UNIVERSITÀ CATTOLICA del Sacro Cuore

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Abstract. This paper aims to present a methodological proposal for the representation and the measurement of the concept of imbalance in sustainable development, as a disequilibrium between economy, society, and environment, starting from a holistic and multidimensional point of view. We apply the conceptual framework of imbalance to the case of European regions to verify its negative effect on perceived wellbeing, by analyzing the cross-linked effects of other determinants, such as income, equality, social capital, and quality of governance. To represent imbalance a standard deviation between six variables is used, starting from the conceptual framework of sustainable development goals of Agenda 2030. Applying bivariate correlations, OLS regressions and Spatial Autoregressive Models, a negative effect of imbalance on life satisfaction emerges.

Keywords. imbalance, sustainability, interdependence, wellbeing, spatial analysis, European regions
***J.E.L.* classification.** Q01, I31, R11, C21

1. Introduction

The Hydra of Lerna is a serpentine monster from Greek mythology, mentioned by Hesiod, Euripides, and Plato, which appears in the myths concerning Hercules. In his second trial, Hercules had to kill this monster, which had six heads. Whenever Hercules managed to cut off a head of the Hydra, two grew. We consider the Hydra as the metaphor of the imbalance of the development of our time. When governments, firms, and citizens scramble to pursue only a few goals of sustainability, problems that are greater in number and intensity are reborn. If economic development pursues only goals of production or GDP growth, evident contradictions of ecological or social nature arise. Hence, sustainable development should embrace multiple objectives, addressing not merely the economic but also social and environmental concerns. As Pope Francis writes in his recent encyclical (2015), "Everything is connected. This requires a concern for the environment combined with sincere love for human beings and a constant commitment to the problems of society "(Laudato Sì, 91).

The present state of imbalance between economy, society and environment arises from not having fully appreciated the interdependence among them, as pointed out in the Agenda 2030 for sustainable development. Whereas properly considering all the Sustainable Development Goals would reflect the true complexity of the phenomenon (UN, 2015). The achievement of the objectives of sustainable development will require resources, analytical tools and decision-making capabilities based on new methodological proposals able to respond to a constantly evolving demand for information. How can we represent the concept of imbalance among the different pillars of sustainable development? What is its role in territorial wellbeing? The aim of this paper is to answer these research questions.

If we use compensatory methodologies in the construction of composite indicators of territorial performance, some specific dimensions of development can determine high average values of that measure, hiding the unbalanced positions of territorial systems

among the different areas of sustainability. In other words, it is possible to obtain rankings that do not highlight unbalanced situations at regional level, due for example to high values in the economic or social sphere but significant deficits in the environmental one. The analysis of the relations between unbalanced development and perceived wellbeing allows us to evaluate the effects on life satisfaction of the "disequilibrium" among the different dimensions of sustainability. In this paper, we adopt a multidimensional point of view to design the unbalanced development in the three spheres of sustainability (economy, society, and environment) and a subjective measure to represent wellbeing. The paper has the following specific objectives: to introduce a methodological proposal for the measurement of the concept of imbalance in territorial development, to apply it to the case of European regions with the aim of presenting a map of the spatial pattern of the phenomenon, to verify the effect of unbalanced development on territorial subjective wellbeing.

The empirical part of the work is based on a set of 248 European regions at NUTS2 level, observed in 2014 by integrating two sources of data: Eurostat and OECD. The following section will introduce a literature review on sustainability and imbalance, wellbeing, and its determinants, ranging from theoretical works to methodological and empirical ones. In the section "Methods and data" some strategies for conceptual and quantitative representation of the imbalance notion will be illustrated. Starting from the description of the variables structure, that section will illustrate a hypothesis to be tested: the negative effect of imbalance on the perception of wellbeing, controlling for socio-economic variables that emerge in literature review. The section "Findings" is divided into two parts: the first one focusing on the geography of imbalance in European regions, the second one aiming at showing the results of the study of causal cross-linked relations between wellbeing, imbalance and other regressors. At first, we run an OLS regression, then, we apply the Spatial Autoregressive Model to deal with autocorrelation phenomena by using a contiguity-based spatial weights matrix. The last section will

present some preliminary conclusions and regional policy implications.

2. *Concept and theory*

This section introduces definitions and theoretical foundations through a short literature review of the two focuses of our research: sustainability and wellbeing with its determinants.

The term sustainability has its origin in ecology: an ecosystem is sustainable if it can maintain its integrity over time (Margalef, 1968; Odum, 1971). In the field of social sciences, there are many descriptive and interpretative models of sustainable development. An interesting classification of these models results from the distinction between weak sustainability (Hediger, 1999; Cabello et al., 2019) and strong sustainability (Daly, 1991; Victor, 1991). This classification focuses on the existence of different types of capital and on the idea of total or partial substitutability among them. Weak sustainability starts from a neoclassical perspective, based on the theories of growth with natural capital (Dasgupta and Heal, 1974; Solow, 1974; Stiglitz, 1974). It assumes that economic, social, and natural capital are substitutable during a certain period. From that point of view the definition of sustainable development aims at maintaining the total capital, that determines the future level of social wellbeing. That approach does not pursue the objective of conserving resources per se, it pursues the conservation or the improvement of aggregate capital from one generation to the next. The technological progress and the existence of natural resources with alternative uses are necessary conditions for the achievement of perfect substitutability between economic, social, and natural capital.

Models based on strong sustainability have as a common point the rejection of the neoclassical assumption of substitutability among the different types of capital, as well as the adoption of a more integrated approach between economy, society, and environment. If the economic systems are on a growth path that allows us to maintain the stock of social and natural capital or

increase over time, it is strongly sustainable. This definition suggests that it is necessary to preserve the economic, social, and natural capital stock at the same time, to avoid a decrease in the total capital stock and wellbeing. A holistic and comprehensive system for evaluating the degree of balance between socioeconomic development and ecological quality is mandatory to implement integrated development policies (Li and Guan, 2018). In the research line on evolutionary economics, it is possible to highlight some applications of the concept of strong sustainability. "Co-evolution" refers to the simultaneous evolution of the dimensions that compose a socioecological system, based on the recognition of relations among them (Gowdy, 2007; Dallara and Rizzi, 2012). From this point of view, sustainable behavior reflects the prudence that characterizes a predator that avoids exploiting its prey too much to ensure a constant amount of food over time (Odum, 1971). The approach of strong sustainability is based on the idea of preserving the stability of socioecological systems and its resilience as necessary conditions for sustainable development (Graziano and Rizzi, 2016; Rizzi et al., 2018).

The idea of sustainability emerged in operational research on indicators in the late 1980s after the Brundtland Commission report (World Commission on Environment and Development, 1987; Holden et al., 2014). Starting from international consensus on the relevance of the topic, social scientists tried to design useful tools able to assess the sustainability of development in countries and territories. The construction of sustainability indicators (SIs) aimed at catching the multidimensionality of the phenomenon is the focus of international organizations such as United Nations, OECD, World Bank. They carry out recommendations in multiple areas of public management ranging from economic and social development to environmental protection. It is possible to highlight the role of OECD in the development of policies but also in methodological recommendations that culminated in the publication of Handbook on constructing composite indicators: methodology and user guide (OECD, 2008).

For their ability to summarize information, SIs can largely attract community attention. SIs integrate different dimensions of

the concept by giving a "context image" and by reducing the size of the list of variables that describe it. They allow spatial comparability between observations and temporal comparability to analyze their evolution, so they can help in interpretation of phenomena. For this reason, they can improve policy debate on sustainability-oriented development (Yang, 2014; Greco et al., 2019). The construction of a SI requires three basic conditions that are: the definition of a specific policy objective, the clear design of the concept to measure and the existence of reliable information to set up and implement the measurement (Bell and Morse, 2008; OECD, 2008). These conditions are essential for the possibility of constructing a composite SI: the satisfaction of the first and second conditions will give it a conceptual framework, while the third one will give it validity. Otherwise, the use of SIs can provide confusing and not robust messages, due to perceived biases or oversimplification. The aggregation of dimensions and sub-dimensions can lead to increasing levels of uncertainty associated with the integration of the various scales and components that the composite indicator attempts to summarize. It is evident that the "one-size-fits-all" approach is inappropriate, since the best choice depends on the corresponding needs of scientists and policymakers (Breslow et al., 2016).

To identify the most suitable aggregation and weighting scheme for constructing SIs, Gan et al. (2017) suggest a four-step process for choosing the most appropriate methods based on research purposes, spatial and temporal scales, and sustainability perspectives. It is possible to categorize them into compensatory and non-compensatory methods and into equal weighting, statistical-based, and participatory methods (OECD, 2008). The choice of aggregation procedures and the controversial issue of the compensation among the indicators turn out to be closely connected: it reflects the intention of the scientist and the policy objective at the base of the research design. Additive SIs (arithmetic mean, sum of ordinal orders, weighted sum of normalized indicators) are completely compensatory. An example of this kind of indicator is the recent Global Index of Agenda 2030 that monitors the achievement of sustainable development goals

and summarizes them into a synthetic measure (Sachs et al., 2018). Multiplicative SIs, such as weighted geometric mean, are partial compensatory since the substitution effect depends on the value of the observation in the indicators that the algorithm aims to summarize. An example of this kind of indicator is the second version of Human Development Index, which applies the geometric mean of three basic dimensions (UNDP, 2010). The choice among weighting procedures and the context of the analysis are closely related. Participatory methods appear to be ideal when there is a well-defined framework for policy behind the construction of SIs (Munda, 2005) whereas statistical-based methods seem to be appropriate to summarize criteria for homogeneous social interest groups (Decancq and Schokkaert, 2016).

The juxtaposition between substitutability and non-substitutability of the dimensions of a concept (and its descriptors/indicators) represented by compensatory and non-compensatory methods inspired the development of methodologies aimed at capturing the synthetic performance through average value and the imbalance among dimensions of this performance through dispersion measures (Mazziotta and Pareto, 2016, Greco et al., 2019).

The concept of wellbeing has a history in the literature extending over two centuries and over several disciplines and it has been developed in psychological and social studies since the seminal contribution of Easterlin (1974), who exposed the existence of a happiness paradox. According to that study, the percentage of people who describe themselves as being «very happy» has remained constant, if not decreased slightly, over previous decades, despite the significant rise in average income. This fact suggests that largely non-material elements may be more important in determining and more effective in delivering happiness than material ones.

The link between wellbeing, collective happiness and life satisfaction are the subject of a wide debate and the focus of numerous surveys at national and international level (Frey and Stutzer, 2000; Maggino and Nuvolati, 2012). Some works show the

importance of space in the analysis of wellbeing, attempting to define measures of wellbeing centered on the multidimensionality of the phenomenon in the conceptual background of sustainability (Graziano et al., 2019; Lenzi and Perucca, 2019).

The definition of wellbeing highlights a variety of components connected to emotional dimensions, life satisfaction and positive functioning that we may observe from both the individual and community points of view (Helliwell et al., 2020).

The first determinant of happiness is personal income in most studies: the subjective wellbeing grows with GDP per capita but at decreasing rates (Layard, 2006; Bruni and Porta, 2016).

The endowment of social capital at community and individual level appears to be strongly associated with wellbeing. According to Coleman's (1988) three dimensions of social capital exist: trust and obligations, information channels, norms, and sanctions. Some papers highlight the predominant role of the components of social capital linked to informal interactions between individuals and to trust rather than components linked to norms, effective sanctions, and formalized relationships (Bjornskov, 2006; Rodríguez-Pose and Von Berlepsch, 2014). Helliwell et al. (2017) analyze the connection between social capital and wellbeing by highlighting the emotional benefits of prosocial behavior in many dimensions of life. The authors show that socioeconomic systems with high levels of social capital and stable prosocial behavior also denote high levels of wellbeing. These results confirm the studies on the relationship between wellbeing and sense of community (Ross et al., 2019).

Some works focus on the positive link between happiness and equality, by adopting a holistic concept of fairness which goes beyond economic wellbeing (Skidelsky, 2012; İşler, 2015) or referring to a wide concept of equality, close to the idea of "self-fulfillment" (Lepenies, 2012). Societies with greater equality levels tend to be stronger, successful, and healthier: life expectancy increases, whereas indicators of social vulnerability such as homicide rate, teenage birth rate, obesity and anxiety show lower levels (Wilkinson and Pickett, 2009). Ferrer-i-Carbonell and Ramos (2014) find that inequality correlates negatively with

happiness in Western societies. Alesina et al. (2004) focus on Europe and the United States in the analysis of the effect on wellbeing of equality, controlling for individual income and for a large set of personal characteristics.

Individual wellbeing also appears positively influenced by the quality of governance (Frey and Stutzer, 2000; Charron et al., 2014), which many past and recent studies indicate as a key variable to explain the positive correlation between institutions and life satisfaction (Rodríguez-Pose and Maslauskaite, 2012; Graziano et al., 2019). Institutions that facilitate individual involvement in politics have a substantial effect on wellbeing. Some studies point out that differences in the relative importance of several aspects of good government, such as technical quality or democratic quality, depend on the level of development of socioeconomic systems (Helliwell et al. 2014; Woo, 2018). Ott (2010) found that the quality of governance (government effectiveness, regulatory quality, rule of law) is more important for individual wellbeing than the size of governments in terms of public expenses or investments. The positive relationship between quality of governance and wellbeing turns out to be strong at country level and independent of the dimension of public structure.

The link between sustainable development and subjective wellbeing has been studied and verified by recent empirical research, highlighting positive and significant correlations. Two types of approaches can be identified, the first based on micro analyses on individuals to verify the effect of environmental conditions (air pollution, greenery, parks, climate) on personal wellbeing; the second based on territorial analyses, at urban or cross-country scale, with local or national average indicators relating to both sustainability and perceived happiness.

In the first line of research, Krekel and MacKerron (2020) study the link between local environmental quality and happiness. In an international analysis that considers over 150 countries, through multivariate regressions the authors find confirmation of the negative effect of air pollution (especially particulate matter, but also temperature average) on life evaluation.

In the second type of approach, there are studies at urban scale and country level. Among the first, Cloutier et al. (2014) define the Sustainable Neighborhoods for Happiness Index (SNHI). With a metric that measures nine subsystems of community development, such as water, energy and waste management, the authors compare some US cities to understand how these practices translate to "opportunities for residents to pursue happiness".

In a study on European regions with some multivariate models, Graziano et al. (2019) show positive effects on life satisfaction of composite indicators of resilience in the sustainability framework and negative impacts of CO2 emissions.

At a cross-country level, Zidansek (2007) observes positive correlations between average value of happiness and environmental sustainability index (ESI), and negative significant correlations between CO2 emissions per unit GDP and average happiness. Linear regressions demonstrate that happier nations are also more energy efficient and require less CO2 per unit GDP.

De Neve and Sachs (2020) highlighted how the Sustainable Development Goals (SDGs) are significantly linked to the levels of life satisfaction in the 162 countries considered. The authors note that the line of best fit is not linear but quadratic, indicating that a higher SDG Index score correlates more strongly with higher subjective wellbeing at higher levels of the SDG Index. Thus, sustainable development results in increasing marginal returns to human wellbeing.

The theme of imbalance has been mostly treated from the point of view of the gap in socioeconomic performances of countries by highlighting historical and institutional determinants of those differences (Lange et al., 2018; Barbier, 2019). But there is a lack of empirical studies on the effects of imbalances among the spheres of sustainability at the territorial level.

3. Materials and methods

This section describes the methodological aspects related to the conceptual construction of imbalance in the spheres of

sustainability, its empirical representation and finally the measure of its role in wellbeing. The first aim of this work is to conceptualize and analyze the phenomenon of imbalance in regional development in a sustainability framework. Our methodological proposal uses the conceptual framework developed by Rizzi et al. (2015) and Graziano et al. (2019). Starting from the point of view of not substitutability of different dimensions of development, we define the imbalance in regional development by the dispersion (standard deviation) among the indicators/descriptors associated to the spheres of sustainable development.

In this paper, we choose six variables to define the three pillars of sustainability. Three of them are directly connected to each sphere, GDP per capita for the economic dimension, Gini index for the social one and natural capital for the environmental one. Three indicators/descriptors are connected to the intersection between each dimension: the unemployment rate, which represents the joining of economic and social dimension; life expectancy, which describes the intersection between the social and environmental ones and particulate matter, which represents the matching between economic and environmental spheres.

We apply a minimum-maximum scaling for each indicator, which is oriented according to the logical direction of the analyzed holistic phenomenon, the concept of sustainability. Thus, the orientation of Gini index, unemployment rate and particulate matter concentration are changed since they are negatively associated with sustainability. Then we calculate the standard deviation among the rescaled indicators for each region and the magnitude of that measure represents the imbalance in sustainable development of each region

The higher the standard deviation is, the more unbalanced the regional development pattern is. The lower the standard deviation is, the more balanced the regional development pattern in terms of sustainability is.

The second aim of this work is to verify something new in the studies on sustainability and wellbeing: the hypothesis of the negative role of imbalance on the territorial wellbeing. We apply

the measure of regional imbalance to verify that hypothesis by studying the relationship with wellbeing as dependent variable. In this perspective, the measure of wellbeing is a subjective indicator connected to the cognitive sphere of life satisfaction (OECD, 2013; Graziano et al., 2019). This choice aims to respond to the increasing demand for integration between qualitative and quantitative aspects of the quality of life (Diener et al., 2006; Bruni and Porta, 2016).

To verify whether and to what extent imbalance acts on wellbeing we use two instruments, namely correlations analysis and econometric models in simple OLS and through spatial autoregressive models. Some determinants of life satisfaction which emerged in the analysis of the literature on wellbeing are introduced, such as the average income per person, the concentration of income, the quality of governance, the endowment of social capital.

The concept and measure of imbalance, the verification of its negative role in regional wellbeing, are applied to the case of European regions and to a dataset made of 248 NUTS2-level units observed in 2014[1]. The construction of the dataset has involved a necessary work of connection between the EUROSTAT nomenclature of territorial units (NUTS) and the OECD one (TLs). The presence of some missing values characterized some variables. In these cases, we apply a filling procedure to solve the problem for some specific regions, by using values at NUTS1 level in place of NUTS2.

We represent regional wellbeing by the subjective indicator of life satisfaction proposed in a survey published by the OECD. It is the average score from 0 to 10 of people that replied to the following question: On which step of the ladder would you say you personally feel you stand at this time? Imbalance is represented by the dispersion (standard deviation) among GDP per capita,

[1] These 248 regions belong to 21 European countries and do not include the regions of Bulgaria, Cyprus, Croatia, Lithuania, Latvia, Malta, Norway, Romania, and the French Oceanic Islands, because of the lack of data.

unemployment rate, life expectancy, natural capital[2] from EUROSTAT statistics, Gini Index, PM 2,5 from OECD statistics. We propose some control variables starting from literature review on the determinants of wellbeing and on sustainability: quality of governance[3] from Quality of Governance Institute, social support from OECD statistics in addition to GDP per capita and Gini index. Social support like life satisfaction is a subjective indicator. It describes the role of social capital in regional wellbeing, and it is calculated as the percentage at regional level of people that replied "Yes" with respect to all respondents to the following question: If you were in trouble, do you have relatives or friends you can count on to help you whenever you need them, or not? The complete description of data is reported in Table A1 in Annex.

The analysis of causal relations among wellbeing, imbalance and the other mentioned regressors starts with an OLS model. Skewness–Kurtosis analysis and Shapiro–Wilk tests for normality of residuals distribution are reported as well as Breusch–Pagan test for heteroscedasticity and Durbin-Watson test for autocorrelation. All the used variables are cross-sectional among the European regions and life satisfaction as well as income per capita, quality of governance, social support and Gini Index are characterized by high spatial autocorrelation (significant Moran's I). The distribution of residuals does not exhibit a constant variance: values of those indicators observed at regional level depend on values of neighboring observations at nearby regions, indicating spatial dependence. Spatial interactions, diffusion effects, hierarchies of place cause spatial dependence among the observations. This phenomenon together with spatial heterogeneity in the relations among variables are typical of spatial cross-sectional variables. To deal with these phenomena and with the violation of the assumption of the classical linear econometric

[2] Natural capital is an indicator that we calculated to describe natural coverage of the land. It is the percentage of total land cover represented by green areas (woodland, shrubland, grassland, bare land, water, wetland)

[3] Quality of governance is a composite indicator that summarizes the following dimensions: corruption, quality of services, impartiality, regulatory quality.

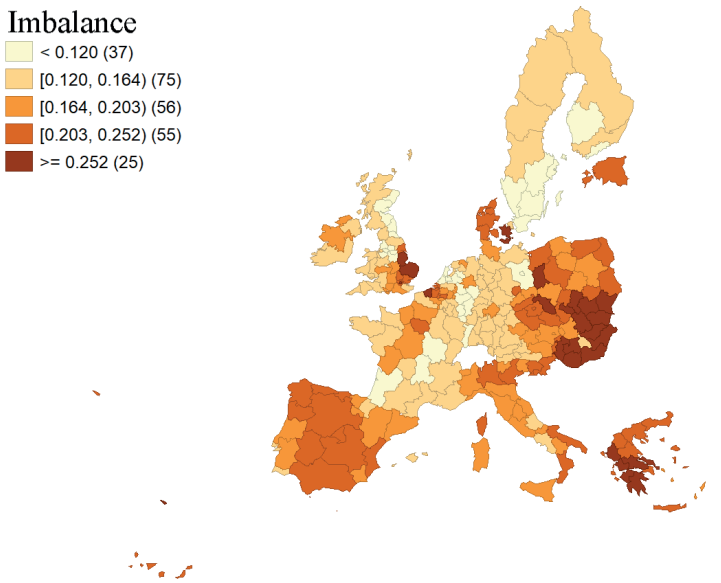
model we implement a spatial autoregressive model (SAR), by using a contiguity-based spatial weights matrix. A spatial lag model and a spatial error model run in both simple and robust methods, by using maximum likelihood estimators (ML) to analyze the role of imbalance on territorial wellbeing.

4. Results

The geography of equilibrium between the different spheres of sustainability is reported in Figure 1. It shows the best positions of the Nordic regions of the Scandinavian Peninsula, but also of some virtuous territories of the United Kingdom, Germany, Holland, and France. In these areas over time, it has been possible to find a positive mix between production and income growth, social inclusion and cohesion, protection of natural and environmental resources.

At the bottom of the ranking, the most unbalanced regions are reported: Inner London in UK, Ipeiros in Greece, Észak-Magyarország, Dél-Dunántúl in Hungary, Região Autónoma da Madeira in Portugal, Moravskoslezsko in Czech Republic, Stredné Slovensko in Slovakia.

These data indicate that the imbalance does not refer only to the economically weaker regions of Europe (Greece, Portugal, Poland, Hungary), but is also present in a patchy way in wealthy regions such as the capital regions of London and Paris or specific areas of Belgium, Spain, United Kingdom, and Italy. The imbalance can therefore occur both in economically rich areas, which reveal deficits in environmental or social terms, and in poor ones, which record good ecological performance.



Source: Authors' elaboration based on Eurostat, OECD, LUCAS and Quality of Governance Institute
Figure 1: The Map of Imbalance

The spatial distribution of the life satisfaction in European regions rewards some areas on the North Sea, in particular the Dutch regions of Zeeland, Groningen and Friesland, the Danish regions of Hovedstaden, Nordjylland and Midtjylland, the Swedish Småland med öarna and some Finnish areas. In the group of the «happiest» ones, the central Austria region of Tirol completes the map of the best regions, such as Länsi-Suomi, Etelä-Suomi and the Alan Islands in Finland, followed by the Drenthe, Gelderland, Zuid-Holland in Netherlands, Cantabria and the Comunidad Foral de Navarra in Spain and Stuttgart, Freiburg, Unterfranken, Bremen, Hannover, Schleswig-Holstein and Saarland in Germany. At the bottom of the list there are the Hungarian regions of

Southern Transdanubia, Southern Great Plain, Northern Hungary, preceded by Greek Ionia Nisia, Central Hungary, Dytiki Makedonia, Northern Great Plain, Sterea Ellada and the Portuguese Algarve, Região Autónoma da Madeira, and Centro.

The links between life satisfaction and the other variables confirm at regional level the main results that emerged in the studies at cross-country levels (World Happiness Report, 2016; 2020): in fact, the matrix in Table 1 highlights the strong and significant positive correlations between the perceived wellbeing indicator and, respectively, GDP per capita, social support, quality of governance, life expectancy. On the contrary, we observe strong negative correlations with the unemployment rate, the density of particulate matter and the concentration of income measured by the Gini index. A significant negative link between the imbalance among the spheres of territorial sustainability and life satisfaction emerges and it suggests that we run an in-depth analysis of the cross-linked effects to verify the hypothesis under study in this work. On the other hand, the density of natural capital, measured as share of green land, do not show a clear relation with life satisfaction in terms of correlation coefficient.

Analyzing the other direct relationships, some significant links emerge, such as the positive ones between GDP per capita and life expectancy, social support and quality of governance and the negative ones between individual income and, respectively, Gini index and unemployment rate.

The bivariate correlations of the imbalance with the other variables highlight significant negative links (with life satisfaction, GDP per capita, quality of governance, social support, and life expectancy) and other positive ones such as with unemployment, Pm 2.5 and to a lesser extent with Gini Index. The correlation between imbalance and natural capital results with expected negative sign, whereas the link with unemployment rate is worthy of further study. Even in this case the correlations with natural capital are not very significant.

	Life sat	Gdp pc	Nat cap	Qual Gov	Soc supp	Unemp	Gini	Pm 2.5	Life exp	Imb
Life sat	1	,633**	-0,022	,787**	,624**	-,538**	-,331**	-,455**	,395**	-,518**
Gdp pc		1	-0,116	,609**	,363**	-,428**	-0,016	-384**	,424**	-,391**
Nat cap			1	-0,036	-0,075	,223**	0,055	-,253**	,184**	-,165**
Qual Gov				1	,580**	-,626**	-,352**	-,513**	,246**	-,499**
Soc supp					1	-,443**	-,159*	-,194**	,142*	-,343**
Unemp						1	,505**	,124	0,098	,414**
Gini Index							1	,044	,175*	,144*
Pm 2.5								1	-,476**	,482**
Life exp									1	-,242**
Imb										1

The Pearson correlation is significant at: **the 0.01 level; *the 0,05 level.
Source: Authors' elaboration based on Eurostat, OECD, LUCAS and Quality of Governance Institute
Table 1: The correlation matrix

The analysis of spatial distribution of the objective variable and of the independent variables suggested that we run an in-depth analysis to assess the presence of spatial dependency in the set of geographical indicators[4]. First of all the analysis focused on the calculation of Moran's index (see Table 2), which measures the global degree of similarity between the intensities of nearby regions, and it has been used in almost all studies employing spatial autocorrelation (Upton and Fingleton, 1985).

Variable	Global Moran's index value
Life satisfaction	0,775**
GDP per capita	0,446**
Gini index	0,629**
Natural capital	0,605**
Unemployment rate	0,864**
PM 2,5 concentration	0,772**
Life expectancy	0,812**
Imbalance	0,601**
Institutional capital	0,829**
Social support	0,514**

The test is significant at: ** 0,01 level
Source: Authors' elaboration based on Eurostat, OECD, LUCAS, and Quality of Governance Institute data
Table 2. The Global Moran's index of the variables

All the variables included in the analysis reveal a clustered spatial pattern. The calculation of Moran's index for Life satisfaction shows a high spatial dependency of the phenomena (0.77) as well as for the case of imbalance algorithm (0.60). A quite

[4] The dataset has been adjusted to detect spatial dependency, by following the steps below: (1) assigning assign the values of other similar areas to the islands (2) editing the corresponding weights matrix, (3) eliminating Canarias, Região Autónoma dos Açores, Região Autónoma da Madeira because of their great distance from the main land (Anselin, 2005).

dispersed spatial distribution pattern only emerges for GDP per capita, as highlighted by the lower value of Moran's Index (0.4).

The calculation of local univariate Moran's indicator for life satisfaction allows us to observe some hotspot regions in Finland, Sweden, Denmark and in the central part of Europe (Kärnten, Steiermark, Oberösterreich in Austria and Tübingen and Unterfranken in Germany) that record high-high values in life satisfaction indicator. It also highlights the existence of some low-low hotspots regions in Southern Europe (Abruzzo, Molise, Puglia, Campania, and Basilicata in Italy, Andalucía in Spain, Norte Algarve, Centro, Alentejo in Portugal, Kentriki Makedonia, Dytiki Makedonia, Thessalia, Ipeiros, in Greece), and Central-Eastern Europe (all region of Poland and Hungary).

The analysis of correlations sets the stage for a further analysis of links to clarify which factors contribute most to explain wellbeing in European regions (see Table 3). First, we run the OLS regression to estimate the cross-linked effects of imbalance, inequality, GDP per capita, quality of governance and social support on perceived wellbeing. An OLS which does not include imbalance, and another one which includes it, are run to observe the change in the coefficients of the variables related to the introduction of imbalance as regressors. The results show the negative and significant effect of imbalance and inequality on wellbeing and the positive and significant effect of GDP per capita, quality of governance and social support. The tests for heteroskedasticity and normality of residuals distribution exhibit the violation of the assumption of the classical linear econometric model. The tests for autoregression of residuals and for spatial dependence of observations show the need for adopting the spatial autoregressive model as a method of analysis to describe the relationships between variables. Spatial lags and spatial errors are reported for both the regression which has imbalance as an independent variable, and the regression which does not have imbalance as N independent variable. The distribution of the error terms does not exhibit a constant variance because values of a given variable observed for some regions depend on values of neighboring observations at nearby regions, indicating spatial

dependence. The spatial autoregressive model (SAR) is implemented, by using maximum likelihood estimators (ML) as parameter for each regression, to consider spatial dependence and spatial heterogeneity in the relationships among variables which are two typical problems of spatial cross-sectional data. A spatial lag model, which does not include imbalance and another one, which includes it are run: they both retain the same parameters signs obtained by the corresponding OLS models. The values of the spatial lag are significant, indicating spatial autoregressive dependence in perceived wellbeing. A spatial error model, which does not include imbalance, and another one, which includes it, are run: they both retain the same parameters signs obtained by the corresponding OLS models. The values of the spatial error are significant, indicating spatial autoregressive dependence in error term.

The results of the various econometric models consistently confirm the relationships already verified in the analysis of correlations. The additional contribution that econometric models offer is to capture the multidimensional links between the different explanatory variables, as well as the spatial autocorrelation models that emphasize the role of territory in explaining the phenomenon of subjective wellbeing.

On the one hand, we confirm also for European regions, that the main determinants of subjective wellbeing are per capita income, social support, quality of governance with a positive sign and inequality in the distribution of income with a negative sign. Quality of governance has the most important effect on how individual perceive their quality of life. Economic wealth and social capital respectively represented by GDP per capita, and the perception of social support seem to be the other two important drivers of subjective wellbeing. Similar results have been published in the different editions of the World Happiness Report, but at the country level.

Indep variables	OLS 1	OLS 2	Spatial lag 1 (ML)	Spatial error 1 (ML)	Spatial lag 2 (ML)	Spatial error 2 (ML)
GDP pc	0.514** (0.081)	0,483** (0,080)	0.281** (0.069)	0.238** (0.070)	0,267** (0,069)	0,222** (0,070)
Gini Index	-0.164** (0.045)	-0.165** (0.044)	-0.072 (0.038)	-0.078 (0.052)	-0,074 (0,038)	-0,092 (0,051)
Quality of govern	0.530** 0.069	0.471** (0.071)	0.319** (0.067)	0.630** (0.074)	0,296** (0,067)	0,594** (0,075)
Social supp	0.367** (0.060)	0.353** (0.059)	0.222** (0.051)	0.242** (0.054)	0,218** (0,051)	0,230** (0,054)
Imbalance		-0.471** (0.149)			-0,246* (0,125)	-0,380* (0,150)
No. obs	248	248	245	245	245	245
R-squared[5]	0,709	0,719	0,800	0,812	0,803	0,816
Test F	151,384**	127,560**				
Normality of errors						
Jarque-Bera test	51,821**	23,781**				
Shapiro-Wilk test	0,952**	0,967**				
Heteroskedasticity						
Breusch-Pagan test	77,028**	61,930**	55,085**	60,046**	78,531**	83.188**
Multicollinearity						
VIF test (mean)	1,739	1,708				
Autocorrelation in the residuals						

[5] R-squared refers to adjusted R-squared in the OLS models

Durbin-Watson test	1,152	1,199				
Spatial dependence						
Lagrange Multiplier (lag)	67.377**	63,070**				
Robust LM (lag)	12.594**	9,936**				
Lagrange Multiplier (error)	59.524**	59,650**				
Robust LM (error)	4.741*	6,515*				
Rho coefficient			0.476** (0.052)		0.461** (0,052)	
Lambda coefficient				0.618** (0.052)		0,607** (0,053)

The quantities in parentheses below the estimates are the standard errors; the coefficients and tests are significant at: ** 0,01 level, * 0,05 level.

Source: Authors' elaboration based on Eurostat, OECD, LUCAS, and Quality of Governance Institute data

Table 3. Wellbeing and imbalance (dependent variable: life satisfaction)

However, the completely new figure that emerges from both OLS regression and spatial correlation analyses is the significant and negative role of the imbalance among the spheres of sustainability. This means that unbalanced territories, which record positive performances on some dimensions of sustainability and at the same time some negative ones on other dimensions, show lower levels of perceived wellbeing. As in the myth of the Hydra of Lerna, when Hercules focuses only on one head of the monster, he does not get any results. The possible explanation of the negative relationship between life satisfaction and imbalance is that the

citizens somehow "feel" the effects of this disequilibrium that determine fears, worries and uncertainties which finally translate into lower levels of perceived happiness. This research allowed us to capture the subjective and objective dimensions of wellbeing and to represent the quality of life at individual and systemic levels. The structure of relationships among dependent and explanatory variables that we proposed goes beyond a strictly economic view. But it still refers to an anthropocentric perspective for the representation of interactions between humans, communities, and environment because the objective variable concerns to individual life satisfaction. However, the analysis focuses on a definition of sustainability based on non-substitutability of its economic, social, and environmental components, on their interdependence and balanced co-evolution. The research design tries to interpret the impact of sustainability on human wellbeing, by highlighting the cross-linked effect among its determinants and introducing the phenomenon of imbalance in sustainable development.

5. Conclusions

The paper has a twofold objective: to construct an index of the imbalance between the spheres of sustainable development in European regions and to verify the relationship between this indicator and subjective well-being. As a first result, we obtained a partially unexpected map, because alongside the traditionally less developed regions of Eastern Europe and the Mediterranean, we encounter some metropolitan areas that show polarized economic, social, and environmental performances and therefore high levels of imbalance. We emphasize that a region could reach balance, by getting high performances in all areas of sustainability, but also with an unsatisfactory and homogeneous downward outcome.

The second new result concerns the link between sustainability and subjective well-being, topics that have hardly been studied in the literature, if not recently. In particular, we verified the existence of a negative relationship between the imbalance in the spheres of sustainable development and life satisfaction, using as control

factors the variables that research into happiness indicators as the most significant determinants, such as personal income, social relations, quality of local institutions, and equality of income distribution. This is an important result to confirm with further empirical checks on a national and regional scale, but we can draw some useful policy implications also at the territorial level. The UN Agenda has given a strong push in planning for sustainable development with the construction of indicators and targets for the 17 SDGs, and many countries and regions are starting to build multi-year plans that consider the different spheres of sustainability. However, it is necessary that national and regional governments, down to municipal institutions, also try to maintain the equilibrium between these objectives, balancing public spending and investments to reach a co-evolution of the different dimensions of collective life.

Just as on an individual level, life is in equilibrium if we give the right weight to the different dimensions of existence (work, affections, culture, entertainment, spirituality), so on a collective level focusing or spending only on the economic or social sphere can become risky.

On the one hand, the complexity of the dimensions of sustainable development requires a multidimensional and holistic perspective; on the other hand, the search for the balance of the different spheres of sustainability becomes important for individual and collective wellbeing.

As Calvino wrote (2016), we must "represent the world as a ball of yarn, a tangled skein of yarn… without diminishing the inextricable complexity or, to put it better, the simultaneous presence of the most disparate elements that converge to determine every event".

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Appendix

Variable	Description	Units of measurement	Source	Time
Life satisfaction	Average score from 0 to 10 of people that replied to the following question: On which step of the ladder would you say you personally feel you stand at this time?	Average score	OECD	2014
GDP per capita	GDP per capita at current prices	Euro per inhabitant	Eurostat	2014
Unemployment rate	Unemployed out of the population between 15 and 74 years	%	Eurostat	2014
Gini Index	Gini (at disposable income, after taxes and transfers)	0-1 scale	OECD	2013
PM 2,5	Average level experienced by the population	µg/m³	OECD	2013
Life Expectancy	Median age of the population at childbirth	Years	Eurostat	2014
Natural Capital	Green areas (woodland, shrubland, grassland, bare land, water, wetland) by total land cover	%	Eurostat	2012

Quality of Governance	Composite indicator that summarizes the following dimensions: corruption, quality of services, impartiality, regulatory quality	Composite Indicator 0-100 scale	Quality of Governance Institute	2013
Social Support	% of people that replied "Yes" to the following question: If you were in trouble, do you have relatives or friends you can count on to help you whenever you need them, or not?	%	OECD	2014

Source: Eurostat, OECD, LUCAS and Quality of Governance Institute

Table A1. The variables used in the model

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