
17	Sardegna	0,76	Puglia	0,99	Sardegna	0,97	Puglia	0,98	Puglia	1,00	Puglia	0,99	Puglia	0,95	Sardegna	-2
18	Basilicata	0,66	Basilicata	0,88	Puglia	0,92	Sicilia	0,94	Sicilia	0,99	Sicilia	0,93	Sicilia	0,91	Basilicata	-2
19	Molise	0,54	Molise	0,73	Molise	0,59	Calabria	0,63	Calabria	0,59	Molise	0,59	Molise	0,57	Liguria	-3
20	Calabria	0,33	Calabria	0,64	Calabria	0,59	Molise	0,60	Molise	0,57	Calabria	0,57	Calabria	0,53	Trentino-A.A.	-5

Source: our elaboration on ISTAT data

Table 38- Social relations: Measure of sampling adequacy and Bartlett test

	2004	2005	2006	2007	2008	2009	2010
Satisfaction with family relations	0.796	0.804	0.772	0.73	0.779	0.765	0.811
Satisfaction with friendship relations	0.786	0.819	0.738	0.705	0.788	0.775	0.785
Synthetic indicator of social participation	0.838	0.866	0.845	0.887	0.782	0.822	0.704
Volunteer work	0.795	0.835	0.825	0.753	0.801	0.93	0.836
Share of population who funded associations	0.9	0.902	0.855	0.776	0.887	0.873	0.787
				overall MSA			
KMO MSA	.822	.845	.805	.765	.807	.829	.782
Bartlett test (sig.)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

Source: our elaboration on ISTAT data

Table 39- Social relations: Component matrix (correlation with the first principal component)

	2004	2005	2006	2007	2008	2009	2010
Satisfaction with family relations	.836	.836	.874	.832	.840	.862	.878
Satisfaction with friendship relations	.884	.875	.890	.881	.908	.892	.882
Synthetic indicator of social participation	.952	.953	.938	.924	.971	.950	.959
Volunteer work	.981	.973	.980	.976	.973	.965	.968
Share of population who funded associations	.979	.978	.972	.981	.983	.968	.978

Source: our elaboration on ISTAT data

Table 40- Social relations: Communalities

	2004	2005	2006	2007	2008	2009	2010
Satisfaction with family relations	.698	.700	.765	.693	.705	.743	.771
Satisfaction with friendship relations	.781	.765	.793	.776	.825	.796	.778
Synthetic indicator of social participation	.907	.908	.880	.854	.943	.902	.919
Volunteer work	.962	.947	.960	.953	.947	.932	.937
Share of population who funded associations	.959	.956	.945	.962	.966	.937	.957

Source: our elaboration on ISTAT data

Table 41- Social relations Index by region and year

	2004		2005		2006		2007		2008		2009		2010		Δ (2010-2004)	
Position	Regions	Index value	Regions	Index value	Regions	Index value	Regions	Index value	Regions	Index value	Regions	Index value	Regions	Index value	Regions	Ranks
1	Trentino-A.A.	4.09	Friuli-V.G.	4.08	Friuli-V.G.	3.94	Friuli-V.G.	3.65	Friuli-V.G.	3.89	Friuli-V.G.	3.70	Friuli-V.G.	3.67	Emilia-Romagna	8
2	Veneto	2.77	Valle d'Aosta	2.69	Valle d'Aosta	2.68	Piemonte	2.80	Piemonte	2.75	Piemonte	2.68	Toscana	2.68	Trentino-A.A.	7
3	Emilia-Romagna	2.64	Lombardia	2.55	Lombardia	2.64	Valle d'Aosta	2.68	Toscana	2.71	Umbria	2.56	Lombardia	2.55	Veneto	5
4	Lombardia	2.59	Toscana	2.54	Toscana	2.59	Umbria	2.57	Veneto	2.68	Valle d'Aosta	2.54	Umbria	2.54	Lazio	5
5	Friuli-V.G.	2.53	Piemonte	2.53	Piemonte	2.57	Lombardia	2.56	Valle d'Aosta	2.60	Lombardia	2.52	Valle d'Aosta	2.52	Basilicata	3
6	Valle d'Aosta	2.44	Veneto	2.40	Veneto	2.45	Toscana	2.53	Trentino-A.A.	2.40	Toscana	2.46	Piemonte	2.49	Marche	2
7	Toscana	2.35	Umbria	2.39	Umbria	2.38	Trentino-A.A.	2.37	Lombardia	2.35	Trentino-A.A.	2.27	Veneto	2.36	Liguria	2
8	Piemonte	2.18	Sardegna	2.24	Marche	2.21	Veneto	2.20	Marche	2.32	Sardegna	2.19	Trentino-A.A.	2.17	Puglia	2
9	Umbria	2.12	Trentino-A.A.	2.11	Trentino-A.A.	2.14	Sicilia	2.14	Umbria	2.16	Marche	2.17	Sicilia	2.15	Abruzzo	1
10	Marche	2.09	Marche	1.98	Sicilia	1.98	Emilia-Romagna	2.07	Sicilia	2.09	Veneto	2.15	Sardegna	2.01	Campania	0
11	Sardegna	1.94	Sicilia	1.95	Emilia-Romagna	1.93	Marche	2.01	Emilia-Romagna	1.99	Sicilia	2.09	Emilia-Romagna	2.00	Lombardia	-1
12	Liguria	1.80	Basilicata	1.85	Molise	1.93	Sardegna	2.00	Sardegna	1.89	Emilia-Romagna	1.98	Marche	1.91	Valle d'Aosta	-1
13	Basilicata	1.75	Liguria	1.74	Sardegna	1.91	Molise	1.85	Molise	1.79	Molise	1.85	Molise	1.87	Sardegna	-1
14	Abruzzo	1.71	Emilia-Romagna	1.73	Liguria	1.71	Abruzzo	1.63	Liguria	1.72	Liguria	1.76	Liguria	1.80	Calabria	-1
15	Lazio	1.65	Molise	1.66	Basilicata	1.43	Basilicata	1.61	Abruzzo	1.53	Basilicata	1.55	Abruzzo	1.65	Piemonte	-2
16	Puglia	1.42	Abruzzo	1.43	Puglia	1.41	Liguria	1.55	Basilicata	1.50	Abruzzo	1.42	Basilicata	1.58	Friuli-V.G.	-4
17	Molise	1.37	Puglia	1.39	Abruzzo	1.34	Puglia	1.39	Calabria	1.38	Calabria	1.42	Calabria	1.58	Molise	-4
18	Calabria	1.28	Calabria	1.39	Calabria	1.34	Calabria	1.33	Puglia	1.36	Puglia	1.37	Puglia	1.34	Toscana	-5
19	Campania	1.28	Lazio	1.27	Campania	1.25	Lazio	1.29	Lazio	1.16	Campania	1.36	Campania	1.26	Umbria	-5
20	Sicilia	1.22	Campania	1.26	Lazio	1.18	Campania	1.23	Campania	1.16	Lazio	1.28	Lazio	1.14	Sicilia	-11

Source: our elaboration on ISTAT data

Table 42-- Regional well-being: Measure of sampling adequacy and Bartlett test

	2004	2005	2006	2007	2008	2009	2010
Culture and free time	0.802	0.835	0.699	0.809	0.912	0.91	0.823
Education	0.81	0.688	0.497	0.939	0.363	0.376	0.453
Employment	0.774	0.783	0.802	0.752	0.741	0.83	0.784
Environment	0.488	0.373	0.413	0.294	0.319	0.361	0.277
Essential public services	0.712	0.774	0.822	0.938	0.885	0.938	0.888
Health	0.942	0.883	0.844	0.853	0.805	0.762	0.818
Material living conditions	0.84	0.807	0.795	0.752	0.794	0.742	0.798
Personal security	0.673	0.636	0.32	0.62	0.749	0.308	0.438
Research and innovation	0.807	0.817	0.754	0.705	0.71	0.826	0.71
Social Relations	0.842	0.774	0.666	0.813	0.75	0.792	0.687
				overall MSA			
KMO MSA	.794	.774	.715	.772	.749	.767	.730
Bartlett test (sig.)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

Source: our elaboration on ISTAT data

Table 43- Regional well-being: Component matrix (correlation with the first principal component)

	2004	2005	2006	2007	2008	2009	2010
Culture and free time	.715	.755	.698	.848	.798	.832	.858
Education	.336	.372	.047	.330	.085	.000	.299
Employment	.830	.884	.767	.929	.807	.872	.917
Environment	.811	.670	.814	.501	.736	.608	.458
Essential public services	.921	.901	.755	.937	.786	.830	.858
Health	.743	.771	.806	.744	.597	.877	.820
Material living conditions	.744	.864	.773	.931	.796	.858	.905
Personal security	.429	.594	.463	.534	.696	.477	.540
Research and innovation	.348	.489	.304	.601	.385	.638	.650
Social Relations	.759	.790	.714	.829	.831	.790	.848

Source: our elaboration on ISTAT data

Table 44- Regional well-being: Communalities

	2004	2005	2006	2007	2008	2009	2010
Culture and free time	.511	.570	.487	.719	.637	.692	.736
Education	.113	.138	.002	.109	.007	.000	.090
Employment	.689	.781	.588	.862	.651	.760	.840
Environment	.657	.449	.662	.251	.541	.370	.210
Essential public services	.849	.812	.571	.879	.618	.690	.736
Health	.551	.594	.650	.554	.356	.769	.672
Material living conditions	.554	.746	.597	.866	.634	.736	.819
Personal security	.184	.352	.214	.285	.485	.227	.291
Research and innovation	.121	.239	.092	.361	.148	.407	.422
Social Relations	.576	.623	.509	.687	.690	.624	.719

Source: our elaboration on ISTAT data

Table 45- Overall index of well-being by region and year

	2004		2005		2006		2007		2008		2009		2010		Δ (2010-2004)	
Position	Regions	Index value	Regions	Index value	Regions	Index value	Regions	Index value	Regions	Index value	Regions	Index value	Regions	Index value	Regions	Ranks
1	Valle d'Aosta	7.30	Valle d'Aosta	5.58	Valle d'Aosta	7.27	Valle d'Aosta	4.15	Valle d'Aosta	5.85	Valle d'Aosta	5.22	Valle d'Aosta	3.44	Toscana	3
2	Trentino-A.A.	4.43	Trentino-A.A.	3.50	Trentino-A.A.	3.80	Trentino-A.A.	3.48	Trentino-A.A.	4.03	Trentino-A.A.	3.57	Trentino-A.A.	3.30	Molise	2
3	Friuli-V.G.	1.54	Friuli-V.G.	1.59	Friuli-V.G.	1.76	Friuli-V.G.	2.21	Friuli-V.G.	1.77	Friuli-V.G.	2.28	Friuli-V.G.	2.16	Lombardia	1
4	Emilia-Romagna	1.26	Emilia-Romagna	1.08	Emilia-Romagna	0.81	Emilia-Romagna	2.15	Emilia-Romagna	0.96	Emilia-Romagna	1.77	Emilia-Romagna	1.62	Piemonte	1
5	Veneto	1.05	Veneto	0.79	Umbria	0.57	Veneto	1.72	Veneto	0.78	Veneto	1.27	Veneto	1.14	Abruzzo	1
6	Toscana	0.99	Lombardia	0.50	Veneto	0.56	Piemonte	1.22	Umbria	0.48	Lombardia	0.90	Marche	0.86	Lazio	1
7	Lombardia	0.71	Toscana	0.44	Abruzzo	0.47	Lombardia	1.02	Lombardia	0.28	Marche	0.67	Umbria	0.82	Valle d'Aosta	0
8	Marche	0.69	Marche	0.43	Toscana	0.33	Toscana	0.92	Marche	0.18	Piemonte	0.62	Lombardia	0.82	Trentino-A.A.	0
9	Piemonte	0.61	Piemonte	0.33	Lombardia	0.28	Marche	0.75	Toscana	0.17	Toscana	0.55	Toscana	0.59	Friuli-V.G.	0
10	Umbria	0.56	Umbria	0.21	Marche	0.23	Umbria	0.66	Abruzzo	0.14	Umbria	0.36	Piemonte	0.31	Emilia-Romagna	0
11	Abruzzo	0.53	Abruzzo	0.20	Piemonte	0.14	Abruzzo	0.17	Piemonte	0.10	Liguria	0.30	Liguria	0.25	Veneto	0
12	Liguria	0.14	Liguria	-0.41	Liguria	-0.15	Liguria	-0.30	Liguria	-0.30	Basilicata	-0.52	Abruzzo	0.07	Puglia	0
13	Lazio	-0.72	Molise	-1.03	Basilicata	-0.41	Molise	-0.76	Molise	-0.45	Abruzzo	-0.53	Basilicata	-0.67	Calabria	0
14	Molise	-0.78	Lazio	-1.23	Molise	-0.72	Lazio	-0.80	Basilicata	-0.54	Lazio	-0.79	Lazio	-0.75	Sicilia	0
15	Basilicata	-0.93	Basilicata	-1.96	Lazio	-1.16	Basilicata	-1.03	Lazio	-1.18	Sardegna	-0.91	Sardegna	-1.21	Campania	0
16	Sardegna	-1.26	Sardegna	-2.00	Sardegna	-1.26	Sardegna	-1.57	Sardegna	-1.38	Molise	-1.36	Molise	-1.22	Liguria	-1
17	Puglia	-2.34	Puglia	-3.06	Puglia	-2.58	Puglia	-2.68	Puglia	-2.94	Puglia	-2.61	Puglia	-2.95	Sardegna	-1
18	Calabria	-2.53	Calabria	-3.80	Calabria	-2.70	Calabria	-3.40	Sicilia	-3.43	Sicilia	-3.30	Calabria	-3.25	Marche	-2
19	Sicilia	-2.97	Sicilia	-3.83	Sicilia	-2.92	Sicilia	-3.88	Campania	-3.94	Campania	-3.46	Sicilia	-3.46	Basilicata	-2
20	Campania	-3.09	Campania	-4.00	Campania	-3.67	Campania	-3.89	Calabria	-4.00	Calabria	-3.68	Campania	-3.60	Umbria	-3

Source: our elaboration on ISTAT data

Table 46 – σ-convergence for each of the indexes of overall well-being, for the overall index of well- being and for per-capita GDP

	CV			σ-convergence rate			MIN		MAX	
	2004	2007	2010	2004-2007	2007-2010	2004-2010		*year*		*year*
Culture and free time	0.58	0.65	0.68	0.12	0.05	0.17	0.58	*2004*	0.70	*2008*
Education	0.7	0.5	0.6	-0.29	0.2	-0.14	0.42	*2009*	0.70	*2004*
Employment	0.55	0.55	0.49	-0.001	-0.11	-0.11	0.49	*2010*	0.56	*2008*
Environment	1.68	1.75	1.24	0.04	-0.29	-0.26	1.24	*2010*	1.75	*2007*
Essential public services	0.64	0.5	0.52	-0.22	0.05	-0.18	0.48	*2009*	0.64	*2004*
Health	0.57	0.67	0.59	0.18	-0.13	0.03	0.45	*2006*	0.67	*2007*
Material living conditions	0.45	0.5	0.47	0.1	-0.06	0.03	0.45	*2004*	0.50	*2009*
Personal security	0.34	0.38	0.54	0.14	0.41	0.6	0.33	*2005*	0.54	*2010*
Research and innovation	0.75	0.77	0.73	0.02	-0.04	-0.02	0.73	*2010*	0.78	*2006*
Social relations	0.82	0.73	0.64	-0.1	-0.13	-0.22	0.64	*2010*	0.83	*2005*
RWBI	0.73	0.59	0.59	-0.19	0.01	-0.18	0.59	*2007*	0.73	*2004*
per-capita GDP	0.73	0.71	0.71	-0.03	0.01	-0.02	0.71	*2007*	0.73	*2004*

Source: our elaboration on ISTAT data

Table 47 - Kendall's index - γ convergence

Year	Culture and free time	Education	Employment	Environment	Essential public services	Health	Material living conditions	Personal security	Research and Innovation	Social relations	RWBI	Per-capita GDP
2004	1	1	1	1	1	1	1	1	1	1	1	1
2005	0.9774 ***	0.9632 ***	0.997 ***	0.9639 ***	0.9218 **	0.9617 ***	0.982 ***	0.9759 ***	0.994 ***	0.9887 ***	0.9985 ***	1 ***
2006	0.9737 ***	0.9361 **	0.997 ***	0.9444 **	0.8767 **	0.9684 ***	0.9617 ***	0.9872 ***	0.9812 ***	0.991 ***	0.9752 ***	1 ***
2007	0.9744 ***	0.9549 ***	0.9925 ***	0.903 **	0.9293 **	0.909 ***	0.9699 ***	0.9865 ***	0.9759 ***	0.9827 ***	0.994 ***	1 ***
2008	0.9752 ***	0.894 **	0.9932 ***	0.9293 **	0.8519 **	0.9556 ***	0.9812 ***	0.9662 ***	0.9722 ***	0.9789 ***	0.9842 ***	1 ***
2009	0.9782 ***	0.8353 **	0.9887 ***	0.918 **	0.8865 **	0.9579 ***	0.9729 ***	0.9827 ***	0.9639 ***	0.9797 ***	0.9857 ***	1 ***
2010	0.9729 ***	0.8571 **	0.9887 ***	0.9316 **	0.8594 **	0.9226 **	0.9789 ***	0.9789 ***	0.9662 ***	0.9744 ***	0.9865 ***	1 ***

* reject null hypothesis at 10%
** reject null hypothesis at 5%
*** reject null hypothesis at 1%

Source: our elaboration on ISTAT data

CONCLUSIONS

The research presented in this thesis concerned the study of European regions' economic and social progress from two different viewpoints. On the one hand, the aim was to assess the impact of European Regional Policy by looking at specific areas of the regional economies. On the other, the analysis pursued two main goals. The first one was the definition of a multidimensional measure of well-being at NUTS 2 level. The second goal was an investigation of the dynamics of well-being and its various dimensions in comparison with those of per-capita GDP, to establish if a process of convergence occurred across regions over time.
Coherently with the recent academic debate, in each of the essays economic and social progress were assessed by considering multidimensional factors that affect regional development beyond productive aspects. The thesis is articulated in three essays: the first carries out a counterfactual evaluation of European Cohesion Policy at the EU NUTS 2 level; the second focuses on well-being measurement and investigates convergence for EU27 regions; lastly, the third essay proposes a measure of well-being and analyses its dynamics for Italian regions by following an alternative methodological approach and by using a specific database for Italy tailored to quantifying well-being.

The first essay initially reviewed the empirical literature on the evaluation of Cohesion Policy effectiveness, which in the past mainly focused on per capita-GDP growth rate. Despite the wide number of empirical contributions in this field, no unambiguous results have yet been reached (Edeerven *et al.* 2002). These studies can be framed by considering, first, their methodological approach and, second, their observed policy effect. In relation to the first criterion, we identified three main approaches: case studies, model simulations and econometric applications. In relation to the latter are two different methodological approaches: the first one is based on econometric regressions; the second belongs to the new strand of treatment effects evaluation. Aside from the methodology used, up until now the evaluation of Cohesion Policy has produced contrasting results. Based on the findings, a further classification of the empirical works contemplates three main strands of studies: those which find positive policy effects, those which prove conditional effects, and lastly, those which demonstrate that policy implementation has a null effect or a negative effect. This essay adopts a treatment effect method named Regression Discontinuity Design (Thistlethwaite and Campbell 1960). The main innovative feature of our analysis can be found in our consideration of two specific fields of intervention for the assessment of EU Regional Policy effectiveness: Research, Technological Development and Innovation, and Transport Infrastructure. Following Barca and McCann (2011), a different outcome variable was used for each field of expenditure: the growth in patent applications for Research and Innovation and the growth in potential road accessibility (Stelder 2014) for Transport Infrastructure. Moreover, the analysis also considered evaluations in terms of per-capita GDP.
The analysis used an original dataset with comparable information at the European regional level including also the certified expenditure for specific interventions over the period 1999-2007. This allowed us to select the regions receiving the specific aids and to adopt the *sharp* version of the RDD methodology.
The sample consisted of the NUTS 2 regions of the EU with 15 member states. We considered two groups of regions in relation to eligibility for Cohesion Policy Objective 1: Objective 1 regions

(treated units) and non-Objective 1 regions (untreated units). The presence of discontinuity in the outcome variable in correspondence with the threshold identifying the two groups was considered as an effect of the policy transfers (treatment). The impact of the policy was estimated both with a non-parametric (local linear regression) and a parametric approach (polynomial regression estimated with OLS). Analyses were conducted separately for the two fields of intervention and for per-capita GDP.

First, the presence of discontinuity was assessed by looking at the most widely used outcome variable: the annual average growth rate of per-capita GDP. We considered the Eurostat database on regional accounts and we referred to a period of fifteen years (from 1995 to 2010) and two sub-periods (1995-2003 and 2003-2010). Moreover, as a further robustness check, we took into account several sample compositions in order to exclude the effects of possible outliers.

However, our findings did not highlight a clear effect of the policy transfers: the results were not statistically significant, though a significant positive effect was found in some cases in the long-run. The impact of the transfers in RTDI and Technical Assistance was then investigated by considering the growth rate in patent applications per million inhabitants (fractional count; by inventor and priority year). The results demonstrated that Objective 1 regions had a higher growth rate in patent applications of at least one percentage point than non-Objective 1. The analysis was defined along two guidelines: by considering different time intervals and several sample compositions. The whole period under study for the outcome variable was 1999-2010, but we looked also at three sub-periods: 1999-2007, 2002-2010 and 2002-2007. The results obtained were robust to both the different periods and different sample compositions analysed. The first three years gave an important contribution to the growth of Objective 1 regions in the outcome variable, while in the last three years, discontinuity was weaker. The positive impact of the policy we observed was not due to the presence of outliers; nor was it dependent on the inclusion in the sample of regions with a worse initial situation, because the results were also robust to different sample compositions. Our findings were strongly confirmed also in a polynomial parametric regression and were robust to the presence of other cut-off points and to discontinuity in another covariate not influenced by the funds. As an additional check, the outcome variable was expressed as difference in levels and no significant discontinuity between the two groups emerged. As for the evaluation of the policy in terms of the growth rate of potential road accessibility, the results appeared less strong than for patent applications and the analysis could not be structured in different time intervals due to a lack of the data. A higher growth rate of 0.9 percentage points was found for Objective 1 regions compared with others. Another important feature stemming from the analysis was the presence in the treated group of two opposite trends in the growth rate of potential road accessibility: on one side, we found that Spanish and Portuguese regions experienced greater growth; on the other, were the Italian, German and Greek regions. The heterogeneity found in the treated group is likely linked to the outcome variable used, that considers only road accessibility and consequently, improvements in road infrastructures. The regions in the sample however received transfers for all kinds of transport projects, so part of the funds may have been devoted to improvement in the accessibility of other transport networks. For this reason, the results obtained are not of negligible importance in identifying the impact of European Regional Policy transfers to Objective 1 NUTS 2 regions.

On the whole, considering the evidence resulting from this essay, a positive impact of European Cohesion Policy was found on consideration of specific fields of intervention and specific outcome variables. Looking at growth in terms of per-capita GDP, on the other hand, the effects of the policy were not clearly defined, especially in the short term.
In all the cases analysed, no discontinuity was found when the outcome variable was expressed as difference in levels, meaning that the backward regions experienced a higher growth rate and the same variation in levels as the more developed regions.
Moreover, regions in the two groups (treated and untreated) showed greater difference in the growth rate of the outcome variable than in the financial transfers they received, which suggests that at the policy is efficient in terms of value for money. This issue opens up new perspectives of research into the intensity of the treatment.

The second essay examines the economic and social progress of European regions in terms of their level of well-being. Interest in the measurement of well-being has grown amongst scholars and major international institutions to such an extent that recent years have witnessed an explosion of studies with a shared awareness of the multi-dimensional nature of well-being. This has given rise to the necessity of indicators and databases on the wide number of factors that researchers consider crucial in affecting progress and quality of life. Many institutions and national governments are at work to define suitable measures of well-being domains (Eurofound 2012; European Commission 2009; OECD 2011, 2013 to name some).
In line with this debate, the second essay aims to contribute to the empirical literature on the measurement of social and economic progress by calculating a synthetic indicator of well-being. It analyses well-being levels and its dynamics for 216 European regions (EU27 member states) at the NUTS 2 level with a threefold aim. First, we constructed six sub-indices in order to synthesize six different dimensions of human well-being (people's health and social conditions; education and long life learning; household material conditions; knowledge economy; local environment attractiveness in terms of infrastructure endowments and tourist inflows; age and gender equality in labour market conditions) and an overall synthetic indicator of regional well-being, the European Well-Being index (EWB). Second, we defined a taxonomy of European regions in relation to well-being dimensions by means of a cluster analysis. Thirdly, we investigated the occurrence of cross-regional convergence/divergence in terms of well-being and per-capita GDP over the period studied.
We selected fifteen variables grouped in the six above-mentioned well-being dimensions and we considered a period of eleven years, from 2000 to 2010, and two sub-periods, the first one from 2000 to 2005 and the second one from 2005 to 2010. The first step of the analysis concerned the construction of the six composite indices of well-being; these partial indicators were later aggregated in an overall index of well-being by adopting the Equal Weight method.
In the second step, a cluster analysis was performed on the six sub-indices, in order to group European regions on the basis of their well-being features and to identify, at the same time, the number of different clusters of European regions on the grounds of their well-being. From the cluster analysis results, European regions were grouped in five distinctive sets in relation to their different levels of well-being: *Low well-being* regions, *Middle-low well-being* regions, *Middle well-being* regions, *Middle-high well-being* and *High well-being* regions. These groups consist of regions

belonging to several countries and the results demonstrate that the cluster solution can predict also other key outcomes, such as regional per-capita GDP.
The perspective of analysis became diachronic in the third step, which involved assessment of the dynamics of well-being across regions. This was carried out by looking at the existence of convergence by means of two non-parametric techniques (σ and γ convergence). The analysis in terms of σ-convergence intended to verify if disparities decreased over time (Friedman 1992). It was led by using three different measures of dispersion: the coefficient of variation, the Theil index and the Gini index. The results showed that, as regards the EWB index, in the ten-year interval analysed, European regions converged independently of the measure of inequality used. Moving our attention to per-capita GDP, the decrease was even higher in value, even though the convergence process was almost completely concentrated in the first sub-period and it was relatively feeble in the second. The trend observed in the inequality measures of GDP was also found for the economic dimension of the EWB, the Material Conditions index. On the other hand, a concave curve was found for the Health, Local Attractiveness and, though less markedly, Education indices. Relative to these domains, there was an increase of the disparities among European regions in the first five years, despite that there was evidence of a stronger convergence in terms of per-capita GDP. In the following five years, on the other hand, whilst GDP convergence rate was feeble, regions became more similar in these dimensions. Conversely, a convex line was obtained for the Labour Market Equality index, meaning that cross-regional gender and intra-generational disparities in the labour market were increasing at the end of the period analysed. A decreasing trend for both sub-periods was instead observed for the Knowledge Economy index, though convergence in the second sub-period was weaker. Convergence was analysed also in terms of intra-distributional mobility dynamics, assessed by means of Kendall's Index of rank concordance (γ convergence- Boyle and McCarty 1997). The results showed no evidence of regional mobility across ranks. This means that the σ-convergence process was not strong enough to foster change in the EU regions ranking list in the time interval considered.
The general picture emerging from this study is that European regions present different features both in terms of GDP and well-being. Well-being is not completely disconnected from the productive aspects captured by GDP, supporting the idea that rather than going "beyond GDP" we need to complement it with additional measures of quality of life. Moreover, the cluster analysis results point to the fact that regional disparities occur not only between countries but also within them, as not all regions of a same country fall in the same group. The major conclusion of the dynamics analysis is that European regions grew more similar over the period analysed both in terms of well-being and per-capita GDP; even though convergence for the latter was significantly slowed down in the second sub-period.

In the third essay, attention moved to the Italian regions. This study used the database recently provided by the Equitable and Sustainable Well-Being (BES) project carried out by the Italian National Institute of Statistics (ISTAT) in conjunction with the National Council for Economy and Labour (CNEL). This project produced a database covering twelve BES dimensions consisting of a set of 134 outcome indicators. In 2013, the first BES report was published (ISTAT 2013). In it, well-being in Italy is examined from a multi-dimensional perspective in line with the recommendations of the "Stiglitz Commission", but without attempting the final step of aggregating the data into a synthetic measure of well-being (Stiglitz *et. al* 2009), which was, instead, a specific goal of the third essay of this thesis.

Our data set consisted of 57 variables at the regional level for the period 2004-2010, grouped in ten dimensions of well-being: Culture and free time, Education, Employment, Environment, Essential Public Services, Health, Material Living Conditions, Personal Security, Research and Innovation and Social relations. For each well-being domain, we constructed a synthetic indicator by means of a principal component analysis (PCA). These sub-indicators were thus synthesized by means of a PCA in an overall Regional Well-Being Index (RWBI). In the second part of the analysis, dispersion in well-being across Italian regions was assessed. We referred to two non-parametric techniques (σ-convergence and γ-convergence), considering both the partial and overall indicators previously calculated, and we considered the whole period and two sub-periods (2004-2007 and 2007-2010). Moreover, we compared the dynamics of regional well-being with those of the traditional indicator of economic performance, per-capita GDP. Our contribution to this area of research is both conceptual and methodological. First, it expands the range of domains and variables used to measure well-being in Italy compared with the previous empirical literature. Second, the selection of the relevant dimensions of well-being following the results of the BES project minimise arbitrariness in the choice of variables. Third, as mentioned above, whilst the BES report did not attempt the final step of synthesizing the data into a overall measure of well-being, this was instead a specific contribution of this essay. Further, to the best of our knowledge, this is the first work to use a two-step principal component analysis to calculate single domain sub-indices, first, and the overall well-being indicator, second, considering the sub-indices as the new variables. Finally, we investigate the regional disparities trends in terms of both partial and overall well-being indicators by means of a convergence analysis.

Results clearly show that differences in well-being between regions do not necessarily reproduce those based on standard economic indicators. From the second part of the study, we see that Italian regions tended to become more similar over time both in terms of per-capita GDP and overall well-being, even if a gradual slowing-down of this process is observed in recent years following the global economic crisis. Moreover, convergence in terms of well-being occurred at a much faster rate than for per-capita GDP. After the crisis, the two indicators – RWBI and per-capita GDP – had different convergence trends: GDP disparities slightly increased; whilst in terms of RWBI, the crisis seems to have caused a rise in the coefficient of variation, followed, however, by a new convergence process, though less intense than in the first sub-period (2004-2007).

The analysis of rank mobility (γ-convergence) showed that for each partial indicator, for RWBI and for per-capita GDP, the value of Kendall's index tends to one. This implies that the relative positions of the regions did not substantially change over time, even though the empirical evidence discussed above showed the occurrence of a process of σ-convergence.

To sum up, the results allow us to conclude that regional differences in well-being are at least as relevant as those in terms of per capita GDP. In fact, different patterns were found for the different dimensions of well-being, highlighting the persistence of disparities in important quality of life aspects across regions and suggesting the need to give more attention in public policy goals and design to quality-of-life features of economic and social progress.

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SOMMARIO

La tesi affronta lo studio del progresso economico e sociale delle regioni europee da due differenti prospettive di analisi. Un primo ambito di ricerca è costituito dalla valutazione del l'impatto della Politica Regionale Europea, considerando specifici campi di intervento e i relativi aspetti delle economie regionali. Un secondo terreno di analisi riguarda la costruzione di indicatori sintetici di benessere e lo studio delle relative dinamiche a livello NUTS 2.

La tesi si compone di tre saggi, ciascuno dei quali adotta, in linea con il dibatto recente, un approccio multidimensionale allo studio del progresso economico e sociale, in cui viene considerato un insieme di aspetti che concorrono a definire il benessere e la qualità della vita e non soltanto quelli più strettamente legati alla produzione.

Il primo saggio, dal titolo "Assessing Cohesion Policy effectiveness on European NUTS 2: Counterfactual evaluation on transport accessibility and research and innovation using a Regression Discontinuity Design approach", presenta una valutazione controfattuale della Politica di Coesione Europea a livello NUTS 2. Nel paragrafo iniziale si propone una rassegna della letteratura empirica sulla valutazione dell'efficacia della Politica di Coesione evidenziando come i contributi in questo campo, quasi esclusivamente focalizzati sull'impatto della policy in termini di crescita del Pil pro-capite, non forniscano risultati unanimi (Ederveen *et al*. 2002). Tali studi vengono nella tesi classificati, dapprima, in base all'approccio metodologico considerato e, successivamente, rispetto all'effetto della politica da essi riscontrato. In relazione al primo criterio, si identificano tre approcci principali: casi studio, modelli di simulazione e applicazioni econometriche. Inoltre, con riferimento a queste ultime, è possibile individuare il ricorso a due differenti tecniche di analisi: la prima si basa sulle regressioni econometriche e valuta la politica applicando le tradizionali equazioni di crescita; la seconda appartiene invece al nuovo filone di ricerca della valutazione controfattuale dell' effetto del trattamento. La valutazione della Politica di Coesione ha comunque prodotto conclusioni finora contrastanti. Sulla base di tali risultati, può essere operata un'ulteriore classificazione dei lavori empirici, individuando tre principali categorie di studi: quelli che trovano un effetto positivo delle politiche, quelli che ottengono un effetto condizionato e, per finire, gli studi che dimostrano che l'implementazione della politica ha effetti nulli o negativi.

Per valutare gli effetti della politica di coesione, questo saggio utilizza un approccio metodologico basato sull'effetto del trattamento e denominato Regression Discontinuity Design (Thistlethwaite e Campbell 1960). La principale caratteristica innovativa della nostra analisi consiste nel considerare due specifici campi di intervento per la valutazione dell'efficacia della Politica Regionale Europea: Ricerca, Sviluppo Tecnologico e Innovazione (RSTI) e Infrastrutture di Trasporto. Seguendo l'approccio proposto da Barca e McCann (2011), per la valutazione della spesa in ciascun campo di intervento si utilizza una specifica variabile di outcome: la crescita nelle domande di brevetto per Ricerca e Innovazione e la crescita nel "potenziale di accessibilità stradale" (Stelder 2014) per le Infrastrutture di Trasporto. La stessa politica è stata, inoltre, valutata in termini di crescita del Pil pro-capite.

L'analisi ha fatto uso di un originale data-set (Commissione Europea-DG REGIO, Ministero per lo Sviluppo Economico-DPS) con informazioni comparabili a livello delle regioni europee includendo inoltre la spesa certificata per specifici campi di intervento nel periodo 1999-2007. Ciò ha consentito di selezionare le regioni che hanno ricevuto specifici aiuti e di adottare la versione *sharp* della metodologia RDD.

Il campione è composto dalle regioni NUTS 2 dell'UE con 15 stati membri. Sono stati considerati due gruppi di regioni in relazione all'eligibilità per l'Obiettivo 1 della Politica di Coesione: le regioni Obiettivo 1 (regioni trattate) e le regioni non-Obiettivo 1 (regioni non trattate). La presenza di una discontinuità nella variabile di outcome in corrispondenza della soglia che separa i due gruppi è considerata come un effetto dei trasferimenti della politica (trattamento). L'impatto della politica è stato stimato sia con un approccio non parametrico (regressioni lineari locali), sia con un approccio parametrico (regressioni polinomiali stimate con OLS). Le analisi sono state condotte separatamente per i due campi di intervento e per il Pil pro-capite.

Nella prima parte di questo lavoro la presenza di discontinuità, che indica che la politica è stata efficace, è stata verificata considerando come variabile di outcome il tasso di crescita annuale del Pil pro-capite in riferimento ad un periodo di quindici anni (dal 1995 al 2010) e a due sotto-periodi (1995-2003 e 2003-2010). Come ulteriore prova di robustezza si sono prese in considerazione diverse composizioni del campione, al fine di escludere gli effetti legati a possibili outliers. I risultati ottenuti non mostrano un chiaro effetto dei trasferimenti della politica. Nella gran parte dei casi i risultati sono privi di significatività statistica, anche se un qualche effetto positivo è stato trovato nel lungo periodo (1995-2010).

La valutazione dell'impatto di trasferimenti in specifici campi di intervento produce risultati differenti, e per certi versi opposti, a quelli riscontrati per il tasso di crescita del Pil pro-capite.

L'impatto dei trasferimenti in RSTI e Assistenza Tecnica è stato valutato considerando il tasso di crescita nelle domande di brevetto per milione di abitanti (conteggio frazionario; per inventore e anno prioritario). I risultati hanno dimostrato che le regioni Obiettivo 1 hanno sperimentato un tasso di crescita nelle domande di brevetto più elevato di almeno un punto percentuale rispetto alle regioni non-Obiettivo 1. L'analisi è stata condotta considerando diversi intervalli temporali e diverse composizioni del campione. L'intero periodo esaminato per la variabile di outcome copre dodici anni (1999-2010), ma l'analisi è stata condotta anche considerando tre sotto-periodi: 1999-2007, 2002-2010 e 2002-2007. I risultati ottenuti si sono rivelati robusti sia per i differenti periodi analizzati, sia per le diverse composizioni del campione. In particolare, è emerso che durante i primi tre anni la variabile di outcome nelle regioni Obiettivo 1 ha sperimentato una notevole crescita, mentre negli ultimi tre anni la discontinuità osservata tra le regioni interessate dalla politica di intervento e quelle non coinvolte perché non Obiettivo 1 si è rivelata più debole. L''impatto positivo della politica non è, peraltro, determinato dalla presenza di outliers e non dipende dall'inclusione nel campione di regioni aventi una peggiore situazione iniziale perché i risultati sono robusti anche per composizioni del campione ripulite da questi effetti. I nostri risultati sono inoltre fortemente confermati anche dalla regressione parametrica polinomiale e sono robusti rispetto alla presenza di altri punti di cut-off e di discontinuità in altre covariate non influenzate dai fondi. Come controllo addizionale, l'analisi è stata condotta anche esprimendo la variabile di outcome come differenza in livelli e in tal caso non è emersa alcuna discontinuità significativa tra i due gruppi.

L'ultima parte del primo saggio si occupa della valutazione della spesa in Infrastrutture di Trasporto in termini di tasso di crescita del "potenziale di accessibilità stradale". I risultati evidenziano un effetto meno forte rispetto alle domande di brevetto e lo studio non può essere strutturato per diversi intervalli di tempo a causa della mancanza dei dati. L'analisi ha evidenziato la presenza di un tasso di crescita più elevato di 0.9 punti percentuali per le regioni Obiettivo 1 rispetto alle altre. Un'ulteriore importante caratteristica emersa è la presenza, all'interno del gruppo dei trattati, di due

diversi trends nel tasso di crescita del "potenziale di accessibilità stradale": da una parte, le regioni spagnole e portoghesi che hanno sperimentato una crescita nettamente più elevata; dall'altra, le regioni italiane, tedesche e greche con dei tassi di crescita più bassi e più simili al gruppo dei non trattati. L'eterogeneità in termini di tassi di crescita del gruppo dei trattati può essere, tuttavia, legata alla natura della variabile di outcome utilizzata, la quale considera soltanto l'accessibilità stradale (e di conseguenza soltanto i miglioramenti nelle infrastrutture stradali). Le regioni del campione, tuttavia, hanno ricevuto trasferimenti per ogni tipo di progetto di trasporto, per cui, parte dei fondi potrebbe essere stata devoluta a miglioramenti nell'accessibilità di altre reti di trasporto, non catturati dalla variabile di outcome utilizzata. Per questa ragione i risultati ottenuti, seppure meno forti di quelli relativi al campo di intervento "Ricerca, Sviluppo Tecnologico e Innovazione" non sono di trascurabile importanza nell'identificazione dell'impatto dei trasferimenti della Politica Regionale Europea alle regioni Obiettivo 1.
Nel complesso, la nostra ricerca, considerando specifici campi di intervento e specifiche variabili di outcome, si riscontra nettamente un impatto positivo della Politica di Coesione. Al contrario, esaminando la crescita in termini di Pil pro-capite gli effetti della politica non sono chiaramente definiti, soprattutto nel breve periodo.
In tutti i casi esaminati, quando la variabile di outcome è espressa come differenza in livelli, non viene riscontrata alcuna discontinuità: in altri termini, le regioni in ritardo, seppure abbiano sperimentato un tasso di crescita più elevato delle regioni più sviluppate, mostrano altresì una analoga variazione in livelli.
Inoltre, le regioni appartenenti ai due gruppi dei trattati e dei non trattati hanno mostrato maggiori differenze nella crescita della variabile di outcome che nei livelli di trasferimenti ricevuti.

Il secondo saggio, dal titolo "Convergence dynamics in European regional well-being" esamina il benessere nelle regioni europee attraverso la costruzione di indicatori sintetici e l'analisi delle dinamiche relative delle regioni in un intervallo di undici anni. L'individuazione di misure appropriate del benessere in una prospettiva multidimensionale è stata di recente oggetto di interesse da parte di studiosi, organizzazioni internazionali e governi nazionali. In particolare, si è affermata la necessità di definire indicatori e database su un ampio numero di fattori considerati cruciali nell'influenzare la qualità della vita e che prescindono dalla dimensione meramente produttiva del progresso.
Il secondo saggio di questa tesi mira, pertanto, a contribuire alla letteratura empirica sulla misurazione del progresso economico e sociale calcolando per 216 regioni Europee (UE a 27 membri) sei sub-indicatori compositi quali misure di altrettante dimensioni del benessere e, a partire da questi, un indicatore sintetico complessivo, l'Indice di Benessere Europeo (EWB dall'acronimo in Inglese). Le dimensioni del benessere esaminate sono: salute e condizioni di vita delle persone; istruzione e apprendimento permanente; condizioni materiali delle famiglie; economia della conoscenza; attrattività dell'ambiente locale in termini di dotazioni infrastrutturali e di flussi turistici in entrata; uguaglianza intergenerazionale e tra sessi nelle condizioni del mercato del lavoro. Attraverso una analisi cluster è stata, inoltre, definita una tassonomia delle regioni europee in relazione alle dimensioni del benessere. Infine, è stata verificata l'esistenza di processi di convergenza/ divergenza tra le regioni europee, sia in riferimento alle diverse dimensioni della qualità della vita e del benessere complessivo, che del Pil pro-capite in un arco temporale di undici anni (2000–2010). I risultati dell'analisi consentono di raggruppare le regioni europee in cinque

clusters, distinti tra loro ma omogenei al loro interno, che rispecchiano differenti assetti del benessere: basso (terzo cluster); medio-basso (primo cluster); medio (secondo cluster); medio alto (quinto cluster) e elevato (quarto cluster). E' interessante notare come le regioni di uno stesso Paese non siano mai incluse tutte nello stesso gruppo, evidenziando l'esistenza di forti disparità regionali in Europa, anche a livello sub-nazionale.

La dinamica del benessere di ciascuna regione viene esaminata guardando all'andamento di tre differenti misure di dispersione dei sub-indicatori e dell'indicatore sintetico complessivo di benessere (convergenza σ) al fine di verificare se le disparità tra le regioni si sono ridotte nel corso del tempo (Friedman 1992): il coefficiente di variazione, l'indice di Theil e l'indice di Gini. I risultati mostrano una tendenza alla convergenza, durante gli undici anni considerati, delle regioni europee in termini di EWB, qualsivoglia misura di dispersione venga adottata. In riferimento al Pil pro-capite la riduzione è stata superiore in valore rispetto a quella in termini di benessere, anche se il processo di convergenza si è manifestato quasi esclusivamente nel primo sotto-periodo (anni 2000-2005) e mostrandosi, invece, molto debole nel periodo successivo. Come era ragionevole attendersi, lo stesso andamento osservato per le misure di dispersione del Pil è confermato per quanto riguarda il sub-indicatore delle condizioni materiali di vita, che rappresenta la dimensione economica nel nostro indice sintetico complessivo di benessere. Trend differenti caratterizzano, invece, gli altri domini, confermando la diversa natura della dimensione economico-produttiva del benessere da quella del complesso insieme di fattori che definiscono la qualità della vita. Per le dimensioni della Salute, Attrattività Locale e, anche se meno marcatamente, per l'indice di Istruzione si osserva, infatti, un aumento delle disparità tra le regioni europee nei primi cinque anni, nonostante la più forte convergenza in termini di Pil pro-capite. Nei cinque anni successivi, invece, mentre il tasso di convergenza del Pil pro-capite era debole, le diverse misure di dispersione indicano che le regioni europee tendono a divenire più simili nelle suddette dimensioni. Al contrario, una curva convessa è stata ottenuta per l'Indice di Uguaglianza nel Mercato del Lavoro: in altri termini, nel secondo sotto-periodo, si è verificato, sul mercato del lavoro, un aumento sia delle disparità tra sessi che di quelle tra generazioni. Un trend decrescente delle misure di dispersione è stato invece osservato per entrambi i sotto-periodi relativamente all'Indice di Economia della Conoscenza, anche se la convergenza nel secondo sotto-periodo appare più debole.

La dinamica del benessere in ambito europeo è stata inoltre esaminata guardando agli spostamenti delle regioni nella classifica del benessere, ovvero alla mobilità nei ranghi all'interno della distribuzione, ricorrendo al calcolo dell'indice di Kendall, a cui in letteratura si fa spesso riferimento come γ-convergenza (Boyle e McCarty 1997). L'analisi non evidenzia alcuna mobilità delle regioni tra i ranghi. Questo significa che nonostante il verificarsi del processo di σ-convergenza, le regioni europee hanno mantenuto sostanzialmente invariata la loro posizione relativa nella classifica in termini di benessere nell'intervallo di tempo considerato.

La ricerca mette in evidenza le forti disparità esistenti tra le regioni europee sia in termini di Pil pro-capite che delle differenti dimensioni della qualità della vita e del benessere complessivo. Tuttavia, l'entità e le dinamiche di tali disparità nelle due sfere, quella economico-produttiva, e quella attinente al complesso dei fattori che concorrono a definire la qualità della vita, non sono coincidenti. Questa evidenza empirica sembra confermare l'importanza di pervenire a misure accurate e multidimensionali del benessere al fine di offrire un adeguato supporto alla progettazione di politiche finalizzate alla riduzione delle disparità regionali e a raggiungere prefissati standard di benessere nei diversi aspetti della qualità della vita.

Nel terzo saggio, dal titolo "Measuring Well-Being in a Multidimensional Perspective: a Multivariate Statistical Application to Italian Regions" l'attenzione si concentra sulla misurazione e l'analisi del benessere nelle regioni italiane. La ricerca è prevalentemente basata sugli indicatori contenuti in una specifica banca dati Istat creata nell'ambito del progetto BES (Benessere Equo e Sostenibile) portato avanti congiuntamente dall'Istituto Nazionale di Statistica (Istat) e dal Consiglio Nazionale per l'Economia e il Lavoro (CNEL).

Questo saggio considera 57 variabili a livello regionale per il periodo 2004-2010, raggruppate in dieci dimensioni del benessere: Cultura e Tempo Libero, Istruzione, Lavoro, Ambiente, Servizi Pubblici Essenziali, Salute, Condizioni Materiali di Vita, Sicurezza Personale, Ricerca e Innovazione e Relazioni Sociali. La ricerca si propone un triplice obiettivo: a) costruire un indicatore sintetico per ciascuna delle dieci dimensioni del benessere considerate, applicando l'analisi in componenti principali (ACP); b) costruire un indice complessivo di benessere considerando come variabili gli indicatori ottenuti nella fase precedente dell'analisi; c) valutare l'esistenza di processi di convergenza tra le regioni italiane in termini di benessere usando due tecniche non parametriche applicate sia agli indicatori parziali che all'indice sintetico complessivo. Inoltre, le dinamiche regionali in termini di benessere vengono confrontate con quelle del Pil pro-capite. Il contributo del lavoro a quest'area di ricerca è, dunque, sia concettuale che metodologico. Si estende, infatti, rispetto alla letteratura empirica esistente, lo spettro di domini e di variabili usate per misurare il benessere in Italia; inoltre, si riduce l'arbitrarietà nella selezione delle variabili usate per descrivere le diverse dimensioni della qualità della vita, prendendo come riferimento le indicazioni contenute nel progetto BES. A differenza di quest'ultimo, tuttavia, un contributo specifico del lavoro è quello di fornire una misura composita di benessere. Sul piano della metodologia utilizzata, questo è il primo studio che usa una ACP in due stadi, in cui al primo stadio si calcolano gli indicatori per ciascun dominio, e nel secondo questi vengono utilizzati come variabili per la costruzione dell'indicatore sintetico complessivo. Infine, a differenza di gran parte degli studi sul benessere delle regioni italiane, è stato considerato anche l'aspetto dinamico, valutando l'andamento delle disparità regionali attraverso l'analisi del tasso di variazione della dispersione del benessere e della mobilità delle regioni tra i ranghi nel periodo considerato.

I risultati dell'analisi in componenti principali mostrano che le differenze in termini di benessere non necessariamente riproducono quelle basate sugli indicatori economici standard. Le differenze regionali nel benessere sono almeno altrettanto rilevanti di quelle in termini di Pil pro-capite, suggerendo la necessità di dedicare maggiore attenzione nella definizione degli interventi e degli obiettivi di politica pubblica agli aspetti del progresso economico legati alla qualità della vita. Infine, la ricerca evidenzia come le regioni italiane tendano a diventare più simili nel periodo considerato, sia in termini di Pil pro-capite che di benessere complessivo, anche se è possibile osservare un graduale rallentamento di questo processo negli anni più recenti, probabilmente come conseguenza degli effetti della crisi economico-finanziaria innescatasi nel 2007. Tuttavia, è possibile notare come la convergenza in termini di benessere sia risultata più intensa ed elevata rispetto a quella riscontrabile osservando soltanto la dinamica del Pil pro-capite. Questo risultato conferma la limitatezza delle analisi della performance dei territori basate esclusivamente sulla rilevazione e la valutazione delle dimensioni meramente produttive.

Infine, l'analisi della mobilità tra i ranghi (γ-convergenza) mostra che la posizione relativa delle regioni non si è modificata sostanzialmente nel tempo, anche se si è verificata una progressiva riduzione delle disparità (σ-convergenza): le regioni italiane, in altri termini, tendono a divenire più simili ma rimangono sostanzialmente immobili nella graduatoria del benessere.