

Public health efficiency and well-being in Italian provinces

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Abstract

The main goal of this paper is to select a set of indicators suitable for evaluating public health efficiency and well-being in Italian provinces. A preliminary model is then proposed for this evaluation based on several relevant indicators, selected from a careful bibliographic review. Those indicators are divided into seven dimensions which then constitute the provincial index of well-being and a mix of input-output which determine the effectiveness and the efficiency of public health. The work begins with a critical review of the literature and analysis of known concepts, methods, tools, and models of measurement of public health efficiency and provincial index of well-being to extract relevant indicators. The most suitable indicators are then grouped to form the basis of a preliminary model for evaluating the impact of public health efficiency on well-being in Italian provinces. My findings will help public health service managers make sound decisions in their attempt to improve the efficiency of the entire national health service through public health, the implementation of competitiveness between public and private health service providers and, finally the well-being of individuals and their community.

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Introduction

The literature of the last two decades has explored the concept of well-being, the definition of which is controversial. From this controversy emerged extensive literature on the various indicators of well-being, understood as the quality of life, lifestyle, living conditions, happiness, life satisfaction, quality of development, and progress. In general, well-being indicates a state which involves biological, psychical, and social aspects of the human being and characterises the quality of life, lifestyle, and living conditions of individuals within and between the community. D. M. Smith (1973) argued that the

term well-being refers to the objective living conditions of people, while the quality of life must be limited to subjective assessments of individuals and their lives. Andrews & Withey (1976, p. 4) focused on the social indicators of well-being and argued that: “A term that has arisen in social indicators work is quality of life. The term sometimes referred to an outsider’s judgements of the quality of life covered in such measures as crowding, decibels of noise pollution, reported crime, and income levels; but it may also refer to the privately known and privately evaluated aspects of life”. Campbell et al. (1976) claimed that well-being can be seen in terms of the satisfaction and dissatisfaction that people draw from different critical areas of their lives such as their marriages, their job, and their homes; and how the satisfaction of such critical areas can cumulate to produce global feelings of satisfaction with life or a general sense of well-being. Interestingly, when it comes to measuring well-being, Campbell et al. (1976) introduced measures that involve a comprehensive assessment of the nature and quality of life experience. They also argued that happiness and satisfaction fit together empirically because they can be used interchangeably to measure the same affective states and precisely the “global sense of well-being”. Sen (1994, p. 344) referred to well-being as the “freedom to achieve levels of basic functionings which people have reason to value”. It’s well-known that Sen’s approach is based on functionings and capabilities. De Leo et al. (1998) suggested that the expression quality of life encompasses all aspects of human life, including the material, physical, social, emotional, and spiritual well-being of everyone. Easterlin (2003, p. 11176) considered “the terms happiness, utility, well-being, life satisfaction and welfare to be interchangeable”. According to Amartya Kumar Sen, winner of the Nobel Prize in economics in 1998 for his contribution to the economics of well-being, it is possible to characterise well-being in terms of the ability to perform functions that one has reason to value.” The capability approach” seen as a different way of understanding equality Sen (1994, p. 334), stands in contrast to other approaches to development in that it includes not only economic factors but also other aspects of human well-being such as freedom, democracy, civic participation, level of instruction, the environment, trust in institutions, health conditions, etc. In this sense, health can also be assessed as a fundamental and basic element of the capabilities that can enable the achievement of” functionings” Sen (1994, p. 337). In my view, Sen (1995) provides, inter alia, solid accounts of the analysis of the relationship between health and well-being and of the relevant problem of converting health among other resources into functionings and the ability to achieve functionings, since conversion relationships may depend on the health status of individuals and the environmental conditions in which they live. Consequently, people in poor health or with disabilities are more likely to experience difficulties in pursuing their goals or face deprivations that may undermine their well-being, given their starting point. At the same time, people living in highly polluted environments will certainly have health problems that will undoubtedly have a negative impact on their quality of life, standards of living or well-being. This paper analyses the relationship between public health efficiency and well-being in Italian provinces. It considers the extent to which public health efficiency can positively influence well-being broadly defined as happiness, life satisfaction, quality of life, standards of living, quality of development or progress (Easterlin, 2003). The idea is that public health efficiency may increase people’s well-being in Italian provinces. I also identify a mechanism that probably amplifies general well-being, that is the process of decentralization, the devolution of certain functions previously held by the central government to regional and local governments. Moreover, following Kyriacou & Roca-Sagalés (2014), it is expected that the existence of power-sharing, in which central and sub-national governments cooperate and jointly decide on policies, increases the effectiveness and efficiency of public health to the benefit of individual and collective well-being.

The Italian case is an excellent laboratory of analysis because there are considerable disparities among the provinces in the geographical distribution of well-being throughout the country. Calcagnini & Perugini (2019a) found that the provinces of the Centre-north have a good level of well-being compared to the southern provinces. Since health condition is one of the main determinants of well-being, it is necessary to examine whether an effective and efficient public health can increase well-being in the Italian provinces. It is well-established that, at sub-national levels of government, Italian provinces are considered the highest level of geographical disaggregation for many analyses such as social goods, income disparities, health, and well-being. Moreover, the Italian provinces ensure a homogeneous comparison in the production of the health service (De Nicola et al., 2012) and in the assessment of well-being (Calcagnini & Perugini, 2019a, b). One peculiarity of this study is that I build a time series with the measure of the provincial index of well-being over the period 2000 to 2016 to carry out a panel data analysis. Previous works are based on cross-sectional analysis through ordinary least squares regarding the estimation of well-being in relation to other indicators (Bruni & Stanca, 2008; Calcagnini & Perugini, 2019a).

To assess the relationship between public health efficiency (PHE) and the provincial index of well-being (PIW), I first evaluate the public health efficiency scores through bootstrap data envelopment analysis. Then, I construct the provincial index of well-being following Calcagnini & Perugini (2019a, b) that developed the quality of regional development index in Italian provinces. Finally, I analyse the relationship between public health efficiency and the provincial index of well-being through a fixed effects model, controlling for province-specific and time-specific effects to reduce the risk of omitted variables. The empirical analysis is done on a balanced panel data of 102 Italian provinces over the period 2000 to 2016. My findings show that public health efficiency is positively and significantly correlated to the provincial index of well-being. However, model estimates through fixed effects can suffer from reverse causality, as public health efficiency can be a consequence of a good quality of life, good living standards and better well-being of people within provinces. The Two-Stage Least Square estimate is a good tool for addressing the problem of reverse causality. Since it is very difficult to find public health efficiency instruments that meet all the conditions of valid instruments at the same time, following Reed (2015) the lagged value of public health efficiency is used as an instrument to avoid simultaneity.

The structure of this paper is the following. In the next section, a theoretical framework is presented. In the third section, public health efficiency is assessed. The fourth section is dedicated to the construction of a provincial index of well-being. The fifth section is dedicated to the empirical strategy. The sixth section presents the baseline estimation results. The seventh section presents the robustness checks and lastly, the concluding remarks.

1. Theoretical framework

In recent years, a consensus has emerged that the metrics of progress and prosperity traditionally used in economics, such as gross domestic product (GDP) and gross domestic product per capita (GDP PC), were no longer suitable for such purposes (Stiglitz et al., 2009). After World War II, GDP PC gained legitimacy and became the fundamental indicator of well-being and the key criterion for measuring the level of well-being. Its creator Kuznets stated that it was difficult to deduce the well-being of a nation from a measurement of national income (Kuznets, 1934). It is widely normalized that the meaning of progress is about improving people's quality of life, people's living standard or people's well-being and

requires looking not only at the economic factors but also at other aspects of individual and collective well-being (O'Donnell et al., 2014). Some academics argued that it was Bob Kennedy's famous speech at Kansas University in 1968 that formalized the wave of criticism of the structural inadequacy of GDP to capture all aspects of well-being in complex Western capitalist societies, followed by some important studies by Nordhaus & Tobin (1972) and Daly & Cobb (1989). For details see Rondinella et al. (2017). Nowadays, there is a growing interest in considering more holistic parameters to monitor progress and prosperity in societies, with several attempts to develop and use alternative indicators (Fan et al., 2018). One of the most important indicators in Italy was developed by public institutes. The National Institute of Statistics (ISTAT) and the National Council for Economy and Labour (CNEL) create a "Steering Committee on measuring the progress of Italian society" (Burchi & Gnesi, 2016, p. 180) to build a dashboard of indicators of equitable and sustainable well-being in 2003, based on regional data. The main objective was to create a well-being indicator considering equity within and between generations, and the environmental, economic, and social perspectives. Other indicators based their conceptual framework on human development. Amartya Sen is the precursor of this concept with his capability approach, in which well-being is based on the concepts of capabilities and functionings. He defines "functionings" as the things people are and do, such as being literate, being adequately nourished and being in a good state of health. Capabilities instead, are all their potential functionings – i.e., what they can be and do in their life (Sen, 1994, 1995). This approach of well-being focuses on people's life conditions in terms of capabilities and functionings instead of people's income or commodities. For an interesting contribution see Dang (2014)'s interpretation. Nowadays, a significant contribution to the measurement of well-being in Italy is the one promoted by the "Sbilanciamoci!" campaign, which for more than 20 years has been calculating the quality of life index for the Italian regions (quality of regional development index) through a consultation process with 46 civil society organisations (Segre et al., 2011; Burchi & Gnesi, 2016; Calcagnini & Perugini, 2019b). In Italy, it is considered that unlike the other indicators, QUARS is better suited to the characteristics of regions or provinces as it identifies key dimensions and variables concerning various aspects of economic progress, environmental sustainability and social well-being in a way that reflects the priorities of civil society (Segre et al., 2011; Rondinella et al., 2017; Calcagnini & Perugini, 2019b).

Cylus & Smith (2020) argue that the well-being agenda is causing a stir in the health policy community, not least because, as Fan et al. (2018) and Anderson & Mossialos (2019) argue, good health is a key component of well-being and a shift in policy focus from traditional economic metrics to social well-being may translate into more resources for health systems. Using municipal data on public health care and self-reported individual data on life satisfaction in Finland in 2000, Kotakorpi & Laamanen (2010) found that high spending on public health care has a positive and significant impact on people's life satisfaction. They also find evidence of an "ends against the middle" equilibrium (Epple & Romano, 1996) in the provision of public health care, in which middle-income individuals prefer higher public spending at the margin than low- or high-income individuals. The rationale is that health care is a normal good, so demand increases as income rises and the fiscal price of public health care increases as income rises. Therefore, the preferred level of public provision may be a non-monotonic function of income more likely because a private healthcare alternative is available. In Italy, according to the Ministry of the economy, public health spending is increasing and in 2017 reached 113.6 billion euros (+11.9% compared to 2013). For more details, see also Signorelli et al. (2020).

Von Heimburg & Ness (2021) emphasise relational well-being and base their analysis on the fact that health is a basic

need and a human right and as such, equity in health and well-being are fundamental to achieving sustainable societies. In the same vein, Wilkinson & Pickett (2009) and Marmot (2020) argued that countries that are more unequal tend to be less healthy, have lower life expectancy and experience more crime; thus, exacerbating persistent and growing inequalities in health and well-being, within and between countries. Following the principle of “health and well-being for all” and “leaving no one behind” (Von Heimburg & Ness, 2021, p. 640), they argue that relational well-being captures a kind of intersection between welfare state, democracy, and human relations, which then goes on to reinforce social justice, capability approach of Sen,¹ and “health and well-being” for all as key public values in societal development.

The Italian approach to the relationship between public health and well-being is more likely linked to urban planning policies. D'Alessandro et al. (2017) argue that factors such as air quality, climate, water quantity and quality, noise and traffic-related injuries associated with the built environment have a direct impact on health. Other factors including the characteristics of the built environment and their design, on the other hand, have an indirect impact on health and well-being as they may influence the feelings and behaviour of individuals and populations. It is worth emphasising that the care, cleanliness, and design of a city have a positive impact on public health. One of the first initiatives in this respect was developed in England more than a century ago as a social reform aimed at reacting to the extremely unhealthy living conditions in the slums of industrialised cities. In those times, contagious diseases had a very negative impact on mortality, especially infant mortality.²

National health and well-being policies are growing and often, they are poorly defined and lack detail, leaving health workers and local authorities to devise and implement local policies and solutions.³ This leads to several practical problems and uncertainties including identifying appropriate local targets, identifying segments of local populations to focus on, and working out the practicalities of coordinating, organising and delivering more organised health and well-being interventions (Ward et al., 2018).

The spread of the COVID-19 pandemic has generated a disruption of daily lifestyles and relational dynamics, with repercussions on the psychosocial well-being of the entire community (Antonicelli et al., 2020). The peculiarities of the COVID-19 pandemic as well as the restrictive measures taken to counter it may have caused experiences of stress, anxiety, and major personality disorders, with an impact on people's mental health.” Il sole 24 ore” published on 20 May 2022 a survey conducted by the Ires research institute of Emilia Romagna on the post-pandemic crisis, which involved 30 thousand high school and university students throughout Italy in one month, with worrying results: 9 out of 10 students plunged into severe psychological distress. Negative emotions including boredom (68%), demotivation (66%), loneliness (62.7%), anxiety (60%), fear and anger (46%) increased during the emergency. At the same time, positive emotions decreased, the sense of freedom (62%), zest for action (60%), serenity (56%) and allergy (55%). The pandemic has also brought about changes in interpersonal relationships, 64 per cent of the students surveyed reveal changes in sleep patterns. The results of this survey forcefully present the country with a youth issue that needs to be addressed promptly and thoroughly.⁴

COVID-19 is primarily a public health issue, so the public health sector must be able to adopt efficient policies to treat and bring back to good health students suffering from these disorders. It is about ensuring good health for these students, so that they can acquire the human capital that contributes to their present well-being (realising the progress they are making in learning) and will contribute to their future well-being, as they will have acquired the skills and abilities, they will need to

be able to get decent jobs (according to their expectations) and achieve a high level of well-being. Also in this context, the impact of public health efficiency on the well-being of these students is of paramount importance; and it is their constitutional right since Art. 32 stipulates that the Republic protects health as a fundamental right of the individual and interest of the community and guarantees free care for the indigent. Given that well-being involves many sectors in a subjective manner, the public health sector seems to be among those that make it possible to guarantee an acceptable level of individual and collective well-being. Given the lack of studies precisely on the impact of public health efficiency on well-being in Italy, I propose to fill this gap by trying to show that, although health is an unavoidable component of well-being, public health services have an important role in favouring the achievement of individual and collective well-being. This discussion leads us to the following hypothesis:

Public health efficiency increases the well-being of individuals and communities.

2. Public health efficiency index

This study analyses the data of 102 provinces over the period 2000 to 2016 in Italy. The source of data is "Health for All", where we collected the data from three inputs and three outputs. The sample of 102 provinces is selected based on the full availability of data at the provincial level, over the period 2000 to 2016. The assessment of public health efficiency will be done in a multi-input and multi-output production process. The inputs variable refers to physicians and dentists, nurses, and hospital beds of public health institutions of each province and the outputs variable refers to hospital discharge, days of hospitalisation for patients residing in the region for hospitalisations exceeding 3 days, and days of hospitalisation for patients hospitalised in a region other than that of residence for hospitalisations over 3 days of each province. Inputs and outputs are measured in terms of physical quantities, as no reliable price data is available (De Nicola et al., 2012). All the inputs and outputs are selected based on a critical review of the inputs and outputs used in previous studies (Levaggi & Zanola, 2004; De Nicola et al., 2012, 2014). A non-parametric frontier approach based on a linear programming framework namely data envelopment analysis (DEA) is used to derive the public health efficiency index. It is widely accepted across all disciplines for benchmarking studies.

To measure technical efficiency, defined as the ability of a set of peer entities or DMUs (Italian provinces) to produce a given set of outputs with minimal inputs, the input-oriented variable return to scale BCC-DEA model is applied.⁵ The efficiency scores are calculated with respect to an empirical frontier Hauner & Kyobe (2010), and a DMU is technically efficient if it lies on the frontier with a score of one. It's worth noting that efficiency defined as above is only the upper bound of true efficiency, since the DMUs which are relatively the best can have room for improving themselves.

The DEA approach is suitable for its ability to identify the frontier without any a priori specification of a functional form of cost minimisation or profit maximisation. Being a deterministic method, it does not require the imposition of any hypothesis on the distribution function of the inefficiency scores and it is well suited to cases of technologies that use multi-inputs to obtain multi-outputs. Following Banker et al. (1984), the efficiency scores are the solution of the equation described below:

$$\min \theta \text{ s.t. } \sum_j \lambda_j X_{jn} \leq \theta X_{in}; \quad n = 1, 2, \dots, N, \quad (1) \quad \sum_j \lambda_j Y_{jm} \geq Y_{im}; \quad m = 1, 2, \dots, M, \lambda_j \geq 0; \quad \sum_i \lambda_j = 1; \quad j = 1, 2, \dots, J$$

where θ represents the efficiency scores of each province i ; X_{in} are the $N \times I$ input matrix; Y_{im} are the $M \times I$ output matrix and a scaling vector λ , the technical efficiency of unit i 's production plan (X^i, Y^i) with respect to those of the benchmark units $j = 1, 2, \dots, J$; ($i \neq j$) under variable return to scale. When all inputs have been set to the highest proportion possible θ , for a given output, there might be a residual slack in some inputs. To cut the slacks s , (1) becomes:

$$\min \theta - \varepsilon \left(\sum_m S_m^+ + \sum_n S_n^- \right),$$

$$\text{s.t. } \sum_j \lambda_j X_{jn} + S_n^- = \theta X_{in}; \quad n = 1, 2, \dots, N, \quad (2)$$

$$\sum_j \lambda_j Y_{jm} - S_m^+ = Y_{im}; \quad m = 1, 2, \dots, M,$$

$$\lambda_j \geq 0; \quad \lambda_j = 1; \quad j = 1, 2, \dots, J,$$

The linear programming envelopment problem (1) provides technical efficiency scores which can be considered weak efficiency scores since it does not account for slack in some inputs. To overcome this issue, the linear programming envelopment problem (2) provides the efficiency scores considering the slacks. Therefore, a DMU is efficient if it lies on the frontier and $S_m^+ = 0$ and $S_n^- = 0$.

Despite the benefits and the wide use of the DEA method, one drawback of this technique is the assumption that deviations from the frontier are the result of inefficiencies. In fact, DEA does not account for measurement error and the corresponding measures of efficiency are sensitive to the sampling variations of the frontier obtained, since the statistical estimators of the frontier are obtained from a finite sample (Simar & Wilson, 1998). Only a few technical efficiency benchmarking studies in the Italian national health service have accounted for these shortcomings (De Nicola et al., 2012, 2014). The bootstrap method introduced by Efron (1979) is a suitable tool for analysing the sensitivity of the measured efficiency scores to the variation of the sampling. To overcome eventual inefficiency, a consistent bootstrap procedure is applied to obtain the sampling distribution of the efficiency scores and, then to correct for the bias (Simar & Wilson, 1998). The results of PHE and bootstrap-PHE with 3000 replicates at 95% confidence interval of the average of the period considered (2000 - 2016), Munim (2020) are given in Figure 1. Map legends of Figure 1. are divided into six classes. However, for our purposes, the interesting results belong to class 1 with the darkest blue colour, which encompasses all the efficient provinces. The maps in Figure 1. are different. In the first map, depicting PHE, the efficient provinces in the Centre-North are those of Aosta, Biella and La Spezia. In the South, the efficient provinces are those of Roma, Rieti, Isernia, Caserta, Napoli, Salerno, Foggia, Salerno, Taranto, Crotone, and Vibo-Valentia. In the Islands, the efficient

provinces are those of Trapani, Agrigento, and Caltanissetta in Sicilia and Oristano in Sardegna. The second map in Figure 1. depicts the bootstrap-PHE, which does not follow the same path as the first and tends to produce more accurate and precise efficiency scores. There seems to be an equal distribution of efficient provinces between the central-northern and southern regions. In the Centre-North, the efficient provinces are those of Aosta, Verbano-Cusio-Ossola, Varese, Milano, Pavia, Padova, Bologna and Pisa. In the South, there are the provinces of Roma, Rieti, Pescara, Isernia, Caserta, Avellino, Crotone and Vibo Valentia. In the Islands, there is only the province of Oristano in Sardegna. However, it should be remembered that the efficiency scores come from the facility (hospital beds), the staff (doctors, dentists, and nurses) and the results obtained in terms of patient discharge and active mobility. These results are comforting, since some provinces are well known in terms of efficiency in general, the provinces of Milano and Roma, also have the best efficiency scores. It should be remembered that some provinces are not in the sample. That is: the provinces of Monza e Brianza, Gorizia, Fermo, Barletta-Andria-Trani, and Sud Sardegna.

Given the strong influence of central and regional government on the provision of health services at the provincial level of administration, highly homogeneous results should be expected among the provinces. But this is not the case (see Figure 1), as the health system seems to function very differently in different environments, suggesting that local factors play an important role (Di Liberto & Sideri, 2015).

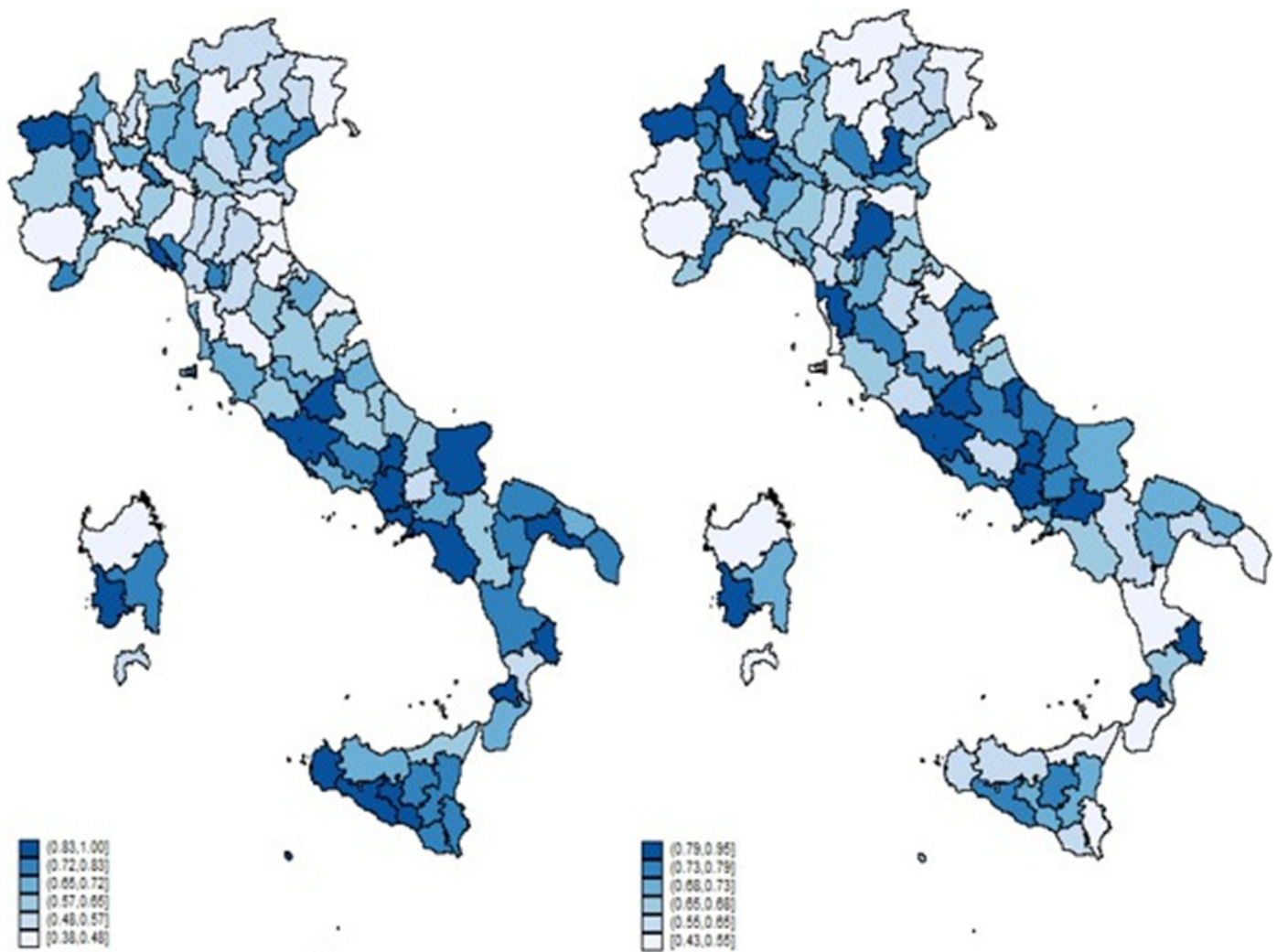


Figure 1: The DEA and bootstrap-DEA public health efficiency scores (average 2000-2016)

Source: elaboration of the author based on the Health for All database

3. Provincial index of well-being

The provincial index of well-being (PIW) is an index of economic progress based on a sustainable well-being approach that considers a good quality of development. One peculiarity of this index is the selection of indicators and dimensions of the well-being index carried out through a consultation process involving associations, non-governmental organisations and networks active on social issues, solidarity, environment, promotion of civil rights, education, health, consumer protection and alternative economic activities (Segre et al., 2011). Indeed, the set of 27 variables used in the construction of the PIW index can be considered as a subset of the 41 variables selected for the construction of the quality of regional development index (QUALità Regional dello Sviluppo, QUARS). In addition, public decision-making through the involvement of civil society actors can provide a valuable resource for political legitimisation (Rondinella et al., 2017), allowing citizens to play an active role within the community and give legitimacy to their choices. Therefore, to give full democratic legitimacy to our provincial index of well-being, I consider that public participation based on the deliberations

of civil society actors is necessary. This sustainable well-being approach is suitable for the Italian context.

The PIW in Italy follows the same theoretical framework and the same methodology as the QUARS. This new indicator is designed for the Italian provinces with variables and dimensions that have had a positive outcome in their validation and legitimisation process. Therefore, the PIW is a synthetic index that can provide a comprehensive picture of the different key dimensions of the quality of life, socioeconomic development, care of the environment, or well-being of the individual. The PIW also relies on the identification of 27 representative variables of the 7 dimensions that combine to form the synthetic PIW. The choice of the variables that enter the calculation of the dimensions represents a compromise between the availability of statistical data, from Istat source, and the need for the latter to be representative of the phenomena under observation (Grasso, 2002). These variables and dimensions are identified within a theoretical framework of reference for the quality of life, living standard or well-being, the result of various consultation and deliberation processes held at the beginning of the 2000s (Segre et al., 2011) and (Rondinella et al., 2017). The dimensions that are aggregated to form the PIW are all of equal importance, they all have the same weight (Segre et al., 2011) and (Calcagnini & Perugini, 2019b).

3.1. Description of dimensions and variables

The twenty-seven variables that make up the seven dimensions of the provincial index of well-being are the following: population density, separate collection or recycling, motorisation rate, local public transport, urban green areas, density of green areas, air quality, unemployment rate, income disparities, business risk, fertility rate, mortality rate, life expectancy for females, life expectancy for males, children or nursery care, home elderly care, electricity interruptions, migrant integration, crime rate, people with diploma, graduate people, people participating in continuing training, gender employment rate, female municipal administrators, young people who do not study and work, municipal administrator, and voter turnout. Four of the 27 variables used for the construction of the provincial index of well-being go in the opposite direction, that is, an increase in each of these variables determines a reduction in overall well-being. These variables are the unemployment rate, Theil index, crime rate, and young people who neither study nor work. Table 1 below reports the descriptive statistics of all the indicators divided into their respective dimensions in which the number of observations, the mean, the standard deviation, the minimum and the maximum are highlighted. As can be seen, the magnitude of the indicators diverges from each other as well as their units of measurement; this makes the standardisation process necessary.

Table 1. Descriptive statistics of variables of the PIW by dimensions

Variable	Obs	Mean	Std. dev.	Min	Max
Environment					
Population density	1,734	250.06	333.75	36.63	2663.88
Waste recycling	1,734	31.35	20.11	.44	87.85
Motorisation rate	1,734	634.75	146.31	411.20	2455.21
Public transport	1,734	88.64	109.46	2.98	790.62
Urban green	1,734	122.66	322.74	.20	2943.63
Urban density	1,734	6.61	9.91	.06	71.86
Air quality	1,671	3.49	3.44	.20	23.386
Economy and Labour					
Unemployment rate	1,734	9.40	5.87	1.30	31.50
Theil index	1,734	.61	.20	.10	1.00
Financial risk	1,734	2.70	2.09	.16	24.43
Health					
Fertility rate	1,734	1299.83	155.47	289.00	4181.00
Mortality rate	1,428	104.07	15.63	51.80	153.79
Female life expectancy	1,734	83.96	1.08	79.94	86.44
Male life expectancy	1,734	78.68	1.43	74.22	82.04
Rights and Citizenship					
Electricity interruption	1,734	2.53	1.49	.40	14.57
Migrant rate	1,734	.05	.04	.004	.16
Children service	1,428	12.88	7.52	.30	40.30
Home assistance	1,428	1.63	1.14	.10	9.30
Crime	1,326	.97	2.49	.00	83.14
Education and Training					
Diploma	1,326	54.12	7.68	30.90	73.00
Graduation	1,326	18.91	5.27	5.30	37.50
Formation	1,326	6.43	1.84	2.40	16.70
Gender equity and Equal opportunity					
Young	1,326	20.528	8.546	4.600	46.200
Gender difference	1,428	20.61	6.21	6.11	41.95
Female administrator	1,326	20.70	7.11	4.80	40.20
Democratic participation					
Municipal administrator	1,326	31.06	5.07	16.00	46.40
Voter turnout	1,224	66.87	9.57	20.00	82.94

3.2. Correlation between indicators

The correlation, measured by the correlation coefficient Rho, which varies between -1 and 1, indicates the strength of the

linear bond between the variables. Table 4.2 reports the linear correlation between the variables used for the construction of the provincial index of well-being (PIW). Given the plurality of links between the variables, I merely mention a few. For example, as regards the Environmental's dimension, there is a positive link between the variable "Female administrator" and the variable "waste recycling" which is 0.62; or the positive link (0.63) between the variables "Female administrator" and "Children service" of Rights and citizenship's dimension. There is a positive link between the variables "Migrant rate" and "life expectancy for females and males", respectively (0.59 and 0.61), emphasizing for instance the importance of the role of carers in supporting and assisting elderly and often lonely people. Furthermore, the dimension of Education and training also has a positive link with the life expectancy of women and men (0.50 and 0.57 on average, unweighted average). These bonds tend to have a positive impact on overall well-being. On the other hand, strong, positive, and complementary links between some variables are observed. As underlined in Istat's 2015, p.133 "Equitable and sustainable well-being of the provinces": "Some indicators within the same domain and within different domains have very high correlation coefficients, in some cases higher than 0.9; it is due to the fact that in the dataset there are sometimes indicators that measure not dissimilar aspects of the phenomena under examination; in some cases they represent a specification of more general measures, in others they are complementary indicators". In fact, the indicators of "Unemployment rate" and of "Young" are highly and positively correlated (0.90) and do not belong to the same dimension. They belong respectively to the Economy and Labour's dimension and the Gender equity and Equal opportunity's one and the rate of young people who neither work nor study represents a specification of the unemployment rate. In other cases, the indicators of the Health's dimension life expectancy at birth assessed separately between women and men are strongly and positively correlated (0.85). The same can be said of the indicators of Education and Training's dimension of people with at least a diploma (Diploma) and people with at least a degree or equivalent (Graduation) which are also highly and positively correlated (0.83). In the last two cases, the indicators are complementary. The analysis of the correlations between the indicators was also carried out taking into account the parsimony of the dataset.

3.3. Directionality issue

One of the main reasons for the standardisation of variables is that an increase in some variables, such as graduates, corresponds to an increase in well-being, while an increase in other variables such as unemployment or crime corresponds to a decrease in overall well-being; that is the directionality issue. In our analysis, an increase in all variables corresponds to an increase in overall well-being, apart from the unemployment rate, the Theil index, the crime rate and young people who do not study or work, the increase of which corresponds to a decrease in overall well-being. To overcome this problem, we need to standardise variables so that an increase in standardised scores leads to an increase in overall well-being. The Gaussian standardisation process and linear scaling technique which produce standardised variables provide consistent ways to standardise variables so that their increases correspond to an increase in well-being (Salzman, 2003).

The technique of standardisation to base year consists in normalising each variable to the first year in which the data are available and aggregating these normalised values. This technique aggregates the percentage changes over time in each variable. The advantage of this technique is that I can calculate the percentage changes of variables over time and build a

time series. It also allows to address the problem of directionality, considering the reciprocity of standardised variables whose decrease corresponds to increases in overall well-being and therefore aggregates these variables in their respective dimensions.

	podens	recy	motrate	putran	urgre	urdens	airqua	unemp	theil	riskfin	hospemi	fertra	assdom	mortra	liexpfe	liexpma	elinter	migint	chiser	crime	diplom	gradua	young	form	gendif	munife	yomuad	vote
podens	1																											
recy	0.066	1																										
motrate	-0.154	0.037	1																									
putran	0.517	0.131	-0.152	1																								
urgre	-0.123	-0.139	0.027	-0.086	1																							
urdens	0.116	-0.050	0.014	0.134	0.690	1																						
airqua	0.174	0.003	0.312	0.151	-0.179	0.039	1																					
unemp	0.020	-0.393	-0.079	-0.228	-0.045	-0.130	-0.130	1																				
theil	0.049	0.154	0.071	0.112	-0.113	-0.046	0.139	-0.0005	1																			
riskfin	-0.079	0.050	-0.033	-0.178	-0.072	-0.174	-0.175	0.452	-0.057	1																		
fertra	0.171	0.331	0.080	0.072	-0.101	0.009	0.062	-0.102	0.070	-0.059	-0.215	1																
assdom	-0.162	-0.047	0.317	-0.030	0.021	-0.043	0.170	-0.092	0.200	-0.195	0.067	0.055	1															
mortra	-0.185	0.105	-0.036	-0.057	0.026	-0.057	-0.012	-0.243	-0.287	0.035	0.091	-0.263	-0.133	1														
liexpfe	-0.073	0.641	0.021	0.134	-0.070	-0.052	-0.072	-0.267	0.014	0.168	-0.210	0.240	-0.170	-0.078	1													
liexpma	-0.020	0.535	-0.019	0.092	-0.104	-0.128	-0.139	-0.014	-0.104	0.326	-0.135	0.318	-0.289	-0.019	0.846	1												
elinter	-0.132	-0.549	-0.080	-0.231	0.003	-0.046	-0.078	0.587	0.035	0.150	0.338	-0.183	0.134	-0.232	-0.534	-0.405	1											
migint	0.103	0.707	0.020	0.231	-0.106	-0.029	-0.077	-0.392	-0.055	0.068	-0.291	0.461	-0.234	0.210	0.665	0.688	-0.594	1										
chiser	0.056	0.397	0.129	0.294	0.011	0.124	0.059	-0.580	-0.149	-0.198	-0.361	0.170	-0.054	0.344	0.381	0.296	-0.599	0.554	1									
crime	0.015	-0.144	-0.006	-0.056	-0.008	-0.034	-0.025	0.178	0.020	0.068	0.080	-0.027	-0.0003	-0.102	-0.117	-0.105	0.180	-0.154	-0.138	1								
diplom	0.055	0.467	-0.010	0.318	-0.017	0.049	0.046	-0.287	-0.059	0.121	-0.053	0.088	-0.205	0.381	0.526	0.561	-0.448	0.622	0.437	-0.161	1							
gradua	0.127	0.378	-0.008	0.341	-0.055	0.005	0.048	-0.113	-0.019	0.211	-0.057	0.019	-0.235	0.318	0.515	0.612	-0.376	0.511	0.377	-0.117	0.829	1						
young	0.023	-0.422	-0.071	-0.244	-0.072	-0.148	-0.113	0.897	-0.024	0.471	0.3226	-0.193	-0.085	-0.251	-0.353	-0.067	0.638	-0.491	-0.628	0.204	-0.375	-0.192	1					
form	0.053	0.302	-0.004	0.262	0.036	0.070	0.052	-0.114	-0.013	0.065	-0.130	-0.058	-0.073	0.186	0.436	0.410	-0.282	0.286	0.362	-0.087	0.609	0.603	-0.231	1				
gendif	-0.020	-0.571	-0.124	-0.226	0.020	-0.060	-0.048	0.403	0.043	-0.027	0.251	-0.115	0.090	-0.470	-0.494	-0.426	0.560	-0.612	-0.629	0.103	-0.613	-0.554	0.456	-0.412	1			
munife	-0.021	0.625	0.025	0.111	-0.108	-0.060	-0.050	-0.161	-0.051	0.183	-0.308	0.090	-0.188	0.364	0.565	0.615	-0.510	0.663	0.578	-0.090	0.502	0.523	-0.268	0.424	-0.679	1		
yomuad	-0.191	-0.101	0.041	-0.199	0.018	-0.047	-0.103	0.285	0.018	0.233	0.125	-0.007	0.120	-0.158	-0.010	0.066	0.188	-0.110	-0.045	0.113	-0.172	-0.070	0.272	-0.050	0.091	0.193	1	
vote	-0.023	0.109	-0.131	0.028	0.024	0.026	-0.218	-0.246	0.091	-0.080	-0.104	-0.002	-0.264	0.098	0.105	0.084	-0.195	0.241	0.239	-0.055	0.145	0.110	-0.241	0.0005	-0.111	0.143	-0.143	

Table 2. Correlation matrix of variable

For instance, if the crime rate doubles in the reference year, the standardized value is halved, and this is the value that will be aggregated. The technique of standardisation to base year can address the problem of directionality but has some shortcomings. The disadvantage is that some variables with low bases relative to the range of values can skew the index and cause small absolute changes in the variable that overwhelmingly affect the composite index. For instance, if the crime rate ranges from 0.5% to 15%, a change from 0.5% to 15% is a thirty-fold increase, and a change from 0.5% to 5% will be a ten-fold increase. However, over a different data range, 10.5% and 15%, the same absolute change, 4.5% from 10.5% to 15%, is less than a 1.5-fold increase (Salzman, 2003).

3.4. Construction

To aggregate a set of values of a different nature into summary values, Segre et al. (2011) and Calcagnini & Perugini (2019b) propose in the first instance, to bring all the variables to values that are comparable to each other: they can be

percentages, or scores established in advance or standardised numbers, it is essential that they are not values linked to a unit of measurement. They also underline that in the specifics of the variables that make up the QUARS it was not possible, and it was not wanted to identify an objective from which to measure a distance. Therefore, it was not possible to identify a maximum and a minimum for all variables. However, one way to work around this problem is to establish that the highest and lowest values of the distribution represent the maximum and minimum, respectively, by assigning the value 100 to the maximum and 0 to the minimum. This procedure, however, collides with a series of problems: first, it cannot be demonstrated with certainty that the province that does best is the one that does well since an absolute objective has not been identified. Secondly, there is the question of the presence of outliers, which are values very far from the mean value. The problem arises when these outliers derive from the peculiarities of a province that do not make these values comparable with those of the other provinces, making the procedure distorting reality.

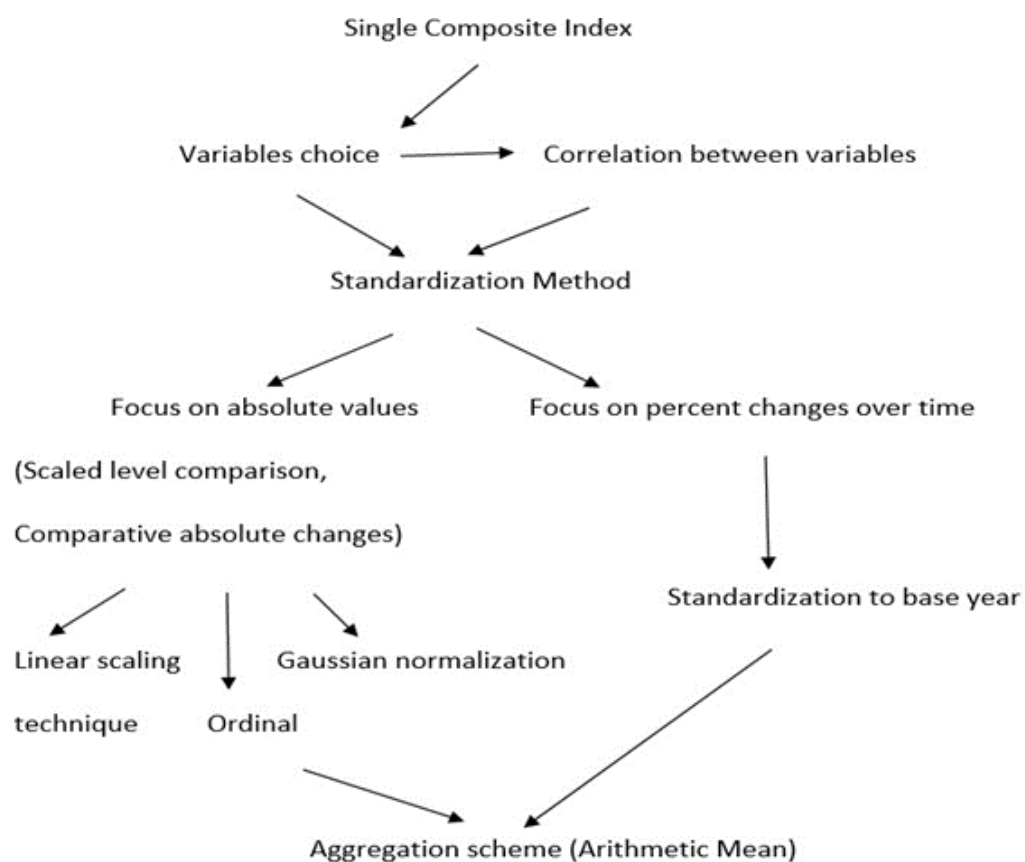
In the construction of the PIW, I follow Segre et al. (2011) and Calcagnini & Perugini (2019b) who have chosen to standardise all the variables to make them comparable since they are expressed in different units of measurement. The following transformation is applied to each value of each indicator:

$$Z_{i,j} = \frac{x_{i,j} - \mu_j}{\sigma_{x_j}}, \quad (6)$$

where $x_{i,j}$ is the datum of the province i relating to the variable j ; μ_j is the mean of the values of all the provinces for the variable j ; σ_{x_j} is the standard deviation of the distribution of the variable j . This value is used to quantify the interval within which the data of the variables are distributed. The mean and standard deviation are the same for all values relating to a variable. In other words, for each variable there is a unique mean value and standard deviation which are the same for all the provinces. $z_{i,j}$ is the datum of the province i relative to the standardised variable j and each $x_{i,j}$ corresponds to one and only one $z_{i,j}$. So, for each indicator, there is a new variable made up of 102 pure numbers without units of measure and with a mean of 0 by construction. If a province has a standardised value of 0 then its starting value was equal to the mean of the values of the provinces. If instead the standardised value is positive then the starting value was higher than the mean: vice versa — if it is negative — then the starting value was lower than the mean. To determine the PIW, I follow the original method, which first consists of standardising all the variables that make up each dimension and then calculating their arithmetic mean in such a way as to obtain an aggregate indicator: a dimension level indicator. The second step consists in aggregating dimensions through arithmetical mean to obtain the PIW. It is the same procedure used by Segre et al. (2011) at regional level of government and Calcagnini & Perugini (2019b) at provincial level of government. To construct a time series, we use the standardisation method for the base year 2000. The final goal is to create a set of PIW for the period 2000-2016.

Figure 2 shows the construction process of the PIW based on the work of Salzman (2003) which is like the process followed by Segre et al. (2011) and Calcagnini & Perugini (2019b) for the construction of their composite index. Their standardisation method focused on absolute values and then they use the simple mean to aggregate the final composite

index (QUARS). For the scope of this study, the logical choice requires the standardisation method to a base year to construct time series and then the arithmetic mean to aggregate the indexes (Salzman, 2003).



Author elaboration based on (Salzman 2003, p.27) scheme of methodological choices associated with Provincial Index of Well-being construction.

Figure 2. Provincial Index of Well-being – Construction methodology

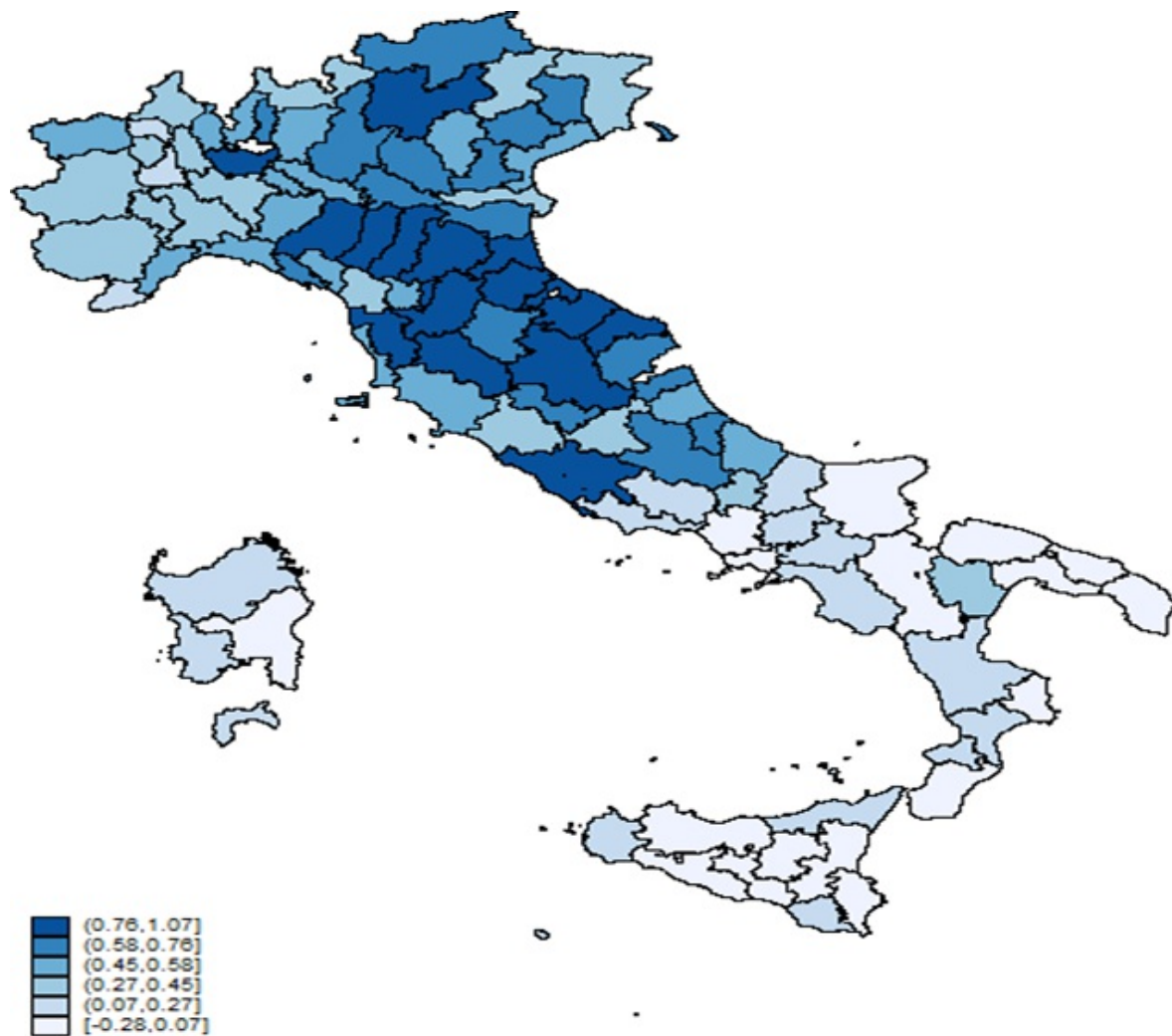


Figure 3. Provincial Index of well-being (Average 2000 - 2016)

Figure 3 shows the average provincial index of well-being for the period 2000-2016. The white colour represents provinces without data; that is the provinces of Barletta-Andria-Trani; Fermo; Gorizia; Monza e della Brianza; and Sud-Sardegna. The colour blue sorts the other 102 provinces according to their well-being index. The provinces with dark blue colour appear to be those with a higher level of well-being: there are provinces located in the Centre-North macro area of Italy and provinces with light Blue colour are those with less well-being: there are in the South macro area. Our findings are in line with the results obtained by Calcagnini & Perugini (2019a, b) since the geographical distribution of the well-being index highlights the existence of two macro areas. In summary, like the quality of the regional development index (QUARS), the PIW uses a normalisation system, standardisation, which by its nature does not allow for the construction of a time series; the reason is purely technical, every year, or in any case every t , the mean, and the standard deviation of the distribution of the 102 provinces (one per province) vary. Therefore, every t the standardisation changes making the standardised values not comparable over time. To construct a time series, it is necessary to fix a point in time t and standardise all the variables of the series with the mean and standard deviation of that t . Salzman (2003) suggests the initial year, $t = 2000$ to see the evolution of the standardised variables.

4. Econometric strategy

4.1. Empirical model and estimation methodology

This analysis studies the period from 2000 to 2016, during which changes occurred in the political and geographical structure of the Italian provinces. In 2003 Italy was divided into 103 provinces, while in 2011 their number increased to 110. In 2016 the number of provinces in Italy was reduced to 107 following the creation of the province of Sud-Sadergna which includes the territories of former provinces of Carbonia-Iglesias, Medio Campidano and Ogliastra. However, the final dataset covers 102 provinces because data for some variables are not available for all provinces. The dataset is constructed using Provincial Index of Well-being (PIW) data, Public Health Efficiency (PHE) bootstrap-DEA score data, and control variable data that will be described in the next subsection. All data are collected on Istat and OECD databases over the period 2000 to 2016. It is worth emphasising that variables are built on data available for different time periods. However, the data show a provincial variability greater than time variability because they measure the structural characteristics of local societies and economies (Calcagnini & Perugini, 2019a). Consequently, the results are not much affected by variables measured over different time intervals.

The empirical analysis is performed on a sample of 102 Italian provinces. The dependent variable provincial index of well-being (PIW) belongs to the interval $[-0.28; 1.07]$ and the main predictor of interest BEFF, the bootstrap-public health efficiency scores, belongs to the interval $[0.39; 0.97]$. The main goal of this study is to analyse the causal effect of public health efficiency on quality of development, life satisfaction, living standard or well-being at the provincial level of administration over the period 2000 to 2016. The relationships between these two indexes are specified by the following equation:

$$PIW_{it} = \alpha + \beta BEFF_{it} + \gamma X'_{it} + \eta_i + \delta_t + \theta_{it}, \quad (7)$$

where PIW_{it} is the index of well-being in province i at time t ; α is a constant that captures the correction factor included in the model comparison; $BEFF_{it}$ is the bootstrap public health efficiency scores; η_i are time-invariant variables which refer to unobservable, full set of province-specific effects; δ_t are province invariant variables which refer to a full set of time-specific effects; X'_{it} is a vector of control variables whose elements will be described in the next paragraph; and θ_{it} is the error term.

I estimated equation (7) through the fixed effects model (FE) under the assumption of strict exogeneity since there is a need to control those characteristics which remain fixed over time. The idea is to assess the net effect of the predictor on the outcome variable. To this aim a robust standard error is needed to control for correlation within provinces (Baltagi, 2008). I also control for province-specific and time-specific effects to reduce the risk of omitted variables. Therefore, I cluster the sample of 102 provinces of the model. Moreover, time dummies are included to control for time effects as often as an unexpected variation or special events affect the outcome variable. If the assumption of strict exogeneity failed, there might be regulatory "bearings" or "buffer" measures to prevent the spread of any shocks from one province to other

provinces or regions and have an impact on the regressor. The Italian regions are equipped with emergency structures, the civil protection department, which is an organised structure, dependent on the Presidency of the Council of Ministers, which aims to intervene promptly and effectively in the situation of natural disasters or emergencies in the country. In fact, at the Global Platform for Disaster Risk Reduction (GP-DRR) in Cancun, Mexico on May 25, 2017, the head of civil protection Curcio Fabrizio said that the Italian civil protection system has been very much engaged in the post-emergency operations; since more or less 70 percent of the entire territory is seismically active and almost 75 percent of the building stock does not adhere to modern seismic standards (Marino et al., 2015). The Italian Civil Protection is a member of the GPDRR which is an international organization that aims at implementing practical measures to reduce economic losses caused by disasters and to effectively protect people, communities, and countries, along with their cultural heritage, health, livelihoods, and socioeconomic assets (Frigerio et al., 2019). In the last 15 years, civil protection interventions have been decisive after the earthquakes (L'Aquila 2009, Emilia Romagna in 2012 and Amatrice and Norcia in 2017) and the floods that hit the territories with a certain frequency. In the Italian panorama, research studies are financed by institutions through universities and research centers to understand these phenomena and to provide policy implications that minimise the damage.

4.2. Control variables

The control variables represent those factors that can have an impact both on the quality of development, life satisfaction or well-being and on the public health efficiency (PHE); the omission of which might distort the estimated impact of PHE on well-being at the provincial level. In recent decades, literature has paid increasing attention to the relationship between economic development, quality of development, life satisfaction or well-being at the local government level (Calcagnini & Perugini, 2019a; Burchi & Gnesi, 2016; Segre et al., 2011).

The control variables are income, taxes, transfers, elderly rate, and institutional quality index. As for income, Calcagnini & Perugini (2019a) argued that the impact of income on happiness or subjective well-being is a controversial issue in the literature. The debate on the relationship between happiness and the economy is currently growing steadily (Bruni & Stanca, 2008). Indeed, the results of Easterlin (1974)'s works had opened the debate on the famous happiness-income paradox. He had found that within a single country, at any given time, the correlation between happiness and income exists and is robust. Across countries, however, poorer countries do not always seem to be less happy than richer countries. One of the most prolific explanations for the happiness-income paradox was based on the relative consumption hypothesis; that is, people are confronted with some reference group when making consumption decisions; therefore, their individual utility does not depend only on the absolute level of consumption but on the relative one (Frank, 2005). Considering these arguments, if everyone is poorer and enjoys less consumption, nothing changes in relative terms and individual happiness, living standard, and well-being are not affected. However, those explanations of the happiness-income paradox do not consider interpersonal relationships as a source of happiness per se (S. Zamagni, 2006). In fact, Bradburn (1969) had found that social relationships are one of the strongest correlations of positive emotions. Bruni & Stanca (2008) found that the relational component of volunteering as active participation in volunteer organizations is associated with greater life satisfaction. If psychology has recognized the interpersonal relationship as an important

determinant of well-being, then relationality can be a basic human need Baumeister & Leary (1995) essential for health and well-being. Easterlin (2003, p. 11177) has also demonstrated that: “on average, an adverse change in health reduces life satisfaction, and the worse the change in health, the greater the reduction in life satisfaction”. Since he considers the terms happiness, utility, well-being, life satisfaction and welfare to be interchangeable, we can conclude that health efficiency has a major impact on well-being.⁶

The relationship between well-being and taxes represents an important finding in the neuroeconomic field (Harbaugh et al., 2007). In fact, the intrinsic motivation of taxpayers to pay taxes constitutes a new determinant of well-being, in the sense that tax honesty generates a greater pay-off than fraud for virtuous taxpayers compared to less virtuous ones (Lubian & Zarri, 2011). Many people pay taxes even when the probability of an audit and the expected penalty are very low.

However, it is more realistic to believe that people may behave differently when dealing with real tax authorities rather than experimenters. A Series of articles report a negative correlation between average levels of fiscal morale and the size of the shadow economy (Torgler & Schneider, 2009; Halla, 2012). Another important issue recalls the attention on the relationship between the government and taxpayers. In general, people are not that willing to pay taxes when they believe that government authorities spend money inadequately and sometimes use that money for their personal purposes (K. W. Smith, 1991). Spicer & Lundstedt (1976) argued that the taxpayer judges the fairness of the terms of trade offered to him by the state considering the quantity and the quality of goods and services supplied with respect to his payment and evaluates the structure of taxation or the fraud of other taxpayers. In fact, Andreoni et al. (1998) show that taxpayers think that it is right not to pay taxes when they are unfair.

Some empirical studies also find that well-being is positively correlated with intergovernmental transfers. Under the so-called capacity equalisation, which is more applicable to federal structures where sub-national levels of government have constitutional expenditure and revenue responsibilities; the aim is to provide each level of government with sufficient funds, own sources plus transfers, to provide a centrally predetermined level of goods and services Bird & Tarasov (2004); as happens in Italy where the central government transfers financial resources to local authorities to allow them to guarantee specific goods and services in sectors such as health, education, public transport, economic development and social protection etc; the main objective being to try to guarantee the same level of well-being to the whole population regardless of the initial endowments.

The aging process presents new long-term care needs to ensure the quality of life or living standard or well-being of an increasingly large segment of the population, the elderly (Ateca-Amestoy & Ugidos, 2013). The elderly rate can be defined as the proportion of elderly people aged 65 or above over of whole resident population. Public finance argues that the quality of life or living standard or well-being of elderly people is determined by three key factors: (1) health conditions, as widely demonstrated in the literature, greater health problems lead to lower well-being (Easterlin, 1974; Baumeister & Leary, 1995), and the public health system must be able to guarantee health care as a constitutional right; (2) financial conditions can generate a higher level of well-being considering that the elderly can enjoy their goods or investments as they have already paid loans or other debts (Ateca-Amestoy & Ugidos, 2013), and (3) finally social goods in the sense of relationality with their family or with the neighbourhood. Wahrendorf et al. (2006) argue in that sense that the quality of the interchange and the intensity of reciprocity are the key variables for well-being.

The Institutional Quality Index (IQI) is a composite indicator that evaluates the institutional quality in Italy. IQI is based on five elementary index groups (corruption assessment, governance, regulation, law enforcement and social participation) and measures institutional quality at the provincial level (Nifo & Vecchione, 2014). According to Helliwell (2011), the social context is one of the main determinants of subjective well-being and the improvement of the social context depends on the quality of the institutions.

5. Baseline results

Table 3 presents the fixed effects estimate results of equation 7, measuring well-being through the Provincial Index of Well-being (PIW) which is also the dependent variable, and the main predictor of interest, which is Public Health efficiency (PHE). To control for institutional, socioeconomic, and demographic variables that may play a key role in explaining differences in quality of development, life satisfaction or well-being, equation 7 includes dummies for each province, such that unobserved heterogeneity due to differences at the province level is controlled for. Therefore, all specifications include province-specific dummies and time-fixed effects over the period 2000 to 2016. The estimates are based on observations between [1326;1734] divided into 102 groups of 14 to 17 observations.

Table 3. Fixed Effects estimates of the impact of public health efficiency on the provincial index of well-being

Dependent variable: PIW

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
BEFF	0.646 * * *	0.546 * * *	0.548 * * *	0.543 * * *	0.543 * * *	0.541 * * *	0.565 * * *	0.633 * * *
	(0.243)	(0.180)	(0.178)	(0.177)	(0.176)	(0.175)	(0.151)	(0.104)
GDPPC		-1.14e-04 * * *	-1.69e-04 * * *	-1.68e-04 * * *	-1.68e-04 * * *	-1.73e-04 * * *	-1.32e-04 * * *	-3.76e-05
		(5.88e-06)	(3.84e-05)	(3.82e-05)	(3.77e-05)	(03.80e-05)	(2.54e-05)	(2.42e-05)
GDPPCSQ			9.54e-10	9.53e-10	9.49e-10	1.01e-09	6632e-10	-4.25e-04
			(6.97e-10)	(6.93e-10)	(6.87e-10)	(6.85e-10)	(4.65e-10)	(4.26e-10)
Taxes				0.0194 * *	0.0378	0.0423	0.0118	0.0563
				0.00175	0.0604	0.0570	0.0403	0.0457
Taxes2					-5.75e-04 1.83e-03	-7.05e-04 1.73e-03	9.37e-05 1.22e-03	-1.36e-03 1.38e-03
Transfers						0.147	0.132	0.0544
						0.123	0.0888	0.0858
IQI							1.108 * * * (0.178)	0.455 * * * (0.162)
Elderly rate								9.407 * * * (2.154)
Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations	1734	1734	1734	1428	1428	1428	1326	1326

Standard errors clustered at provincial level in parentheses; * $p < 0.10$, * * $p < 0.05$, * * * $p < 0.01$

The results of the estimate are reported in Table 3. To assess the impact of public health efficiency on well-being, I first estimate the model without controlling for the rest of the well-being determinants (column 1). The public health efficiency coefficient is positive and highly statistically significant. More specifically, the coefficient 0.646 is the expected change in the expected value of well-being (PIW) associated with a one-unit increase in the observation value i of public health efficiency (BEFF). In other words, a one-unit increase in BEFF observed in province i is associated with a 0.646 increase in the expected value of PIW.

Columns (2) and (3) present, respectively, the results that control for the income (GDPPC) and the square of the income (GDPPCSQ). The estimated income coefficient is negative and highly statistically significant (column 2). But this is not the case when the model is increased with the square of income (column 3) since GDPPC becomes negative and GDPPCSQ positive. Only GDPPC is highly statistically significant, GDPPCSQ is not significant. Moreover, the p-value of the F statistic of both GDPPC and GDPPCSQ is 0.0000; meaning that these two regressors are jointly significant for the model. This result is consistent with the controversial impact of income on well-being (Calcagnini & Perugini, 2019a). Columns (4) and (5) show estimated coefficient when the model is increased, respectively, with Taxes and the square of Taxes (Taxes2). Taxes positively affects well-being and it is statistically significant. But this is no more the case when the model

is increased by Taxes2. The Taxes coefficient remains positive and the Taxes2 coefficient negative; both coefficients are not statistically significant. But the p-value of the joint test of Taxes and Taxes2 is 0.0000, that is, both regressors are important for the model. These results are consistent with Levinson's (2012) findings. Transfers is positively correlated with well-being, but its coefficient is not statistically significant. The results are in line with Bird & Tarasov's (2004) one (column 6). Instead, columns (7) and (8) report an increase in the model, respectively with institutional quality index (IQI) and Elderly rate. The estimated IQI and Elderly rate coefficients are positive and highly statistically significant, with higher coefficients compared to other regressors (1.108 and 9.407) respectively. These results confirm (Easterlin, 1974; Baumeister & Leary, 1995) the findings and Helliwell's (2011) analysis, respectively.

6. Robustness checks

6.1. Reverse causality

The causal interpretation of regression results is generally difficult in the social sciences but is a particularly sensitive issue in the present analysis, given the characteristics of the relationships under investigation and the panel nature of the dataset (Bruni & Stanca, 2008). The finding of an association between public health efficiency (PHE) and provincial index of well-being does not in itself imply a causal relationship. This relationship could be a reverse causality, in the sense that the quality of development or well-being could lead to higher levels of the local public health system. Certainly, it cannot be ruled out that causality goes in both directions. Along these lines Easterlin (2003, p.11177) states: "if health is conceived unidimensionally, a plausible a priori argument can be made that life satisfaction affects health, as well as vice versa. But when health is characterized multidimensionally ... the plausible inference is that greater health problems result systematically in less happiness".

The possibility that endogeneity may arise from omitted variables affecting both dependent and explanatory variables should also be considered. However, the use of control factors and province-specific dummy variables in equation (7) makes this cause of endogeneity a relatively minor concern. To account for these potential endogeneity issues which can make inconsistent the fixed effects estimate, we also estimate the relationship of interest by instrumental variables (2SLS); that is, to estimate the causal effect of public health efficiency on well-being consistently and free from asymptotic bias from unobserved time-varying heterogeneity. Since it is generally difficult to find good and valid instruments, I use the lagged values of the public health efficiency as instruments (Reed, 2015). De facto the lagged values of public health efficiency are related to its current values but are not independently related to the quality of development, quality of life, living standard or well-being.

Table 4 reports the 2SLS estimation results of the impact of public health efficiency on well-being. By relaxing the assumption of strict exogeneity, the coefficients of the main regressor of interest are positive and highly statistically significant in all model specifications, indicating that the effect of public health efficiency on well-being is not spurious. The coefficient of the main predictor of interest is higher than the one obtained through the fixed effects estimates. For instance, in model (1) the fixed effects estimated coefficient of public health efficiency on well-being is 0.646, and when the model is estimated through a 2SLS estimate, it is equal to 0.870. In this estimation, the contribution of the control

variables appears remarkable, as the addition of these increased the statistical significance from model (1) statistically significant to model (6) highly statistically significant. Moreover, the coefficient of the last model (0.915) remains higher than that obtained in the previous fixed-effects model (0.633).

The Kleibergen & Paap (2006) rank LM statistic can be seen as an under-identification test of whether the equation is identified; that is, the excluded instruments are relevant, meaning correlated with the endogenous regressors. It is essentially the test of the rank of a matrix: under the null hypothesis that the equation is under-identified, the matrix of the reduced form coefficients on the excluded instruments (Z_i) has rank = $k-1$, where k is the number of endogenous regressors. Under the null hypothesis, that statistic is distributed as a Chi-squared (2).

Table 4. 2SLS estimates of the impact of public health efficiency on the provincial index of well-being

Dependent variable: PIW

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
BEFF	0.870 *	0.791 * *	0.774 * *	0.762 * *	0.762 * *	0.764 * *	0.788 * *	0.915 * * *
	(0.464)	(0.357)	(0.360)	(0.358)	(0.355)	(0.357)	(0.305)	(0.206)
GDPPC		-1.13e-04 * * *	-1.68e-04 * * *	-1.68e-04 * * *	-1.66e-04 * * *	-1.65e-04 * * *	-1.32e-04 * * *	-3.59e-05
		(5.29e-06)	(3.30e-05)	(3.27e-05)	(3.18e-05)	(3.30e-05)	(2.55e-05)	(2.43e-05)
GDPPCSQ			9.55e-10	9.56e-10	9.41e-10	9.27e-10	6.57e-10	-4.43e-10
			(5.95e-10)	(5.91e-10)	(5.76e-10)	(5.90e-10)	(4.67e-10)	(4.25e-10)
Taxes				0.0203 * * *	0.133 * *	0.134 * *	0.0124	0.0575
				(2.84e-03)	(0.0587)	(0.0579)	(0.0391)	(0.0446)
Taxes2					-3.53e-03 * *	-3.54e-03 * *	6.03e-05	-1.42e-03
					(1.77e-03)	(1.75e-03)	(1.19e-03)	(1.34e-03)
Transfers						-0.0320	0.125	0.0440
						(0.126)	(0.0896)	(0.0862)
IQI							1.103 * * *	0.442 * * *
							(0.181)	(0.165)
Elderly rate								9.502 * * *
								(2.162)
Kleibergen-Paap LM P-value	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Kleibergen-Paap Wald statistic	208.15	205.50	206.37	205.32	204.33	207.33	213.48	200.79
Number of observations	1632	1632	1632	1428	1428	1428	1326	1326

Standard errors clustered at provincial level in parentheses; * $p < 0.10$, * * $p < 0.05$, * * * $p < 0.01$

A rejection of the null hypothesis means that the matrix is full column rank, and the model is identified. Kleibergen & Paap

(2006) rank LM statistic indicates that all the specifications of our model are identified. Another important test is that of weak identification, which arises when the excluded instruments are weakly correlated with the endogenous regressors. In that case, the estimators, more likely, perform poorly and the Cragg & Donald (1993) test for weak instruments is not valid while a correspondingly robust Kleibergen and Paap Wald rank F statistic is appropriated. Stock & Yogo (2002) have compiled the critical values for the Kleibergen & Paap (2006) Wald rank F statistic which correspond to those of the Cragg and Donald F statistic for independent and identically distributed errors term case. According to those critical values, in all the specification models of equation (7), the null hypothesis that the equation is weakly identified is rejected since their values are all greater than 10, meaning that all the specification models are identified. The over-identification restriction test does not lead to rejecting the hypothesis of the validity of the instrument. Overall, the results of instrumental variable estimation appear to support the causal interpretation that public health efficiency has a positive impact on well-being.

6.2. Sensitivity analyses

6.2.1. Min-max linear scaling transformation

Over the past two decades, many composite indexes of economic and social well-being have been developed (Ferriss, 2000) and many of these have been proposed by public institutions, government agencies and the media (Hagerty et al., 2001). However, the advantages and disadvantages of each of them must be systematically evaluated. Besides, the robustness of the resulting index must also be assessed. Indeed, the descriptive analysis of our data makes it possible to highlight some weaknesses or criticalities that can give rise to cases of limited robustness of some indicators determined by rare phenomena, by strong links in the data of neighbouring territories and by the crushing of data on the values of provincial capitals or metropolitan cities. These are issues relating to the selection of indicators, issues relating to the synthesis of a set of variables. It is one of the reasons why the most appropriate method to be found to construct a composite index depends on the type of indicator, the type of aggregation and the type of weights used to build it (for Economic Co-operation & Development, 2011). Segre et al. (2011) argued that it also depends on the soundness of its assumptions, the good practices that assess its confidence and the uncertainties associated with its development process. A sensitivity analysis is carried out precisely to evaluate the effect of the methodology used to construct the basic composite indicator of the provincial index of well-being (PIW). It is a question of evaluating how the selected variables are treated with respect to the normalization, weighting, and aggregation procedures.

However, our sensitivity analysis is different from that developed by Segre et al. (2011) and Calcagnini & Perugini (2019a) to test the robustness of the regional quality of development index (QUARS); since I have built a time series of the provincial index of well-being (PIW). Our sensitivity analysis is based on one new well-being index in addition to the basic PIW. The procedure used for its construction consists in the first case of standardising all the variables to the base year 2000 through the minmax linear scaling technique, then aggregating the standardized variables within their respective dimensions through an arithmetic mean and finally aggregating the seven dimensions, once again, through an arithmetic mean to obtain the minmax provincial index of well-being (PIW-minmax).

As for the minmax linear scaling technique, the data are scaled in relation to the minimum and maximum values of the variable to the base year 2000. If an increase in the variable to be standardized corresponds to an increase in well-being,

then the variable is scaled as follows:

$$\frac{Value - min}{Max - min},$$

instead, if an increase in the variable to be standardised corresponds to a reduction in overall well-being, then the variable is scaled according to the complementary formula:

$$\frac{Max - Value}{Max - min}.$$

In the different aggregation processes all variables and dimensions have the same weight.

Table 5 reports the 2SLS estimates of the provincial index of well-being considering the min-max aggregation, which shows that public health efficiency still has a positive and significant impact on well-being even if the coefficients of the main regressor of interest are very low than those obtained in the previous analysis in all specification models. For example, the estimated coefficient of public health efficiency on well-being in model (1) is 0.216, instead of 0.713 in model (1) of the previous subsection. So, public health efficiency increases well-being at the provincial level, also considering the min-max linear scaling transformation.

Table 5. 2SLS estimates of the impact of public health efficiency on the provincial index of well-being with min-max linear scaling technique

Dependent variable: PIW with min-max linear scaling technique

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
BEFF	0.216 *	0.201 * *	0.199 * *	0.197 * *	0.197 * *	0.197 * *	0.132 * *	0.155 * * *
	(0.109)	(0.0866)	(0.0875)	(0.0874)	(0.0859)	(0.0863)	(0.0599)	(0.0441)
GDPPC		-2.16e-05 * * *	-2.82e-05 * * *	-2.82e-05 * * *	-2.76e-05 * * *	-2.77e-05 * * *	-1.23e-05 * *	4.91e-06
		(1.32e-06)	(9.04e-06)	(9.00e-06)	(8.71e-06)	(8.92e-06)	(5.45e-06)	(5.21e-06)
GDPPCSQ			1.15e-10	1.15e-10	1.10e-10	1.11e-10	-2.45e-11	-2.22e-10 * *
			(1.62e-10)	(1.62e-10)	(1.57e-10)	(1.59e-10)	(9.97e-11)	(9.24e-11)
Taxes				3.19e-03 * * *	0.0379 * *	0.0379 * *	-6.58e-03	1.53e-03
				(8.89e-04)	(0.0151)	(0.0152)	(9.10e-03)	(9.15e-03)
Taxes2					-1.08e-03 * *	-1.08e-03 * *	2.49e-04	-1.66e-05
					(4.58e-04)	(4.60e-04)	(2.76e-04)	(2.76e-04)
Transfers						1.14e-03	0.0358 * *	0.0213
						(0.0319)	(0.0145)	(0.0145)
IQI							0.162 * * *	0.0433
							(0.0335)	(0.0312)
Elderly rate								1.706 * * *
								(0.407)
Kleibergen-Paap LM P-value	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Kleibergen-Paap Wald statistic	208.151	205.502	206.365	205.323	204.329	207.332	213.479	220.794
Number of observations	1632	1632	1632	1428	1428	1428	1326	1326

Standard errors clustered at provincial level in parentheses; * $p < 0.10$, * * $p < 0.05$, * * * $p < 0.01$

6.2.2. Dimensionality

The issue of dimensionality can also be considered, that is, verifying whether the results of the PIW are sensitive to the exclusion of one of the dimensions, in particular the health dimension (Saltelli et al., 2008). Let's remove that dimension and construct a new provincial index of well-being by aggregating the other six dimensions through the simple arithmetic mean and re-examining the relationship between public health efficiency and the provincial index of well-being.

The results are reported in Table 6 and confirm that the coefficient of the main regressor of interest is positive and statistically significant in all specification models. Moreover, the size of these coefficients is in line with the one obtained through the 2SLS estimates of public health efficiency on well-being, showing that the input and output variables used to derive technical efficiency are not correlated with those used to calculate *Health* dimension. Therefore, we can conclude in light of these analyses that public health efficiency increases well-being at the provincial level.

Table 6. 2SLS estimates of the impact of public health efficiency on the provincial index of well-being without the *Health* dimension**Dependent variable:** PIW without health dimension

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
BEFF	0.713 *	0.644 *	0.630 *	0.617 *	0.617 *	0.617 *	0.757 * *	0.876 * * *
	(0.412)	(0.328)	(0.331)	(0.329)	(0.327)	(0.327)	(0.296)	(0.206)
GDPPC		-9.87e-05 * * *	-1.43e-04 * * *	-1.43e-04 * * *	-1.42e-04 * * *	-1.42e-04 * * *	-1.17e-04 * * *	-2.79e-05
		(5.25e-06)	(2.88e-05)	(2.86e-05)	(2.80e-05)	(2.89e-05)	(2.36e-05)	(2.27e-05)
GDPPCSQ			7.70e-10	7.71e-10	7.61e-10	7.67e-10	5.66e-10	-4.57e-10
			(5.23e-10)	(5.19e-10)	(5.10e-10)	(5.19e-10)	(4.35e-10)	(3.98e-10)
Taxes				0.0219 * * *	0.0983 *	0.0982 *	-2.86e-03	0.0392
				(1.91e-03)	(0.0556)	(0.0559)	(0.0406)	(0.0373)
Taxes2					-2.38e-03 (1.68e-03)	-2.38e-03 (1.69e-03)	5.82e-04 (1.23e-03)	-7.92e-04 (1.13e-03)
Transfers						0.0127 (0.114)	0.149 * (0.0846)	0.0735 (0.0808)
IQI							0.959 * * * (0.174)	0.344 * * (0.161)
Elderly rate								8.842 * * * (1.983)
Kleibergen-Paap LM P-value	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Kleibergen-Paap Wald statistic	208.151	205.502	206.365	205.323	204.329	207.332	213.479	220.794
Number of observations	1632	1632	1632	1428	1428	1428	1326	1326

Standard errors clustered at provincial level in parentheses; * $p < 0.10$, * * $p < 0.05$, * * * $p < 0.01$

Concluding remarks

The burgeoning interest in quality of development, quality of life, living standard or life satisfaction has certainly produced efforts to increase the quantity and quality of well-being data, research, and policy analysis (Calcagnini & Perugini, 2019a). Since the signing, in September 2000, of the main objectives of the "New Millennium Development", there has been an increase in studies on the theme of well-being in the world and particularly in Italy where the issues of equity, equality and green development have been held in public debates and have recalled the attention of scholars and policymakers.

Despite differences in methodologies and theoretical approaches, all studies show an attempt to overcome the use of the

gross domestic product (GDP) as a measure of well-being Monni (2002); Burchi & Gnesi (2016); Segre et al. (2011); Calcagnini & Perugini (2019a, b). One of the important aspects of these studies is that the dimensions of well-being are linked to local characteristics and consequently, the index of well-being shows a high degree of variability within some Italian regions and among neighbouring provinces.

I focused on the relationship between public health efficiency and well-being. I estimate an empirical model and its coefficient shows that public health efficiency maintains a significantly positive effect on well-being. Indeed, when I estimate the model through a fixed effects estimate, the coefficient is high (0.646) and increases in size and magnitude when estimating the model through 2SLS estimates (0.870) and through 2SLS but, removing Health's dimension in the construction of a provincial index of well-being (0.713). Conversely, this coefficient is low (0.216) when I estimate the model through 2SLS but considering a provincial index of well-being deriving from the min-max linear scaling transformation. Therefore, I can say that the empirical model is robust to instrumental variable estimation and consequently to address potential simultaneity. These results confirm the theoretical hypothesis and are in addition to the existing literature that investigates the reasons for the persistent socioeconomic backwardness of Southern Italy (V. Zamagni, 1978; Daniele & Malanima, 2014; Di Liberto & Sideri, 2015). However, these findings should also attract the attention of local authorities, which play an important role in designing and implementing policies to promote the efficiency of local public health which, in turn, will increase the well-being of individuals and communities.

Moreover, the impact of public health efficiency on well-being is measured over a seventeen-year period and is analysed empirically through a balanced panel data model. It is the first time that a study on well-being and its determinants, at a local level, has been carried out using a panel data model; almost all the empirical analyses are examined through a cross-section analysis (Bruni & Stanca, 2008; Calcagnini & Perugini, 2019a).

Finally, it is well known that empirical studies on well-being are somewhat controversial as the construction of the well-being index strongly depends on its definition and the variables used, which in turn depend on the subjectivity of the researcher. Nevertheless, our findings are robust to different model specifications and support the theory that public health efficiency positively affects well-being. This must be exploited by local public authorities in the definition of policies to increase people's well-being.

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Footnotes

¹ Capability approach of Amartya Sen states that progress does not coincide with a country's level of opulence, but rather with people's quality of life and freedom of choice (Sen, 1994)

² Glasgow Centre for Population Health (GCPH). The built environment and health: an evidence review, 2013

³ This seems to have occurred in Italy after the first reform of the National Health Service in 1978 until the 1990s

⁴ Source: <https://www.ilsole24ore.com/art/covid-e-crisi-post-pandemia-ansia-e-stress-nove-studenti-dieci-AEiGCDaB>

⁵ BCC refers to Banker, Charnes and Cooper, who developed the model

⁶ Even though we are aware that those notions are not conceptually identical

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