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I feel good: Exploring the influence of social and environmental dimensions of regional development on the subjective well-being of European citizens

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ABSTRACT

This article investigates how regions' ability to pursue sustainable development trajectories affects individual subjective well-being. In particular, it disentangles the social and environmental dimensions of sustainability by examining the relative role of social capital, public safety, and green innovation capacity in shaping individuals' quality of life. Empirically, the study relies on a cross-sectional analysis of 255 European regions over the period 2000–2018, using data from the OECD Regional Well-Being database, OECD RegPat, ARDECO, Eurostat, the EU Labour Force Survey, and the EU-NED database. The results show that subjective well-being is positively influenced by all dimensions of sustainability, with social factors exerting a stronger effect than environmental ones. The conclusions highlight relevant policy and managerial implications for steering future regional development trajectories.

1. Introduction

Sustainability has become a pervasive topic in academic research, spanning multiple disciplines, while sustainable development has emerged as a key objective of both national and international policies (Gladwin et al., 1995; Harris, 2003). The Brundtland Commission (World Commission on Environment and Development, WCED, 1987) defined sustainable development as a form of development that meets present needs without compromising the ability of future generations to meet their own. This concept seeks to reconcile economic progress with the preservation of social and environmental balance.

From a policy perspective, several landmark events and documents have shaped the global path toward sustainable development. These include the 1992 Rio Conference and its subsequent Rio+10 and Rio+20 summits; international agreements such as the Kyoto Protocol on carbon dioxide (CO_2) emissions; the adoption of global targets like the Millennium Development Goals in 2015; and major ecosystem and climate assessments, including those by the Millennium Ecosystem Assessment (MEA, 2005), the Intergovernmental Panel on Climate Change (IPCC, 2007), and the National Ecosystem Assessment (NEA, 2011).

From an academic perspective, Stiglitz et al. (2009) urged scholars to move beyond traditional measures of economic performance and social progress based on Gross Domestic Product (GDP). This is not only because GDP fails to capture income distribution within countries, but also because it neglects key dimensions related to sustainability. An increase in GDP per capita does not necessarily translate into an improvement in societal well-being. Consequently, any meaningful assessment of the "wealth of nations", or "commonwealth" (Berry, 2012), should incorporate measures of natural capital, social capital, and individual well-being (Pretty, 2013).

This study contributes to the growing literature examining the relationship between sustainability and well-being, a core dimension of social progress. While some studies have investigated how spatial characteristics affect well-being in urban areas (Morrison, 2011; Ala-Mantila et al., 2018), and others have analyzed the role of individual and contextual determinants of well-being across European regions (Aslam and Corrado, 2012), the connection between sustainability and well-being remains relatively underexplored. This paper addresses this gap by proposing a novel framework to analyze well-being in the context of sustainability, moving beyond purely economic indicators to account for the socio-environmental dimensions of development.

Although several studies have examined the effects of social and environmental conditions on individuals' quality of life, very few have integrated both dimensions within a single empirical analysis (Barbieri

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et al., 2016). This gap is particularly striking given the strong emphasis of the European policy agenda on promoting a dual transformation of regions that simultaneously addresses social and environmental challenges.

In this context, we adopt a multidimensional perspective on sustainability, focusing on its social and environmental dimensions, and investigate how this framework influences individual well-being. By explicitly considering the interaction between these two dimensions, we aim to provide a more holistic understanding of the complex and multifaceted nature of well-being. This integrated approach allows us to identify potential synergies that may be overlooked when each dimension is analyzed in isolation. Moreover, it helps bridge disciplinary boundaries and offers new insights for the design of sustainable regional development policies. In doing so, we respond to the call by Giannetti et al. (2015) to explore alternative measures of well-being that can support the advancement of sustainability.

Measuring well-being is inherently complex and largely depends on its theoretical definition. The concept has evolved substantially over time and has been approached from multiple disciplinary perspectives. While well-being was traditionally associated with the satisfaction of physiological, emotional, and economic needs, it is increasingly conceptualized in relation to health and understood through a more holistic lens. The first official definition of modern well-being was introduced by the World Health Organization (WHO) in 1948 and later revised by the Health Commission of the European Observatory on Health Systems and Policies. The updated definition describes well-being as an emotional, mental, physical, social, and spiritual state that enables individuals to realize and sustain their potential within society (Sedita and Orsi, 2014).

Numerous epidemiological and psychosocial studies have developed so-called "happiness indicators" to examine the relationship between income and individual happiness (Csikszentmihalyi, 2000; Easterlin, 2001). Other contributions have explored the geographical dimension of happiness (Bernini and Tampieri, 2019), while some have focused on subjective well-being as a means to understand how individuals perceive and evaluate their lives (Dolan et al., 2008).

In this study, we adopt the concept of subjective well-being within the broader context of sustainability and rely on a multidimensional sustainability framework. Accordingly, our research question is the following: *What is the relationship between the social and environmental dimensions of sustainability and regional well-being?*

To address this question, we conduct an empirical analysis of 255 European regions, examining the distinct effects of each dimension of sustainable development on regional well-being. Data are drawn from the OECD Regional Well-Being database, OECD RegPat, ARDECO, Eurostat, the EU Labour Force Survey, and the EU-NED (European National Election Dataset). The empirical strategy is based on a cross-sectional analysis, with the dependent variable represented by the Life Satisfaction Index (average 2006–2014), a subjective measure of well-being reflecting the extent to which individuals' lived experiences align with their long-term aspirations and expectations (Stone and Mackie, 2014).

The findings contribute theoretically to the literature on regional well-being and provide policy-relevant insights into how social and environmental sustainability can serve as key pathways for improving quality of life at both the individual and societal levels.

The remainder of the article is structured as follows. Section 2 presents the theoretical framework and develops the hypotheses. Section 3 describes the research design, the variables, and the methodology, and discusses the results. Section 4 concludes by highlighting the main theoretical contributions and policy implications.

2. Theoretical background and hypotheses

2.1. The relationship between the social dimension of regional development and well-being

The social dimension of regional development can be captured by examining levels of public safety and social capital within a region. This perspective is consistent with the 2030 Agenda for Sustainable Development, and in particular with Sustainable Development Goal 11 (SDG 11), which aims to make cities and human settlements inclusive, safe, resilient, and sustainable. Public safety and social capital represent key enablers of SDG 11 and play a central role in enhancing citizens' well-being.

Public safety directly affects individuals' quality of life, mental and physical health, economic opportunities, and the overall stability of society (Sloane and Choi, 2016). A secure environment allows individuals to live without fear, pursue economic and social opportunities, foster social relationships, and realize their full potential (Kuroki, 2012). This aspect is particularly relevant for families with children (Uyan-Semerci et al., 2017). Investments in public safety, including crime prevention, urban planning, and community policing, contribute to well-being by creating environments in which citizens feel protected and free to participate in economic, social, and recreational activities.

Social capital, by contrast, is a collective asset generated through social relationships, shared norms, and trust, which facilitate cooperation and collective action for mutual benefit (Bourdieu, 1986; Coleman, 1988, 1990) and foster civic engagement (Putnam, 1993). Institutions also play a critical role in shaping social capital by influencing the broader social and political environment in which interactions take place (North, 1990; Olson, 1982).

The literature provides multiple definitions of social capital. Coleman (1988), for example, emphasizes its relational nature, highlighting the importance of social ties, group memberships, networks, and community norms. Within this relational perspective, trust, honesty, volunteerism, sociability, and civic involvement emerge as key manifestations of social capital. Sorenson et al. (2009) focus on family social capital, defined as the positive network of relationships among relatives that can influence the performance of family businesses. Building on this body of research, it is possible to distinguish between community-level and individual-level social capital (Frey and Stutzer, 2002). Community-level social capital is typically measured using indicators such as generalized trust, participation in associations, volunteering, and other forms of civic engagement. Individual-level social capital, by contrast, is commonly assessed through the strength and frequency of personal relationships with friends, relatives, and colleagues (Olsen and Dahl, 2007).

Two main strands of research have examined the relationship between social capital and well-being (Helliwell, 2001; Bjørnskov, 2008; Puntscher et al., 2015). The first focuses on objective well-being, primarily related to health outcomes, while the second addresses subjective well-being, with particular attention to life satisfaction. Studies belonging to the first strand consistently report a positive association between social capital and well-being (Folland and Rocco, 2014), especially when considering the psychosocial dimensions of health (Folland and Iversen, 2014). Research within the second strand emphasizes that informal social interactions and interpersonal trust, as key dimensions of sociability, are among the main drivers of happiness and life satisfaction (O'Riordan, 2013; Rodríguez-Pose and Von Berlepsch, 2014; Bartolini and Bilancini, 2010).

Building on this literature, we propose our first hypothesis.

Hypothesis 1. *Social capital and public safety, as two key social dimensions of regional development, positively affect regional subjective well-being.*

2.2. The relationship between the environmental dimension of regional development and well-being

In recent years, a growing body of literature has examined various aspects of environmental issues, partly in response to the increasing attention of policymakers to the European Green Deal (Van den Bergh et al., 2011; Markard et al., 2012; Liu et al., 2020). Despite this expanding interest, relatively limited attention has been devoted to the relationship between environmental factors and well-being (Dolan et al., 2008). Some scholars argue that environmental quality plays a relatively minor role in shaping well-being compared to other determinants, such as regional disparities, gross domestic product (GDP), or levels of human development (Bonini, 2008).

By contrast, more recent empirical evidence indicates that higher levels of pollution are associated with lower levels of subjective well-being (Cheng et al., 2022). Other studies offer a more nuanced perspective, showing that individuals' pro-environmental behavior can generate both positive and negative effects on life satisfaction. On the one hand, environmentally responsible behavior may enhance life satisfaction, as it is often perceived as morally commendable. On the other hand, it can require substantial personal effort, such as changes in consumption habits, which may negatively affect quality of life (Venhoeven et al., 2013).

Environmental innovation (EI) is commonly defined as "new or modified processes, techniques, systems, and products to avoid or reduce environmental damage" (Kemp and Arundel, 1998, p. 1). Interest in EI has grown steadily over time, driven by the idea that strengthening a region's capacity for environmental innovation can improve environmental quality while simultaneously fostering sustainable economic growth (Horbach, 2008; Cainelli et al., 2012; Antonioli et al., 2013; Cainelli and Mazzantini, 2013; Costantini et al., 2013; Horbach and Rennings, 2013; Marin and Mazzanti, 2013; Antonioli et al., 2016; Horbach, 2018; Bassetti et al., 2021; Castellacci, 2021).

Empirical research has mainly assessed environmental innovation by measuring regions' capacity to develop green technologies, most commonly through patent-based indicators (Ghisetti and Quatraro, 2017; D'Agostino and Moreno, 2019; Quatraro and Scandura, 2019; Montresor and Quatraro, 2020; Biggi et al., 2022; Capone et al., 2024).

However, the broader societal benefits of environmental innovation are often overlooked in the literature (Barbieri et al., 2016), despite sustained policy attention to this issue. For example, the United Nations Environment Programme (UNEP, 2011) highlights that the green economy can enhance human well-being and social equity while substantially reducing environmental risks and ecological scarcities. Nevertheless, examining the relationship between environmental innovation and well-being remains a complex task. Aldieri et al. (2019) point out that the relationship between happiness, innovation, and environmental factors lacks a clear causal direction, underscoring the need for further empirical investigation.

In our analysis, we argue that environmental innovation capacity extends beyond research laboratories in universities and specialized firms to reach broader society, particularly through public engagement initiatives such as seminars, training activities, and outreach events. The diffusion of environmental awareness associated with these processes contributes to the creation of a "green atmosphere", which may positively influence citizens' perceptions of quality of life. Moreover, given that the locus of invention is often closely connected to the locus of need for specific technologies, it is reasonable to expect that early applications of new green technologies are more likely to emerge at the local level (Quatraro et al., 2024).

Finally, green technologies play a central role in achieving a long-term sustainable transition. From a long-term perspective, empirical evidence suggests that sustained improvements in well-being must be aligned with environmental preservation (Bonini, 2008).

Building on these arguments, we propose our second hypothesis.

Hypothesis 2. *Environmental innovation capacity, as a key environmental dimension of regional development, positively affects regional subjective well-being.*

3. Research design

3.1. Data and method

This study aims to assess the extent to which social and environmental development indicators influence individuals' life satisfaction across European regions. To this end, the analysis adopts a regional perspective, identifying regions according to the Nomenclature of Territorial Units for Statistics (NUTS-2) classification defined by the European Commission.

The empirical analysis relies on data collected from multiple sources:

a) OECD Regional Well-Being, which builds on the Better Life Initiative and provides a set of well-being indicators normalized using a min–max procedure and scaled from 0 to 10 to ensure comparability across indicators;
b) OECD RegPat, which offers data on patents registered with the European Patent Office, including technological classifications and inventors' addresses, thus allowing the identification of green patents at the regional level;
c) ARDECO (Annual Regional Database of the European Commission's Directorate-General for Regional and Urban Policy);
d) Eurostat, which provides harmonized European statistics in collaboration with national statistical institutes and other national authorities in European Union Member States;
e) EU Labour Force Survey and EU-NED (European National Election Dataset).

Due to data availability constraints, we conduct a cross-sectional analysis based on a final dataset comprising 255 regions across 22 European countries. The sample excludes Bulgaria, Cyprus, Croatia, Lithuania, Latvia, Malta, and Romania, while Norway is included. Overall, the data cover the period from 2000 to 2018.

3.2. Variables

3.2.1. Dependent variable

In this study, we adopt a subjective perspective on well-being, based on individuals' self-assessments. Specifically, we use the Life Satisfaction Index provided by the OECD Regional Well-Being database, which is part of the OECD Better Life Initiative. This index is derived from survey data collected through the Gallup World Poll and measures overall life satisfaction on a scale ranging from 0 to 10. It captures the extent to which individuals perceive their lives as aligned with their long-term goals and expectations (Stone and Mackie, 2014).

Respondents are asked to imagine a ladder with steps numbered from 0 at the bottom to 10 at the top, where the top represents "the best possible life for you" and the bottom represents "the worst possible life for you". To obtain a regionally comparable indicator, we compute the average life satisfaction score for each region by aggregating individual-level responses.

From the OECD Regional Well-Being platform,[1] we retrieve two versions of the life satisfaction data. The first version (*Life.Satisf_v1*), labelled as 2014, includes responses collected between 2006 and 2014, depending on the region. The second version (*Life.Satisf_v2*) refers to data for 2018, as reported in the most recent release of the regional database (November 2022).

The first version presents several limitations. Most importantly, it reflects a fragmented data collection period that includes years affected

[1] Data available here: https://www.oecdregionalwellbeing.org/.

by the Great Financial Crisis (2007–2009). As a result, regional scores may vary depending on the specific year of data collection, potentially introducing bias, particularly if observations were collected during or immediately after the crisis rather than in later years (e.g. 2013–2014), when economic recovery was underway. Moreover, differences in regional resilience may have influenced the extent to which the crisis affected perceived well-being.

To address these issues, we include *Life.Satisf_v2* in the analysis as a robustness check and compute the mean of the two measures (*Life.Satisf_mean*) to partially correct for potential time-related distortions.

Fig. 1 illustrates the distribution of the average life satisfaction index across European regions.

3.2.2. Exploratory variables

3.2.2.1. The social dimension of regional development. To examine the social dimension of regional development, we adopt two measures: *Social.Capital* and *Public.Safety*.

Social.Capital refers to the networks, shared values, and trust that connect individuals and communities, facilitating coordinated actions, collaboration, and civic participation toward shared goals. In this study, Social.Capital is proxied using two indicators: social network support (*Social Capital – f1*) and voter turnout (*Social Capital – f2*).

Social network support reflects an individual-level dimension of social capital and captures the network of informal relationships that individuals are able to develop and maintain over time (Sorenson et al., 2009; Olsen and Dahl, 2007). It is measured as the percentage of people who report having friends or relatives they can rely on in times of need, based on data collected between 2000 and 2013.

Voter turnout, by contrast, serves as a proxy for civic engagement and citizens' sense of civic responsibility (Putnam, 1993; Kwon et al., 2013; Olsen and Dahl, 2007). It is measured as the average percentage of voters in a region over the period 1990–2005.

Data on social network support are sourced from the OECD Regional Well-Being database, while voter turnout data are drawn from EU-NED, the European NUTS-Level Election Dataset, available through the Harvard Dataverse platform (Schraff et al., 2022). Prior to averaging, both indicators are normalized using a min–max procedure and scaled to a 0–10 range to ensure comparability.

Public.Safety refers to protection from violence, crime, and discrimination, ensuring a secure and stable living environment. In this study, it is proxied using two reverse-coded indicators: homicide (*Public Safety – f1*) and robbery rates (*Public Safety – f2*).

Operationally, public safety is computed as the average of the inverse values of: (a) the regional homicide rate, measured as the number of homicides per 100,000 inhabitants over the period 2000–2013, and (b) the regional robbery rate, measured as the number of robberies per 100,000 inhabitants over the period 1990–2005. The first indicator is sourced from the OECD Regional Well-Being database, while the second is drawn from the ARDECO database. Prior to aggregation, both indicators are normalized using a min–max procedure and scaled to a 0–10 range to ensure comparability.

3.2.2.2. The environmental dimension of regional development. The environmental dimension of regional development is measured through the rate of green inventions, referred to as *Env.Inn*. Although the use of invention data as a proxy for innovation presents some limitations, since patents typically reflect innovation capacity rather than innovation adoption, the propensity of regional firms and individuals to generate green inventions provides a robust indicator of a region's commitment to the green transition.

This patent-based measure captures the regional tendency to produce technological knowledge related to green and clean technologies. It is calculated as the fractionalized number of environment-related patents filed in a given region divided by the total number of patents originating from the same region. Patent data are drawn from the OECD RegPat database, and green patents are identified using Cooperative Patent Classification (CPC) codes related to climate change (see Appendix A).

Patents are assigned to regions using a fractional counting method based on inventors' addresses. The final indicator is computed as the mean value over the period 2000–2005.

3.2.2.3. Control variables. *Pop.Density* (population density) serves as a proxy for the positive externalities associated with urbanization processes. Despite potential drawbacks, such as higher living costs and pollution, urbanization is generally associated with greater availability of services (e.g. schools, healthcare, restaurants), social and cultural activities, and employment opportunities, all of which can positively affect life satisfaction. Population density is computed as the logarithmic transformation of the number of inhabitants per square kilometer. Population data are drawn from Eurostat for the period 2000–2005.

GDP.capita (gross domestic product per capita) proxies the economic wealth of regions. GDP represents the sum of gross value added by institutional sectors or industries, plus taxes and minus subsidies on products that are not allocated to specific sectors or industries. A

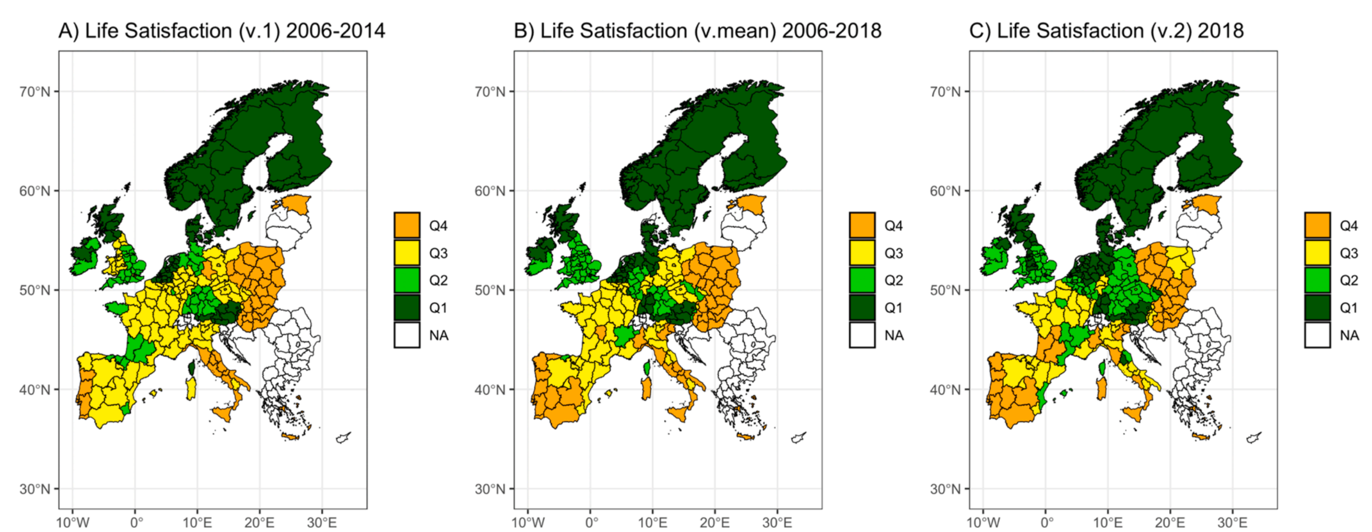

Fig. 1. Quartile distribution of different versions of Life Satisfaction.
Note: Predicted life satisfaction values are based on full model (5) in Table 3.

substantial body of research, starting with Easterlin (1974), has examined the relationship between GDP and subjective well-being (see also Easterlin and O'Connor, 2022). GDP data are obtained from the ARDECO database. GDP per capita is operationalized as the average value over the period 2000–2005, calculated by dividing regional GDP by regional population. A logarithmic transformation is applied prior to its inclusion in the empirical models.

Tech.Capacity (technological capacity) is considered a key driver of regional development and plays a dual role in our analytical framework. First, technological advancement enhances productivity and efficiency, contributing to higher wages and economic growth. Innovations such as automation and digitalization reduce costs and improve access to goods and services, while advances in medical technology, mobility, and communication strengthen economic resilience and overall well-being. Second, regional technological capacity is measured using the logarithmic transformation of the number of patents per capita, as reported in the OECD RegPat database for the period 2000–2005. This measure allows us to isolate the general effect of technological innovation from the green innovation component, which is introduced separately in the model.

Employ.Rate (employment rate) is included given its expected strong correlation with both economic growth and individual well-being. A high employment rate implies that a larger share of individuals earns an income and can meet basic needs without financial stress, which is likely to enhance life satisfaction. Employment data are drawn from the Eurostat database and refer to the ratio of employed individuals to the working-age population over the period 2000–2005. The variable is normalized using a min–max procedure and scaled to a 0–10 range.

Hours.Worked (average hours worked per employee) is included to capture the time-constraint dimension of well-being. Longer working hours may reduce leisure time and work–life balance, potentially leading to lower perceived life satisfaction. This variable includes regular hours worked by full-time, part-time, and part-year employees, as well as paid and unpaid overtime and hours worked in secondary jobs. Data are sourced from the ARDECO database and operationalized as total annual hours worked (in millions) divided by the total number of regional employees (in thousands) over the period 2000–2005. A logarithmic transformation is applied to reduce skewness.

Manuf.Spec (manufacturing specialization) is derived from Eurostat and controls for regional industrial structure. The underlying rationale is that service-oriented regions may exhibit higher levels of well-being compared to manufacturing-based regions. The variable is operationalized as the percentage of regional employees working in the manufacturing sector relative to total employment, averaged over the period 2000–2005.

High.Edu (education) is measured using data from the EU Labour Force Survey available through the Eurostat platform. It is defined as the percentage of the population aged 25–64 that has completed tertiary education and is operationalized as the average value over the period 2000–2005. The relationship between education and well-being is potentially ambiguous. On the one hand, higher education improves access to better job opportunities and higher income, thereby enhancing well-being. On the other hand, it may increase aspirations and expectations that, if unmet, could lead to dissatisfaction and lower life satisfaction.

Cooling.Days (cooling degree days) is a weather-based technical indicator capturing the need for air conditioning in a given region. It reflects higher temperatures and sun exposure, which are often associated with outdoor activities, tourism, and a more relaxed lifestyle. The indicator is sourced from Eurostat and is operationalized for the period 2000–2005 using a logarithmic transformation.

Air.Quality (air quality) captures environmental conditions that have been shown to affect both physical and mental health, and thus individual well-being. It is measured as the average concentration of PM2.5 experienced by the population in each region over the period 2003–2013. Data are drawn from the OECD Regional Well-Being database. The variable is normalized using a min–max procedure and scaled to a 0–10 range.

Finally, to control for unobserved structural, cultural, institutional, and economic heterogeneity across countries, we include country-level fixed effects through the use of country dummy variables.

3.3. Model specification

Life satisfaction is measured as a continuous variable defined on a bounded scale ranging from 0 to 10, and therefore cannot take values outside this interval. Standard linear regression models, such as Ordinary Least Squares (OLS), assume that the dependent variable is unbounded and normally distributed. Applying OLS to bounded data may lead to biased coefficient estimates and incorrect standard errors.

To overcome these limitations, we employ a Power Logit Regression (PLR), a flexible modeling approach specifically designed for continuous outcomes defined on a bounded support (Queiroz and Ferrari, 2023). This method allows for a more robust empirical analysis, as it is less sensitive to outliers and skewed distributions than traditional OLS and provides stable estimates of central tendency that are not unduly influenced by extreme values.

The full model is specified as follows:

$$y_r = \alpha_0 + \beta_1 social.dimension_r + \beta_2 Env.dimension_r + \delta Controls_r + \varepsilon \tag{1}$$

where represents average life satisfaction aggregated at the regional level (r), and a power logit transformation is applied through the following function:

$$Y(y, \mu, \sigma, \lambda) = \frac{1}{\sigma y(1 - y^{\lambda})} r(z^2);\ y \in (0, 1) \tag{2}$$

$$\text{with } z = \frac{1}{\sigma}\left[log\left(\frac{y^{\lambda}}{1 - y^{\lambda}}\right) - log\left(\frac{\mu^{\lambda}}{1 - \mu^{\lambda}}\right)\right] \tag{3}$$

which centers the distribution around the median (μ), while accounting for the dispersion parameter (σ) and the power parameter (λ). The power parameter (λ) governs the skewness of the distribution, allowing the transformation to flexibly adapt to different distributional shapes. Specifically, values of $\lambda > 1$ stretch the transformation to better capture the tails of the distribution, whereas values of $\lambda < 1$ compress it around the central values.

In our PLR model, we adopt the slash distribution family, a robust alternative to the normal distribution that offers greater flexibility when the dependent variable exhibits heavy tails or potential outliers. In addition, we introduce an extra *zeta* parameter (ζ) to modify the inverse link function and enhance the model's ability to fit bounded responses near the upper and lower limits of the scale. Higher values of ζ increase the flexibility of the transformation, allowing for a better fit when predicted values are clustered near the boundaries.

To ensure the robustness of our analysis, we address potential issues related to endogeneity, multicollinearity, and heteroskedasticity. First, to mitigate endogeneity concerns, we account for potential simultaneity bias by lagging both explanatory and control variables. When this was not feasible, because some variables, such as social network support and homicide rates, were drawn from the same data sources as life satisfaction and referred to partially overlapping time periods, we constructed composite indicators for social capital and public safety, as described above. These composite measures were obtained by averaging each variable with a second indicator, namely voter turnout and robbery rates, respectively, which were sourced independently and measured in an earlier period relative to life satisfaction (see Table 1). Nevertheless, we do not explicitly control for reverse causality in this analysis.

Second, we assess potential multicollinearity by computing the Variance Inflation Factor (VIF) for both exploratory and control variables. All VIF values are below the more conservative threshold commonly adopted in the literature (O'Brien, 2007), indicating that

Table 1
Descriptive statistics.

Variables	*Source*	*Description*	*mean*	*sd*	*min*	*max*	*obs*
Life.Satisf_v1	OECD Well-Being	First data version (2006-2014)	5.58	2.44	0.07	9.99	255
Life.Satisf_mean	OECD Well-Being	Average data version (2006-2018)	6.20	2.16	0.38	9.81	255
Life.Satisf_v2	OECD Well-Being	Second data version (2018)	6.81	2.06	0.76	10.00	255
Social Capital – f1	OECD Well-Being	Social network support (2000-2013). Normalized and scaled	7.97	1.70	0.00	9.99	255
Social Capital – f2	European NUTS-Level Election	Voter Turnout (1990-2005). Normalized and scaled	5.54	2.54	0.00	9.99	255
Public Safety – f1	OECD Well-Being	Number of homicides per capita (2000-2013). Normalized and scaled.	8.71	1.59	0.03	9.99	255
Public Safety – f2	Eurostat	Number of robberies per capita (2000-2005). Normalized and scaled	9.46	1.42	0.00	10.00	255
Env.Inn	OECD RegPat	Share (2000-2005)	4.72	4.57	0.00	39.77	255
Pop.Density	Eurostat	Log (2000-2005)	4.99	1.23	1.94	9.16	255
GDP.capita	ARDECO database	Log (2000-2005)	9.90	0.60	8.26	11.80	255
Tech.Capacity	OECD RegPat	Log (2000-2005)	4.99	1.23	1.94	9.16	255
Employ.Rate	Eurostat	Log (2000-2005)	6.20	2.62	0.00	9.78	255
Hours.Worked	ARDECO	Log (2000-2005)	6.87	0.86	3.34	9.10	255
Manuf.Spec	ARDECO	Share (2000-2005)	18.50	6.82	5.22	35.18	255
High.Edu	EU Labour Force Survey	Share (2000-2005)	20.74	8.06	4.30	46.10	255
Cooling.Days	Eurostat	Log (2000-2005)	2.87	1.77	0.00	6.34	255
Air.Quality	OECD Well-Being	Average level of PM2.5 (2003-2013). Normalized and scaled	4.79	2.13	0.00	9.83	255

multicollinearity is not a major concern. Third, to account for potential heteroskedasticity in the error terms and to obtain more reliable estimates, we employ robust standard errors, also referred to as heteroskedasticity-consistent standard errors.

4. Analysis and results

Table 1 reports the descriptive statistics for all variables included in the analysis. For each variable, the table provides information on the data source, the reference time period, and whether the values have been normalized, scaled, or log-transformed. It also reports the minimum and maximum values, as well as the mean and standard deviation.

Table 2 reports the pairwise correlation coefficients among the variables. All exploratory variables display a significant positive correlation with the dependent variable. By contrast, correlations between exploratory and control variables are generally low, with only a few cases approaching a value of 0.50.

To further assess potential multicollinearity, we compute the Variance Inflation Factor (VIF) for each OLS specification and report the maximum, median, and dispersion values in parentheses. All maximum VIF values remain below the commonly accepted threshold of 10, indicating that multicollinearity is not a serious concern.

Table 3 presents the results of the models based on the first version of the life satisfaction variable (*Life.Satisf_v1*), which relies on data collected between 2006 and 2014, depending on the region. This table provides the basis for the discussion of the empirical evidence related to the validation of the research hypotheses.

Exploratory variables are introduced sequentially to assess the stability of coefficient signs and to evaluate the incremental improvement in model performance. Across Tables 3 to 5, we report: (1) a baseline model including only control variables; (2) a summary model for each research hypothesis, incorporating the relevant exploratory variables; (3) a full model including all control and exploratory variables; and (4) an interaction model.

Models (2) and (3), which focus on the social dimension, show that life satisfaction is explained only when social capital and public safety are considered separately. In particular, Models (3) and (5) highlight a positive and statistically significant effect of social capital, while suggesting that public safety has a statistically insignificant effect. These results indicate that the components of the social dimension may exert heterogeneous effects on life satisfaction, providing partial support for Hypothesis 1.

Model (4) examines the role of environmental innovation (*Env.Inn*) in enhancing regional well-being. The results show that regions with a stronger propensity to invest in green technologies are more likely to develop a livable and sustainable environment, thereby increasing residents' life satisfaction. The positive and statistically significant coefficient provides support for Hypothesis 2.

The full model (Model 5) confirms the individual effects observed in the previous models. The interaction model (Model 6) reveals a mild synergistic effect between the social and environmental dimensions, captured by the interaction term (*Soc.Capital* × *Env.Inn*).

To interpret the magnitude of the social and environmental effects, it is important to note that coefficients derived from the PLR model cannot be interpreted as marginal effects in the same way as in OLS or standard logit models. For this reason, we do not compute the exact change in the dependent variable associated with a one-unit variation in the explanatory variables. Instead, we illustrate effect magnitudes using marginal

Table 2
Correlation matrix.

	Variables	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	Life.Satisf_v1	1														
2	Life.Satisf_mean	0.97	1													
3	Life.Satisf_v2	0.84	0.95	1												
4	Social.Capital	0.75	0.71	0.61	1											
5	Public.Safety	0.25	0.26	0.25	0.32	1										
6	Env.Inn	0.1	0.09	0.06	0.05	-0.17	1									
7	Pop.Density	0.03	0.06	0.09	0.06	-0.09	-0.13	1								
8	GDP.Capita	0.69	0.69	0.62	0.7	0.16	-0.11	0.22	1							
9	Tech.Capacity	0.45	0.48	0.47	0.42	0.21	-0.1	0.28	0.5	1						
10	Employ.Rate	0.59	0.67	0.72	0.42	0.24	-0.06	0.16	0.43	0.5	1					
11	Hours.Worked	-0.13	-0.12	-0.08	0.03	0.13	-0.07	0.48	-0	0.21	0.03	1				
12	Manuf.Spec	-0.09	-0.04	0.02	-0.05	0.34	-0.06	-0.02	-0.3	0.21	0.25	0.2	1			
13	High.Edu	0.24	0.29	0.33	0.11	0.04	0.1	0.11	-0.1	0.23	0.58	0.14	0.3	1		
14	Cooling.Days	-0.6	-0.64	-0.64	-0.31	0.01	0.01	0.03	-0.3	-0.18	-0.66	0.14	0.01	-0.48	1	
15	Air.Quality	0.26	0.25	0.22	0.2	-0.05	0.06	-0.36	0.33	-0.11	0.01	-0.18	-0.34	-0.28	-0.32	1

Table 3
PLR Modelling of life satisfaction (based on the first data version).

	Dependent variable: Life.Satisf_v1 – average value at regional level (using the first data version, from 2006 to 2014) – scaled between 0 and 1.					
	(1)	(2)	(3)	(4)	(5)	(6)
Constant	1.311***	1.219***	1.342***	1.274***	1.199***	1.187***
	(0.133)	(0.124)	(0.127)	(0.130)	(0.122)	(0.119)
Social.Capital		0.418***			0.414***	0.412***
		(0.075)			(0.072)	(0.071)
Public.Safety			-0.051		-0.019	
			(0.048)		(0.030)	
Env.Inn				0.124***	0.107***	0.098***
				(0.027)	(0.028)	(0.026)
Soc.Capital × Env.Inn						0.040†
						(0.022)
Pop.Density	-0.055	-0.029	-0.062	-0.027	-0.006	-0.002
	(0.043)	(0.041)	(0.041)	(0.043)	(0.040)	(0.039)
GDP.Capita	0.222*	0.224**	0.235**	0.206*	0.210*	0.192*
	(0.092)	(0.085)	(0.089)	(0.089)	(0.083)	(0.082)
Tech. Capacity	0.024	0.034	0.016	0.029	0.035	0.036
	(0.036)	(0.033)	(0.034)	(0.035)	(0.032)	(0.031)
Employ.Rate	0.351***	0.227**	0.369***	0.377***	0.256**	0.257**
	(0.085)	(0.082)	(0.081)	(0.083)	(0.079)	(0.078)
Hours.Worked	-0.002	-0.044	-0.007	-0.004	-0.035	-0.030
	(0.035)	(0.033)	(0.034)	(0.033)	(0.032)	(0.032)
Manuf.Spec	-0.024	-0.025	-0.014	-0.009	-0.008	-0.011
	(0.036)	(0.034)	(0.035)	(0.036)	(0.034)	(0.033)
High.Edu	-0.244*	-0.297***	-0.259**	-0.231*	-0.285***	-0.284***
	(0.095)	(0.088)	(0.090)	(0.093)	(0.085)	(0.085)
Cooling.Days	-0.069	-0.093	-0.089	-0.094	-0.123†	-0.136*
	(0.075)	(0.069)	(0.071)	(0.072)	(0.067)	(0.066)
Air.Quality	0.073	0.071	0.0566	0.069	0.066	0.057
	(0.055)	(0.051)	(0.052)	(0.053)	(0.049)	(0.049)
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	258	258	258	258	258	258
Lambda λ	$2.921e^{-08}$	$4.146e^{-08}$	$5.646e^{-08}$	$1.701e^{-08}$	$7.571e^{-08}$	$5.751e^{-08}$
Log-likelihood	331.9	346.6	341.9	340.1	355.4	356.4
AIC	-597.7	-625.2	-615.9	-612.2	-638.8	-640.7
Pseudo R^2	0.731	0.732	0.719	0.736	0.736	0.733
Upsilon Stat.	0.175	0.189	0.146	0.149	0.179	0.186
VIF median (dispersion)	1.218 (1.83)	1.253 (2.51)	1.238 (1.76)	1.229 (1.14)	1.275 (2.50)	1.263 (2.45)

Notes:
† $p<0.1$;
* $p<0.05$;
** $p<0.01$;
*** $p<0.001$. Power Logit regression is implemented by using PLreg package in R software and setting power logit slash family, shape parameter zeta (ζ=4) and maximum likelihood estimation method.

According Queiroz and Ferrari (2024), coefficients are interpreted with respect to the conditional median of the dependent variable. Exploratory and control variables are mean-centered. Robust Standard Errors are in parentheses.

effect plots.

Fig. 2 depicts the predicted conditional median of life satisfaction as a function of the observed values of the social dimension, measured by *Social.Capital*, and the environmental dimension, measured by *Env.Inn*, while holding all other variables at their mean values. The figure shows that: (a) a 10-percentage-point increase in *Social.Capital* (equivalent to a one-point increase on a 0–10 scale) is associated with an approximate one-point increase in the predicted median life satisfaction, ceteris paribus; and (b) a 10-percentage-point increase in *Env.Inn* leads to an increase of about 0.7 points in the predicted median life satisfaction on the same 0–10 scale.

To assess the consistency of the model specification, we first examine the Akaike Information Criterion (AIC). The AIC decreases with the inclusion of the exploratory variables relative to the baseline model, which includes only control variables. This result indicates that the full model (Model 5) provides the best overall fit. Among the partial specifications, Model 2, which includes social capital, exhibits greater consistency than Model 4, which includes only the environmental dimension. Moreover, the interaction specification in Model 6 appears to yield only a limited improvement in model fit.

Second, we report the Upsilon statistic for each model as a diagnostic measure of distributional adequacy. Upsilon captures the divergence between the empirical distribution of the response variable and the theoretical distribution implied by the model. Following Queiroz and Ferrari (2023), lower values of Upsilon, approaching zero, indicate a better alignment between the model assumptions, including the link function and the distributional family, and the observed data. Based on this criterion, we adopt the slash distribution family with the zeta parameter (ζ) set to 4, as this specification minimizes the Upsilon statistic across the different model configurations.

Finally, the power parameter lambda (λ) acts as a flexibility parameter within the link function, enabling the model to accommodate the asymmetries and nonlinearities that characterize bounded outcomes. Values of λ between 0 and 1 indicate that the transformation compresses central values while assigning greater weight to deviations in the distributional tails. In our case, λ is very close to zero, implying that the transformation closely approximates a log–log function. This suggests that the strength of the predictors' effects increases asymmetrically at higher levels of life satisfaction, allowing the model to more accurately capture the skewed and nonlinear nature of subjective well-being data, which would not be adequately modeled using a standard logit specification.

Table 4 presents the results of the models based on the mean of the two life satisfaction measures (*Life.Satisf_mean*) for the period

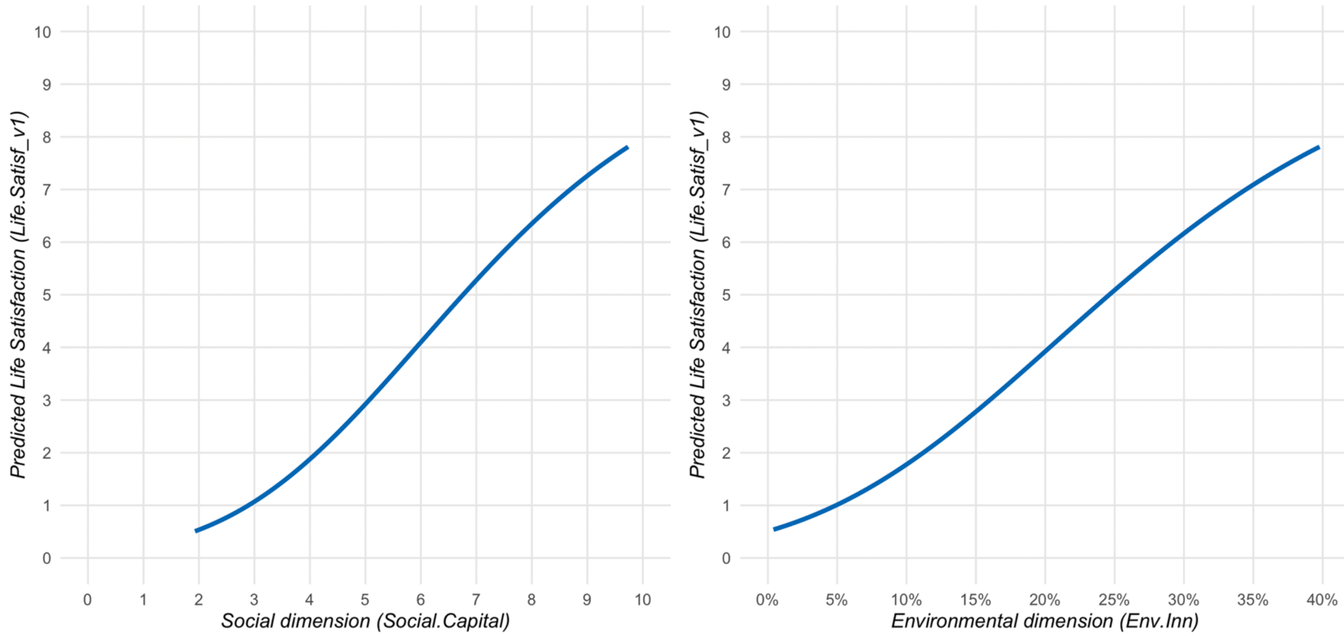

Fig. 2. Magnitude of prediction effect on life satisfaction.

2006–2018. The findings are consistent with those reported in Table 3 and, in particular, confirm the stronger and positive effect of social capital relative to public safety, as well as the significant role of EI capacity. While the results reinforce the greater impact of social capital compared to the environmental dimension, they also highlight an amplified effect of the interaction between the two.

In terms of model consistency and explanatory performance, the AIC identifies the interaction model (Model 6) as the most robust specification. Moreover, the Upsilon statistics for this model are even lower, that is, closer to zero, than those reported in Table 3, indicating an improved distributional fit. Notably, the estimated lambda (λ) parameter is substantially higher than in the previous specifications, while remaining within the 0 to 1 range, thus preserving the flexibility of the transformation function.

Finally, Table 5 presents the model estimates based on the second version of the life satisfaction measure (*Life.Satisf_v2*) for the year 2018. The results confirm only the positive and statistically significant role of EI. By contrast, social capital and public safety no longer exhibit a statistically significant association with life satisfaction. Similarly, higher education no longer shows a negative relationship with life satisfaction, diverging from the patterns observed in the earlier specifications.

Compared to the previous models, these findings suggest that EI capacity is the only factor that continues to exert a consistent and meaningful influence on life satisfaction. Nevertheless, a modest positive interaction between social capital and environmental innovation persists, indicating a potential indirect contribution of the social dimension mediated through environmental factors.

The AIC identifies the model including only the environmental dimension as the most consistent and best-fitting specification. At the same time, the lambda (λ) and Upsilon statistics remain in line with those reported in earlier models, indicating stable model adequacy and consistent transformation behavior across specifications.

Overall, the results suggest that social capital plays an important role in shaping life satisfaction, while public safety does not appear to exert a significant effect. However, the relevance of the social dimension declines over time, as the most recent data indicate that neither social capital nor public safety significantly affects life satisfaction. By contrast, the environmental dimension remains consistently significant, suggesting that a region's capacity to invest in and promote green technologies is associated with higher levels of life satisfaction.

5. Conclusions

5.1. Theoretical contribution

The novelty of our contribution is twofold.

First, our findings provide robust evidence of the relevance of the social dimension of regional development for residents' well-being. In particular, social capital, measured through indicators of social network support and civic engagement, emerges as a more consistent predictor of subjective well-being than public safety. This result supports previous research emphasizing the importance of sociability and interpersonal trust in shaping individuals' life satisfaction (Bartolini and Bilancini, 2010; Rodríguez-Pose and von Berlepsch, 2014). Compared to other dimensions, social capital appears to play a more prominent role in shaping individuals' perceptions of "feeling good."

While the existing literature has often examined social capital in isolation, our approach explicitly integrates it with environmental factors. For example, Burlina and Rodríguez-Pose (2023) highlight the negative impact of social isolation on economic performance but do not explore its implications for well-being. Similarly, Portela et al. (2013) analyze the effects of social capital on subjective well-being without jointly considering environmental aspects. Our study contributes to bridging this gap by examining the combined role of social and environmental dimensions in explaining regional life satisfaction across Europe.

Second, our analysis highlights the enduring importance of the environmental dimension. Specifically, we focus on regional capacity for environmental innovation (EI) and its relationship with life satisfaction. The results consistently show that regions investing in green technologies tend to report higher levels of well-being among residents. This finding is consistent with the literature emphasizing the long-term benefits of eco-efficient development for subjective well-being (Bonini, 2008; Aldieri et al., 2019).

Importantly, our analysis also shows that not all forms of innovation contribute equally to well-being. Only innovation oriented toward environmental sustainability, rather than general technological advancement, exhibits a positive and persistent association with life satisfaction. This supports recent arguments that the content of innovation, rather than its sheer intensity, is crucial for sustainable development (Sedita, 2024). Emerging research on the "dark side" of

Table 4
PLR Modelling of life satisfaction (based on the mean of data versions).

	Dependent variable: Life.Satisf_mean – average value at regional level (using the mean of data versions, from 2006 to 2018) – scaled between 0 and 1.					
	(1)	(2)	(3)	(4)	(5)	(6)
Constant	1.504***	1.474***	1.521***	1.478***	1.145***	1.448***
	(0.105)	(0.103)	(0.107)	(0.104)	(0.103)	(0.100)
Social.Capital		0.208**			0.202***	0.209***
		(0.058)			(0.058)	(0.057)
Public.Safety			-0.031		-0.010	
			(0.035)		(0.032)	
Env.Inn				0.095***	0.085***	0.078***
				(0.022)	(0.023)	(0.021)
Social.Cap × Env.Inn						0.045*
						(0.021)
Pop.Density	-0.044	-0.032	-0.050	-0.030	-0.022	-0.016
	(0.037)	(0.036)	(0.038)	(0.037)	(0.036)	(0.035)
GDP.Capita	0.151*	0.147*	0.164*	0.150*	0.148*	0.132†
	(0.072)	(0.069)	(0.073)	(0.071)	(0.069)	(0.068)
Tech. Capacity	0.024	0.029	0.021	0.027	0.030	0.032
	(0.028)	(0.027)	(0.029)	(0.028)	(0.027)	(0.027)
Employ.Rate	0.237***	0.171**	0.241***	0.261***	0.193**	0.187**
	(0.064)	(0.064)	(0.064)	(0.064)	(0.064)	(0.063)
Hours.Worked	0.013	-0.008	-0.015	0.009	-0.004	0.004
	(0.033)	(0.032)	(0.032)	(0.032)	(0.031)	(0.030)
Manuf.Spec	-0.006	-0.007	-0.001	0.002	0.002	0.002
	(0.027)	(0.027)	(0.028)	(0.027)	(0.027)	(0.027)
High.Edu	-0.140*	-0.164*	-0.143*	-0.145*	-0.165*	-0.156*
	(0.072)	(0.070)	(0.072)	(0.071)	(0.069)	(0.068)
Cooling.Days	-0.104†	-0.111†	-0.106†	-0.111†	-0.123*	-0.143*
	(0.062)	(0.060)	(0.061)	(0.059)	(0.058)	(0.058)
Air.Quality	0.049	0.047	0.049	0.052	0.049	0.041
	(0.042)	(0.041)	(0.041)	(0.041)	(0.040)	(0.040)
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	258	258	258	258	258	258
Lambda λ	0.179	0.108	0.196	0.236	0.138	0.126
Log-likelihood	377.2	383.5	377.6	384.3	390.2	392.5
AIC	-688.5	-699	-687.2	-700.5	-708.4	-712.9
Pseudo R^2	0.912	0.914	0.913	0.918	0.919	0.920
Upsilon Stat.	0.084	0.098	0.080	0.071	0.080	0.081
VIF median (dispersion)	1.239 (1.97)	1.277 (2.74)	1.259 (1.68)	1.243 (1.13)	1.301 (2.76)	1.284 (2.73)

Notes:
† $p<0.1$;
* $p<0.05$;
** $p<0.01$;
*** $p<0.001$. Power Logit regression is implemented by using PLreg package in R software and setting power logit slash family, shape parameter zeta (ζ=4) and maximum likelihood estimation method.

According Queiroz and Ferrari (2024), coefficients are interpreted with respect to the conditional median of the dependent variable. Exploratory and control variables are mean-centered. Robust Standard Errors are in parentheses.

innovation further cautions against investments in technologies that may generate environmental damage or exacerbate social inequalities (Coad et al., 2021; Diemer et al., 2021; Biggi and Giuliani, 2021). Yet, empirical evidence on how social and environmental dimensions jointly shape well-being remains limited. Our findings offer new insights in this direction. Overall, our results contribute to a growing body of evidence suggesting that GDP alone does not fully capture societal well-being. By including GDP as a control variable in our models, we are able to isolate the role of social and environmental factors in explaining life satisfaction. Even after accounting for regional economic performance, the capacity to foster social capital and promote environmental innovation remains significantly associated with higher levels of well-being.

These findings align with broader critiques of GDP as a sole indicator of progress and support calls for alternative, multidimensional approaches to development (Kubiszewski et al., 2013; Costanza et al., 2016). In this perspective, our results also contribute to the ongoing debate on post-growth and degrowth strategies (Kallis, 2018). While we do not explicitly assess the desirability of economic contraction, our findings suggest that well-being can be enhanced through social and environmental development, regardless of whether GDP increases. This opens space for policy strategies that prioritize quality of life and sustainability over economic expansion as an end in itself.

5.2. Policy implications

From a policy perspective, local and regional governments should consider how to more effectively integrate social capital into planning and decision-making processes. This includes designing interventions aimed at improving the balance between work and leisure, strengthening social ties, and fostering civic participation, not merely to enhance productivity, but to improve life satisfaction in line with the evolving objectives of the European Union. Achieving these goals requires participatory governance and co-designed policies that reflect the values, preferences, and needs of local communities.

From a measurement perspective, several European national statistical offices have begun to complement traditional economic indicators with well-being measures alongside social and environmental metrics, in line with the Sustainable Development Goals of the UN 2030 Agenda (ISTAT, 2019). Our analysis supports and reinforces the value of this multidimensional approach, particularly at the sub-national level, where policy interventions can be more effectively targeted and adapted to local contexts.

Table 5
PLR Modelling of life satisfaction (based on the second data version).

	Dependent variable: Life.Satisf_v2 – average value at regional level (using the second data version, 2018) – scaled between 0 and 1.					
	(1)	(2)	(3)	(4)	(5)	(6)
Constant	1.856***	1.856***	1.864***	1.828***	1.829***	1.820***
	(0.132)	(0.132)	(0.132)	(0.134)	(0.135)	(0.133)
Social.Capital		0.021			0.000	0.015
		(0.073)			(0.075)	(0.074)
Public.Safety			-0.020		-0.003	
			(0.040)		(0.040)	
Env.Inn				0.063**	0.062*	0.061*
				(0.031)	(0.031)	(0.028)
Social.Cap × Env.Inn						0.043†
						(0.023)
Pop.Density	0.004	0.005	0.001	0.018	0.017	0.019
	(0.046)	(0.046)	(0.047)	(0.047)	(0.048)	(0.047)
GDP.Capita	0.090	0.089	0.100	0.090	0.092	0.080
	(0.087)	(0.087)	(0.089)	(0.088)	(0.090)	(0.088)
Tech. Capacity	-0.012	-0.012	-0.015	-0.013	-0.013	-0.010
	(0.034)	(0.034)	(0.034)	(0.034)	(0.034)	(0.034)
Employ.Rate	0.152†	0.146†	0.155†	0.172*	0.172*	0.157†
	(0.079)	(0.081)	(0.079)	(0.080)	(0.083)	(0.083)
Hours.Worked	-0.014	-0.016	-0.011	-0.018	-0.017	-0.006
	(0.040)	(0.041)	(0.041)	(0.041)	(0.041)	(0.040)
Manuf.Spec	0.007	0.007	0.011	0.014	0.014	0.016
	(0.033)	(0.034)	(0.034)	(0.034)	(0.034)	(0.033)
High.Edu	-0.124	-0.128	-0.125	-0.126	-0.126	-0.111
	(0.088)	(0.089)	(0.089)	(0.087)	(0.088)	(0.088)
Cooling.Days	-0.148†	-0.146†	-0.152*	-0.156*	-0.157*	-0.181*
	(0.076)	(0.077)	(0.077)	(0.076)	(0.077)	(0.077)
Air.Quality	0.014	0.014	0.014	0.015	0.015	0.005
	(0.053)	(0.053)	(0.053)	(0.053)	(0.053)	(0.054)
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	258	258	258	258	258	258
Lambda λ	0.241	0.245	0.257	0.281	0.283	0.273
Log-likelihood	385.2	385.2	385.4	387	387	388.3
AIC	-704.3	-702.4	-702.6	-706.1	-702.1	-704.6
Pseudo R^2	0.864	0.864	0.864	0.865	0.864	0.866
Upsilon Stat.	0.094	0.096	0.096	0.093	0.094	0.094
VIF median (dispersion)	1.254 (2.01)	1.296 (3.02)	1.274 (1.64)	1.259 (1.16)	1.323 (3.09)	1.306 (3.09)

Notes:
† $p<0.1$;
* $p<0.05$;
** $p<0.01$;
*** $p<0.001$. Power Logit regression is implemented by using PLreg package in R software and setting power logit slash family, shape parameter zeta (ζ=4) and maximum likelihood estimation method.

According Queiroz and Ferrari (2024), coefficients are interpreted with respect to the conditional median of the dependent variable. Exploratory and control variables are mean-centered. Robust Standard Errors are in parentheses.

5.3. Managerial implications

At the managerial level, organizations also play a crucial role in enabling this transition. In particular, firms can design and adopt circular business models that reward conscious behavior, both within the organization and among consumers. Such models support sustainability by extending product lifecycles, reducing resource use, and promoting collaborative forms of consumption, all of which can contribute to higher levels of well-being.

Moreover, companies should commit to transparent and credible communication regarding their green investments in order to build trust and avoid the reputational risks associated with greenwashing (Blasi et al., 2021). By doing so, firms can help shift consumer preferences and social norms toward more sustainable and ultimately more satisfying forms of economic activity.

5.4. Limitations and future research

This study has several limitations that should be acknowledged.

First, the causal design could be strengthened. As institutional and academic attention to well-being and quality of life continues to grow, more regular and harmonized longitudinal data are likely to become available in the future. This would enable more rigorous panel-based analyses aimed at tracing the evolution of the drivers of well-being over time.

Second, our analysis of the social and environmental dimensions relies on a set of proxy indicators that, while theoretically grounded and widely used in the literature, do not fully capture the multidimensional nature of constructs such as social cohesion, environmental quality, or institutional trust. Future research could benefit from incorporating a broader range of indicators to provide a more comprehensive and fine-grained understanding of how territorial characteristics relate to individual well-being.

Third, we acknowledge that, despite our methodological efforts, including the use of Power Logit Regression to address the bounded nature of the dependent variable, concerns related to residual endogeneity, simultaneity, and model specification cannot be entirely ruled out. Future studies would benefit from access to richer data environments, such as panel datasets, instrumental variables, or natural experiments, which would allow for stronger causal identification strategies.

Finally, the analysis is conducted at the NUTS-2 regional level, which represents a pragmatic compromise between data availability and cross-country comparability within Europe. However, extending the analysis to more granular territorial units, such as NUTS-3 regions, could uncover meaningful within-region heterogeneity and support the design of more precisely targeted place-based policy interventions.

CRediT authorship contribution statement

Stefania Oliva: Writing – review & editing, Writing – original draft, Conceptualization. **Silvia Rita Sedita:** Writing – review & editing, Writing – original draft, Supervision, Resources, Project administration, Methodology, Conceptualization. **Ivan De Noni:** Writing – review & editing, Writing – original draft, Validation, Methodology, Investigation, Formal analysis, Data curation. **Luigi Orsi:** Writing – review & editing, Writing – original draft, Validation, Methodology, Investigation, Formal analysis, Data curation.

Appendix A

Class	*Subclass*	*CPC code*
Climate Change Mitigation Technologies Related To Energy Generation, Transmission Of Distribution	Renewable Energy Generation	Y02E10
	Energy Generation From Fuels Of Non-Fossil Origin	Y02E50
	Combustion Technologies With Mitigation Potential	Y02E20
	Nuclear Energy	Y02E30
	Technologies For An Efficient Electrical Power Generation, Transmission Or Distribution	Y02E40
	Enabling Technologies	Y02E60
	Other Energy Conversion Or Management Systems Reducing Ghg Emissions	Y02E70
Capture, Storage, Sequestration Or Disposal Of Greenhouse Gases	Co2 Capture Or Storage	Y02C10
	Capture Or Disposal Of Greenhouse Gases Other Than Co2	Y02C20
Climate Change Mitigation Technologies Related To Transportation	Road Transport	Y02T10
	Rail Transport	Y02T30
	Air Transport	Y02T50
	Maritime Or Waterways Transport	Y02T70
	Enabling Technologies In Transport	Y02T90
Climate Change Mitigation Technologies Related To Buildings	Integration Of Renewable Energy Sources In Buildings	Y02B10
	Energy Efficiency In Buildings	Y02B20
		Y02B30
		Y02B40
		Y02B50
		Y02B60
		Y02B70
	Architectural Or Constructional Elements Improving The Thermal Performance Of Buildings	Y02B80
	Enabling Technologies In Buildings	Y02B90
Climate Change Mitigation Technologies Related To Wastewater Treatment	Wastewater Treatment	Y02W10
	Solid Waste Management	Y02W30
	Enabling Technologies Or Technologies With A Potential Or Indirect Contribution To Ghg Mitigation	Y02W90
Climate Change Mitigation Technologies In The Production Or Processing Of Goods	Technologies Related To Metal Processing	Y02P10
	Technologies Relating To Chemical Industry	Y02P20
	Technologies Relating To Oil Refining And Petrochemical Industry	Y02P30
	Technologies Relating To The Processing Of Minerals	Y02P40
	Technologies Relating To Agriculture, Livestock Or Agroalimentary Industries	Y02P60
	Technologies In The Production Process For Final Industrial Or Consumer Products	Y02P70
	Climate Change Mitigation Technologies For Sector-Wide Applications	Y02P80
	Enabling Technologies With A Potential Contribution To Ghg Emissions Mitigation	Y02P90

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