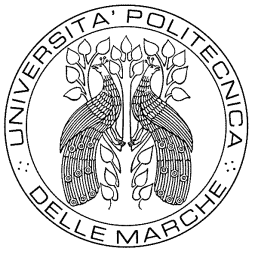

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The impact of public health efficiency on income disparities and well-being: Evidence from Italian provinces

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1 Introduction

National governments play a key role in the development and growth process and in the well-being of the population and community in each country. Governments derive their legitimacy from the need to ensure the implementation of policies focused on the effective and efficient use of available resources, be they natural, labour, material and informational, guaranteeing equity in income redistribution and the provision of guarantees of fundamental social rights and freedoms, as well as the maintenance of law and order. In fact, in the context of modern welfare economics, the efficiency of a government is measured by the degree to which the public sector performs these tasks (Kokhanovskaya *et al.*, 2019).

The public finance ideally suggests that every government has three main problems to solve: the achievement of a more equitable distribution of income; maintaining high employment with stable prices and creating an efficient pattern of resource use i.e., ensuring an efficient allocation of resources over time or an efficient economic growth model (Oates *et al.*, 1972). The complexity of the simultaneous meeting of these three questions suggests that an efficient government can find the best possible solution within a framework of freedom and justice. This is relevant because a government may be able to guarantee the population an efficient provision of goods and services as closely as possible to their needs. Government efficiency also means doing more for less. It is about maximising outcomes, such as the volume of services provided, while minimising the inputs (quantity of resources or capital) needed to produce those services and maintain or improve quality. Efficiency can be measured by how much it costs to deliver a programme compared to previous years, or the relative results government gets from a certain level of spending. Valeriani *et al.* (2011) show that government efficiency leads to higher economic growth and reduces income disparities among local governments. An earlier study by Lessmann (2009) showed empirically that when government efficiency is high, economic growth reduces income disparities in developed countries. Analysing the same topic in developing countries, Lessmann (2012) finds that the quality of government plays an important role in deepening income disparities among localities. These results are confirmed by Hung *et al.* (2020)'s findings showing

provinces in Vietnam. On the other hand, Helliwell e Huang (2008) point out that the ability of government to provide a reliable environment and deliver goods and services efficiently increases overall well-being. Italy can be seen as a special case as it may be used to illustrate the benefits that efficiency can bring to governments (central, regional and local). Helliwell e Putnam (1995) examine the case of Italy and find a strong convergence of economic development and growth between northern and southern regions during the 1960s and 1970s and significant evidence that convergence is faster and income levels higher in regions with more social capital measured as civic community index, regional government efficiency index, or citizen satisfaction surveys with regional governments. In fact, the regional government index and the citizen satisfaction survey indicate that not only were services such as education, health, public transport, cultural affairs, among others, efficiently provided, but also that the citizenry recognised this. However, they also find a clear reversal of convergence from 1983 to 1990 and argue that the lack of efficiency in implementing regional government reforms, especially in the south was partly responsible for this reversal, which represents the historical dichotomy registered in Italy during the occupation period (Daniele e Malanima, 2014) and (Di Liberto e Sideri, 2015). Finally, they show that citizens' satisfaction after regional government reforms increases in the North rather than in the South, as efficient regional governments foster greater economic growth. Daniele e Malanima (2014) also find similar results and show that while regional convergence has occurred within both northern and southern regions, the divergence between North and South persists. This discussion leads us to argue that government efficiency enables better economic growth, lower income disparities and higher overall well-being across Italian provinces.

It is relevant to study government efficiency in health sector because greater public health efficiency may generate higher labour productivity which may reduce disparities in the income distribution and increase the well-being of individuals and communities. These issues have not been addressed in the literature and through this thesis, an attempt is made to illustrate the theoretical link between more public health efficiency, more labour productivity, less income disparities and more well-being. In other words, public health efficiency promotes a quantitative and qualitative increase in labour productivity because an efficient health system allows the worker to receive treatment, recover health and return to work as soon as possible, effectively maintaining productivity gains, reducing income disparities and increasing overall well-being. Therefore, an attempt is made to show that higher public health efficiency determines more labour productivity, reduces income disparities and increases the overall well-being of population among Italian provinces. In this thesis, we follow the so-called traditional interest in government efficiency in which studies on public sector efficiency have mainly focused on the efficiency of particular areas of public service delivery such as education, health services, local public transport, economic affairs, cultural affairs, etc.[1]

[1]For interesting contributions see Barbetta e Turati (2001), Afonso *et al.* (2005) and De Nicola *et al.* (2012, 2014).

The thesis is divided into three chapters. The first chapter provides a review of the literature on government efficiency, illustrating, firstly, its definition; secondly, its measurement methods and, finally, the related literature. The public finance literature defines three types of efficiency: technical efficiency, productive efficiency and allocative efficiency. Technical efficiency defines the relationship between inputs (capital and labour) and outcome; productive efficiency defines different combinations of inputs according to their relative costs and the derived outcome; and allocative efficiency defines both the productive efficiency with which resources are used to produce a given outcome and the efficiency with which these outcomes are distributed within a given community. The methods used to measure government efficiency are essentially divided into two groups: quantitative and qualitative methods. The most widely used quantitative methods include data envelopment analysis, free disposal hull, stochastic frontier approach and speed of payment. Qualitative methods, on the other hand, include balanced scorecard, performance rating and self-assessment health. The literature background illustrates the relationship between government efficiency and some socio-economic outcomes intimately linked to it. That is, fiscal decentralisation, economic growth, income disparities and well-being.

Chapter 2 analyses the impact of public health efficiency on income disparities in Italian provinces through the transmission channel of labour productivity and is organised as follows. First, the origin, evolution and funding of the Italian health system are illustrated, moving from a system based on insurance funds to the current system managed by both the central and regional governments and financed by local taxes and transfers from the central government. Second, the theoretical background is reviewed, in which the theoretical hypotheses are illustrated:

Hypothesis 1. Public health efficiency should reduce income disparities in Italian provinces. The idea is that improving health efficiency may determine the reduction of differences on the distribution of income among provinces, with the labour productivity being an important channel.

Hypothesis 2. Public health efficiency should be expected to be labour productivity enhancing to the extent that it increases the quality and quantity of labour. Third, public health efficiency indexes are evaluated through data envelopment analysis and bootstrap-data envelopment analysis to strengthen the results. This process seems to be suitable for measuring public health efficiency in Italy (De Nicola *et al.*, 2012, 2014). Fourth, income disparity indexes are calculated through personal income tax and taxpayers aggregated at provincial level, i.e., the population-weighted coefficient of variation and Theil indexes. Fifth, the econometric strategy is illustrated. Sixth, the baseline results are shown, in which it is demonstrated that public health efficiency negatively and significantly affects income disparities. Seventh, the robustness of the previous results is checked. Eighth, the transmission channel through which public health efficiency reduces income disparities is developed.

Chapter 3 examines the impact of public health efficiency on well-being in the Italian provinces. The chapter is organised as follows. First, the theoretical

background is presented, in which the last theoretical hypothesis of this thesis is illustrated:

Hypothesis 3. Public health efficiency should increase the overall well-being at provincial levels of government. Second, the provincial index of well-being is calculated following the QUARS (quality of regional development index) model used in the studies by Segre *et al.* (2011) and Calcagnini e Perugini (2019b) to assess the quality of regional development (QUARS) index at the regional and provincial levels of government, respectively. In this section all the 27 variables used to construct the provincial index of well-being are described as well as the methodology. Third, the econometric strategy is explained. Fourth, baseline results are presented showing that public health efficiency has a positive and significant impact on well-being across Italian provinces. Fifth, robustness checks show that not only is there no reverse causality problem, but sensitivity analysis confirms the baseline results. Therefore, in this thesis, we show that public health efficiency reduces income disparities through the channel of labour productivity and increases the overall well-being in Italian provinces.

2 A literature review on government efficiency

2.1 Definition of government efficiency

The debate on public finance is essentially about the rationalisation of economic and financial resources in developed, emerging, and developing countries. This practice of rationalising or rather reducing investment expenditure and current expenditure, based on the elimination of any waste of resources appears necessary to increase the performance and efficiency of the public sector to cope with the persistent economic crisis that has afflicted almost all countries in the world since the late 1980s. Boetti *et al.* (2011) identified the reorganisation of some states in the "federal" sense as one of the policies capable of providing solutions to that issue.

The implementation of regionalist designs (Italy) and federalist designs (Australia, Canada, Ethiopia, Germany, Nigeria, Spain and Switzerland) have facilitated the redistribution of functions and powers among the different levels of government (central government, regional government and local government) based on the criterion of closer proximity of institutions to citizens (Bosi, 2010; Brosio e Piperno, 2014), on the criterion of accountability (Hauner e Kyobe, 2010; Sacchi e Salotti, 2014), and above all, on the criterion of effective and efficient management of available resources (Musgrave, 1959; Oates *et al.*, 1972). In this sense, the equation to be solved is how to combine the effective and efficient management of public resources by implementing waste reduction policies of resources collected at local level and the various incoming intergovernmental transfers.

Public finance, theoretically, suggests that public goods are provided as a result of transfers, and tax revenues and are widely appreciated by individuals and communities. However, there is a significant political cost of taxation since it reduces the popularity of politicians and their likelihood of being re-elected (Geys *et al.*, 2010, 2013). The reluctance to pay taxes and the appreciation of the provision of public goods indicate that voters are concerned with a cost-efficient provision of public goods (Geys *et al.*, 2013). Along this line,

Musgrave (1959) argued that individual preferences must be translated into a budgetary decision through a political process, involving the individual preferences recorded by the vote and the response of those political parties or leaders to whom the voter delegates the final decision. Seen from this angle, the effective and efficient management of resources in the public sector largely departs from the original definition of the concept of efficient management of resource use proposed by the Italian economist Vilfredo Pareto and taken up by Musgrave: "A given economic arrangement is efficient if there can be no rearrangement which will leave someone better off without worsening the position of others. Thus, it is impossible in this situation to change the method of production, the mix of goods produced, or the size of the public sector in a way which would help A without hurting B and C. If, on the other hand, such a change is possible, then the prevailing arrangement is inefficient and an efficiency gain can be had by making the change" (Musgrave, 1989, p. 60).

On the other hand, the public sector literature also seems to agree that greater efficiency of government is the only way to avoid an increase in public sector expenditure and consequently, an increase in taxes. It can be observed that, in emerging countries, rapid economic growth leads to an increase in demand for public services which, in turn, generates an increase in public spending for the "Wagner law" and the only way to avoid rise in the tax burden is to achieve higher levels of efficiency through good governance and greater institutional quality (Easterly e Levine, 1997; Hauner e Kyobe, 2010). It should be noted that Wagner's law, by the German economist Adolph Wagner, states that the causes of the increase in public expenditure fall into three categories: a) the replacement of private activities arising from industrialisation and urbanisation; b) the existence, between the public good, of higher goods (education and culture) whose demand increases more than proportionally with respect to income; c) the time horizon in which the convenience of certain investments (railway infrastructure) which requires increasing public intervention, is measured as well as the existence of natural monopolies. Put differently, the income elasticity of a significant number of public goods exceeds the unit and therefore the ratio of non-military public expenditure to gross domestic product (GDP) tends to grow with GDP per capita (Di Majo, 1998).

Three types of efficiency can be defined in the literature: technical efficiency, productive efficiency, and allocative efficiency. In general, technical efficiency refers to the relationship between input-resources (capital and labour) and outcome. A technically efficient intervention is obtained when the maximum possible improvement of the outcome is obtained from a series of inputs. Conversely, an intervention is technically inefficient if an equal or greater result can be produced with less than one type of input (Worthington, 2000).

However, following Palmer e Torgerson (1999) technical efficiency cannot directly compare alternative interventions, in which an intervention produces the same or better outcome with less or more than one resource and more than another. As different combinations of inputs are used, the choice between interventions is based on the relative costs of these different inputs. Therefore,

productive efficiency refers to maximising a given outcome for a given cost or minimising the cost for a given outcome. As for the single function of the public sector, productive efficiency makes it possible to assess the relative quality-price ratio of interventions with directly comparable outcomes. It cannot address the impact of reallocating resources to a wider level because the outcomes provided are disproportionate.

To take resource allocation decisions in a wider context, an overall or global efficiency measure is needed. The concept of allocative efficiency considers not only the productive efficiency with which the resources of a given public sector function is used to produce a given outcomes, but also the efficiency with which these outcomes are distributed within the community. As stated above, theoretically, the efficient model of resource use is such that any alternative model worsens the situation of at least one person. In practice, strict compliance with this criterion proved impossible. Moreover, this criterion would eliminate the inefficient changes that have led many people to feel much better at the expense of some slightly worse. Allocative efficiency is obtained when resources are allocated to maximise the well-being of the community.

Therefore, the technical efficiency addresses the problem using to the maximum advantage given resources; productive efficiency that of the choice of various combinations of resources in order to obtain the maximum benefit at a given cost; and allocative efficiency the question of achieving the right mix of political programs to maximise the well-being of society (Palmer e Torgerson, 1999). Although productive efficiency implies technical efficiency and allocative efficiency implies productive efficiency, the reverse implications do not necessarily hold. Palmer e Torgerson (1999) also argue that in case of budget constraints, the concept of productive efficiency will eliminate as inefficient given combinations of technically efficient resource inputs, and the concept of allocative efficiency will eliminate some productively efficient resource allocations.

2.2 Economic definition of efficiency

Considering a production process that uses n inputs $X \in R_+^N$ to obtain m outputs $Y \in R_+^M$. The maximum level of outputs Y deriving from the use of inputs X and, conversely, the minimum level of inputs X necessary to obtain outputs Y, is defined as follow (Barbetta e Turati, 2001, p. 103):

$$P : R_+^N \longrightarrow Y = P(X) : R_+^M \longleftrightarrow L : R_+^M \longrightarrow X = L(Y) : R_+^N;$$

where the hypothesis on the concavity of the production process is also assumed; that is $Y' > 0$ and $Y'' < 0$. Therefore, production units considered inefficient, given a certain level of use of inputs X, do not produce maximum outputs Y (or conversely, given a certain level of production Y does not minimise the use of inputs X). That is the technical inefficiency or Debreu-Farrell inefficiency (Lovell *et al.*, 1993).

There is also allocative inefficiency or Koopmans inefficiency other than technical inefficiency which not only considers the previous production process, but also considers the cost w of the inputs X and the price p of the outputs Y. Therefore, the production process is efficient in an allocative sense if it chooses the quantities of inputs X that minimise its costs. A production process that is technically efficient may be inefficient in the allocative sense, but the reverse is not true (Lovell *et al.*, 1993).

An important issue to consider is the constraints imposed on public finance by the Stability and Growth Pact[1] and Fiscal Compact[2], which have imposed on EMU countries the control of their budgetary balances and the stock of debt with respect to general government, that is in the case of Italy, consolidating the accounts of central government, sub-national governments and social security institutions (D'Inverno *et al.*, 2018; Santolini, 2020).

The Domestic Stability Pact (DSP) is a set of rules adopted by the Italian Parliament with the aim of involving local authorities in the achievement of public finance objectives that the country has assumed by adhering to the Stability and Growth Pact. Patrizii *et al.* (2006) claimed that an examination of the debt trend of the Italian public administration, disaggregated by sector (central government, social security agencies, regional government, and local government) not only highlights the difficulties in linking the balance valid for the purposes of the SGP and the aggregate adopted for the domestic constraint, but also that the SGP is programmatic in nature. In fact, it can be shown that both the definition of the financial balance and the expenditure to be considered for the purposes of the DSP have been modified each year. Following the 2008-2009 financial crisis, which highlighted the criticalities of the rules of the DSP, tightening its limits, a process of gradual adjustment and consolidation of these rules was introduced with Decree Law N. 112/2008. On April, 17th 2012 Constitutional Law N. 1/2012 was approved with the aim of introducing a balanced budget into the Italian constitution, in compliance with the constraints deriving from European Union regulations. Therefore, the definition of government efficiency considers the existence of a trade-off between the compliance with budgetary constraints and the effective provision of public goods and services.

Despite the broad interest in government efficiency, studies measuring the efficiency of the public sector have focused mainly on efficiency in particular sector of the provision of public goods and services such as education, health services, local public transport, economic affairs, cultural affairs (e.g., library, museum, theatre), social affairs (e.g., residential home for elderly, welfare centre), sport facilities (e.g., public swimming pools, sport fields), and traffic

[1]The Stability and Growth Pact (SGP) is an international agreement, concluded and signed in 1997 by the Member States of the European Union, to control their public budgetary policies, in order to maintain the requirements for accession to the Economic and Monetary Union of the European Union (Eurozone) or to strengthen the path of monetary integration undertaken in 1992 with the signing of the Maastricht Treaty.

[2]The Fiscal Compact was created to provide solutions to the problems that have arisen in respecting the convergence rules of the Stability and Growth Pact. These changes led to the birth of the Fiscal Compact on 30 January 2012 signed by the European Council.

facilities (e.g., tram, harbour) (Barbetta e Turati, 2001; Afonso *et al.*, 2005; De Nicola *et al.*, 2012, 2014). Geys *et al.* (2013) argue that "composite" or "global" efficiency measurements are more difficult to implement because it is difficult to define appropriate indicators for quantity and quality at such a general level. However, there are many articles that have assessed the "global" efficiency of local government around the world: Italy (Bollino *et al.*, 2012; Lo Storto, 2013), Belgium (Geys e Moesen, 2009), Brazil (Da Cruz e Marques, 2014), Finland (Loikkanen e Susiluoto, 2005), Germany (Geys *et al.*, 2010; Kalb *et al.*, 2012), Greece (Athanassopoulos e Triantis, 1998; Doumpos e Cohen, 2014), Japan (Nijkamp e Suzuki, 2009; Nakazawa, 2013), Norway (Borge *et al.*, 2008), Portugal (Afonso e Fernandes, 2006, 2008; Afonso e Venâncio, 2016; Da Cruz e Marques, 2014), the Czech republic (Št'astná e Gregor, 2015), and Spain (Prieto e Zofio, 2001; Balaguer-Coll *et al.*, 2007, 2013; Benito *et al.*, 2010; Cuadrado-Ballesteros *et al.*, 2013).

In Italy, discussing the efficiency of the public sector requires first of all a correct evaluation of the performance of public government institutions (central government, regional governments, provincial administration and municipalities, etc.) for which the application of the microeconomics categories of input and output, of production function and cost is not so obvious (Boetti *et al.*, 2011; Geys *et al.*, 2013). Moreover, the concept of efficiency applied to the functions performed by government institutions may take on a meaning of relative productivity as it is the case for the activities carried out by firms Boetti *et al.* (2011) and may derive from a careful assessment of the capacity of these institutions to better allocate resources to the objectives to be achieved, ensuring acceptable levels of essential public services while minimising production costs (Musgrave, 1959; Oates *et al.*, 1972). Along this line, the public sector can be more or less efficient on the basis of a benchmarking analysis with other units involved in the same production process Bogetoft e Otto (2010) and will be spoken of greater efficiency only when from such comparison it will emerge that the public sector is able to achieve the same final results in terms of goods and services delivered using fewer resources (Farrell, 1957).

2.3 Measurement and methodological issues

The question of measuring efficiency arises with the seminal works of Farrell (1957) in the private sector and outspread by the works of (Charnes *et al.*, 1978). It took until the 1990s to develop efficiency measures in the public sector (D'Inverno *et al.*, 2018). Nowadays, the existing literature on the measurement of public sector efficiency can be essentially divided into two macro groups: quantitative and qualitative analysis.

2.3.1 Quantitative analysis

Several methods have been developed over the past three decades to address the empirical issues of estimating the frontier of unknown and unobservable public sector efficiency. However, the commonly used methods follow a para-

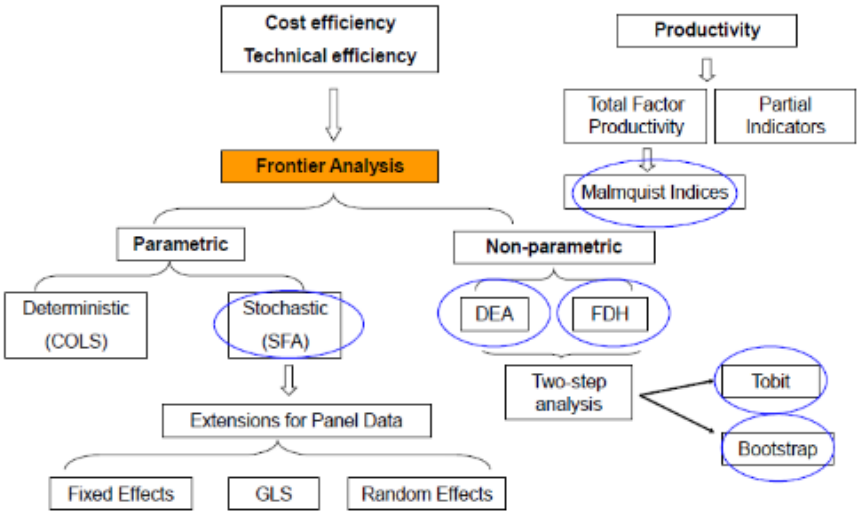


Figure 2.1 – Efficiency assessment methods
Source: elaboration of Afonso *et al.* (2020, p. 10)

metric or non parametric approach and a stochastic or deterministic approach. The parametric approach assumes a specific functional form for the relationship between input and output as well as for the inefficiency term embedded in the deviation of the values observed from the frontier; it is based on econometric methods. The non parametric approach evaluates the frontier directly from the data without imposing any specific functional constraints: it uses mathematical programming techniques. The deterministic approach considers all deviations from the frontier as a source of inefficiency, while the stochastic approach considers those deviations as a combination of inefficiency and random shocks outside the control of the decision maker. Among the numerous techniques belonging to the parametric and stochastic approach, stochastic frontier analysis (SFA) plays an important role, while the data envelopment analysis (DEA) and the free disposal hull (FDH) are among the most used method of non parametric and deterministic approach. For an excellent review of early contributions see Farrell (1957), Charnes *et al.* (1978), Worthington (2000), Cooper *et al.* (2001, 2006, 2011) and Geys *et al.* (2013). Figure 2.1 shows some available methods for the evaluation of efficiency in which DEA, FDH and SFA are highlighted among others because they are the most suitable in evaluating the efficiency of public sector.

Data envelopment analysis and Free disposal hull

The DEA method is a non-parametric frontier approach based on a linear programming framework. It is widely accepted across all disciplines for benchmarking studies. Cooper *et al.* (2011) define the DEA as a relatively new "data oriented" approach for evaluating the performance of a set of peer entities called decision making units (hereafter, DMUs), which convert multiple inputs into multiple outputs. As the matter of fact, the DEA applications used

DMUs of various forms to evaluate the performance of entities including the performance of countries or regions, since they require very few assumptions. Munim (2020) argued that in DEA, a virtual frontier defining the best in class is estimated based on the inputs and outputs of the DMUs and then, other DMUs are compared with the best in class to estimate the technical efficiency.

To measure technical efficiency, defined as the ability of a set of peer entities or DMUs to produce a given set of outputs with minimal inputs, the input-oriented study is applied. Alternatively, the output-oriented study assesses the maximum level of output which can be produce with a given set of inputs. The two measures produce the same results under constant return to scale and different results under variable return to scale. The efficiency scores are calculated with respect to an empirical frontier Hauner e 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. Inefficient DMUs scores belong to the interval [0,1), where a score of 0.8, for instance, implies that the same output might be produced with only 80% of the input.

The DEA approach is suitable for its ability to identify the frontier without any a priory 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:

$$
\begin{aligned}
&min \quad \theta, \\
s.t. \quad &\sum_j \lambda_j X_{jn} \leq \theta X_{in}; \quad n = 1, 2, ..., N \\
&\sum_j \lambda_j Y_{jm} \geq Y_{im}; \quad m = 1, 2, ..., M, \\
&\lambda_j \geq 0; \quad \sum_j \lambda_j = 1; \quad j = 1, 2, ..., J,
\end{aligned}
\tag{2.1}
$$

where θ represents the efficiency scores of each province i; X_{in} are the N x I input matrix; Y_{im} are the M x 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,. . . ,J. 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, (2.1) becomes:

$$
\begin{aligned}
&min \quad \theta - \varepsilon\left(\sum_m S_m^+ + \sum_n S_n^-\right), \\
s.t. \quad &\sum_j \lambda_j X_{jn} + S_n^- = \theta X_{in}; \quad n = 1, 2, ..., N,
\end{aligned}
\tag{2.2}
$$

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

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

The linear programming envelopment problem (2.1) provides technical efficiency scores which can be considered as weak efficiency scores since it does not account for slack in some inputs. To overcome this issue, the linear programming envelopment problem (2.2) provides the efficiency scores taking into account the slacks. Therefore, a DMU is efficient if it lies on the frontier and $S_m^+ = 0$ and $S_n^- = 0$.

In DEA, the production frontiers are divided into two main classes: the convex and the non-convex frontiers. FDH frontier approach are an important class of DEA non-convex production frontier. The first model of FDH production frontier was introduced in public sector by Deprins *et al.* (1984). The FDH method imposes the fewest restrictions on data compared to DEA, as it only assumes the free disposability of resources and seems to provide higher efficiency scores than their convex counterparts, considering production process with different return to scale (constant, variable, non-increasing, and non-decreasing). Single input-output DEA and FDH production frontier are illustrated in Figure 2.2 which shows not only a piecewise linear locus connecting all the efficient decision-making units (DMUs), that is, the DEA production frontier but also shows the FDH vertical step-ups frontier. The feasibility hypothesis, shown by the piecewise linearity, implies that the efficiency of C is not only classified with respect to the real performers A and D, called peers of C, but is also assessed with a virtual decision maker, V, which uses a weighted collection of inputs A and D to produce a virtual output, DMU C, which would have been considered efficient by FDH, is below the variable returns to scale efficiency frontier, XADF, according to the DEA ranking. FDH tends to assign efficiency to more DMUs than DEA. The only difference between DEA and FDH is that the DEA estimator assumes that the efficient frontier is convex instead of vertical step-ups frontier for FDH. The input-oriented technical efficiency of C is now defined by $\frac{Y_V}{Y_C}$ (Charnes *et al.*, 1978) and (Banker *et al.*, 1984). If instead the production set is characterised by a constant return to scale technology, the frontier may likely be represented by a radius that extends from the origin through the efficient DMU (OA). Following this standard, only A maybe rated efficient. However, the XADF frontier reflects the variable return to scale: the XA segment reflects the local increasing returns to scale, the AD and DF segments reflect the decreasing returns to scale. It should be remembered that the constant returns to scale of technical efficiency is equal to the product of variable returns to scale of technical efficiency and scale efficiency. Therefore, the DMU D is technically efficient but scale inefficient, while the DMU C is neither technically efficient nor scale efficient. The scale efficiency of C is evaluated as $\frac{Y_N}{Y_V}$ (Charnes *et al.*, 1978) and (Banker *et al.*, 1984).

As extensively found in the literature, government efficiency can be measured through DEA and FDH methods. In most cases, a Banker, Charnes, and

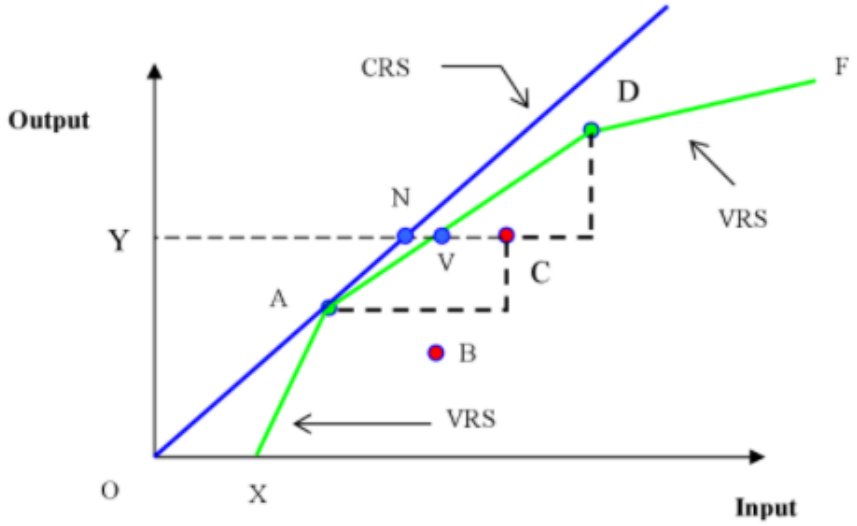


Figure 2.2 – DEA and FDH production frontier
Source: elaboration of Herrera e Ouedraogo (2018, p. 5)

Cooper (BCC) variable returns to scale (Banker *et al.*, 1984) is used instead of a Charnes, Cooper, and Rhodes (CCR) constant returns to scale (Charnes *et al.*, 1978), in accordance with theoretical models of fiscal policy, in which the positive effects of productive government spending weaken as government or spending ratios become larger (Barro, 1990).[3] Following Rayp e Van De Sijpe (2007), the BCC model that measures government efficiency involves identifying a production possibility frontier constructed by "enveloping" the data points under the assumption of convexity and free disposability, while containing all observed input-output combinations. Moreover, government efficiency is measured as the distance to the constructed production possibility frontier.

The FDH model outperforms the basic DEA model by assuming free disposability; that is, by relaxing the convexity assumption of the basic DEA model in defining the production possibility set from observations. The FDH model is considered as an update of the basic DEA model. The shape of the FDH production frontier resembles that of a step-ups. DEA and FDH are alternative non-parametric techniques for constructing production possibility frontiers, and for measuring the performance of production units with respect to these frontiers (Lovell *et al.*, 1993).

Shortcomings in the non-parametric method result from the sensitivity of the results to sample variability, data quality and the presence of outliers. Furthermore, as production set frontier estimators, DEA and FDH estimators suffer from slow convergence rates due to the curse of dimensionality, limiting their utility to estimate efficiency in cases of multiple inputs or multiple outputs, or when the sample size is not extremely large (Wheelock e Wilson, 2003). Simar e Wilson (2000) proposed some solutions to overcome these problems.

[3]BCC refers to Banker, Charnes and Cooper and CCR to Charnes, Cooper and Rhodes. They elaborated respectively BBC-DEA and CCR-DEA models.

They have shown that bootstrap methods are recommended for combinations of multiple inputs and multiple outputs. We will discuss this in Chapter 2. Other solutions for noisy data or outliers are the construction of a frontier that does not envelop all data points, that is, the construction of a minimum expected input function or maximum expected output functions. Rayp e Van De Sijpe (2007) argue that a parametric alternative to DEA is SFA, which has the conceptual advantage of dealing with random noise, whereas DEA attributes any deviation from the efficient frontier to inefficiency.

Stochastic frontier analysis

Stochastic frontier analysis is a parametric approach to measure efficiency developed by Aigner *et al.* (1977) and Meeusen e van Den Broeck (1977). This methodological approach is based on the estimation of a production or cost function where deviations from the estimated frontier may likely be interpreted as the inefficiency of a given decision-making unit. However, Geys *et al.* (2013) argue that, given the possible presence of measurement errors in the input and output variables used, the entire deviation from the optimal performance does not necessarily reflect inefficient behaviour.

Consider the level of production of the first decision-making unit defined by:

$$y_i = p(x_i) + \upsilon_i$$

where $\upsilon_i = \nu_i - \mu_i$ represents the deviations from the production frontier due to the combined action of efficiency μ_i and other random noise ν_i. Following Bogetoft e Otto (2010) and Geys *et al.* (2013), we also assume that μ_i and ν_i are independent and uncorrelated.

The compound error distribution function υ_i is specified assuming that the error term ν_i is distributed as a normal random variable, while the inefficiency term μ_i may have different specifications, even though the most used in empirical literature seems to be half-normal distribution (Greene, 1993; De Borger e Kerstens, 1996; Worthington, 2000; Méon e Weill, 2005; Geys *et al.*, 2013).

Choosing the Cobb-Douglas production function as a functional form, we have:

$$y_i = \gamma x_{\upsilon_i}^{\beta} \tag{2.3}$$

where γ represents the level of technology. Turning to logarithms we have:

$$lny_i = ln\gamma + \beta lnx_i + ln\upsilon_i \tag{2.4}$$

which can be rewritten for simplicity such as:

$$Y_i = \Gamma + \beta X_i + \Upsilon_i \tag{2.5}$$

where $Y_i = lny_i$; $\Gamma = ln\gamma$ and $\Upsilon_i = ln\upsilon_i$. To estimate the parameters of the "best practice" frontier, econometric techniques are used. In fact, following Barbetta e Turati (2001) equation (2.3) can be estimated by the Modified Ordinary Least Squares (MOLS) or the Maximum Likelihood Estimator method (MLE).

The MOLS technique aims to re-establish one of the basic assumptions of ordinary least squares (OLS) in order to obtain consistent estimators, which are still inefficient compared to those obtained with the MLE Greene (1993, p. 77). Based on our hypotheses, $E(\Upsilon) = |\mu| \neq 0$. For the OLS method applied to equation (2.3) to return consistent estimators, the hypothesis $E(\Upsilon) = 0$ needs to be restated. In that case, it may be appropriate to subtract from compound error Υ_i, the estimated residual mean $E(\mu_i)$. Equation (2.3) will be rewritten as follows:

$$Y_i = \Gamma + \mu + \beta X_i + \Upsilon_i - \mu \tag{2.6}$$

or

$$Y_i = a + \beta X_i + e_i \tag{2.7}$$

where $a = \Gamma + \mu$ and $e_i = \Upsilon_i - \mu$. The OLS estimators applied to equation (2.5) allow to obtain consistent estimators for the coefficient β but not for the constant γ. However, it is easy to obtain an estimator that is also consistent for the constant through the following relation:

$$\hat{\Gamma} = a - \mu \tag{2.8}$$

Assuming that μ_i is half-normal distributed Barbetta e Turati (2001, p. 112), it can be shown that:

$$E(\mu_i) = (\frac{2}{\pi})^{\frac{1}{2}}\sigma_\mu$$

and therefore we will have Greene (1993, p. 77):

$$\hat{\Gamma} = a - \hat{\sigma}_\mu(\frac{2}{\pi})^{\frac{1}{2}} \tag{2.9}$$

The "best practice" frontier can be estimated using the alternative technique of MLE. Assuming, also in this case a half-normal distribution for the error term related to inefficiency μ_i, it is possible to show that the likelihood function can be written as (Greene, 1993, p. 76):

$$l(\gamma, \beta, \sigma, \lambda) = -Iln\sigma - \Psi + \sum_{i=1}^{I}\left(ln\Phi\Big(\frac{-\upsilon_i\lambda}{\sigma}\Big) - \frac{1}{2}\Big(\frac{\upsilon_i}{\sigma}\Big)^2\right) \tag{2.10}$$

where I is the number of production units, Ψ is a constant, $\lambda = \left(\frac{\sigma_\mu}{\sigma_\nu}\right)$, $\sigma^2 = \sigma_\mu^2 + \sigma_\nu^2$, and $\Phi(.)$ is the distribution function of a standard normal random variable. Maximising the likelihood function leads to consistent and efficient estimators compared to those obtained with ordinary least square estimators.

From the estimates of the efficient frontier with one of the two methods (MOLS or MLE), the residuals $\Upsilon_i = \nu_i + \mu_i$ are obtained and not the component related to the inefficiency μ_i; since it will be deduced indirectly. From half-normal distribution the following equation can be derived (Greene, 1993, p. 80-81):

$$E(\mu_i|\upsilon_i) = \frac{\sigma\lambda}{1+\lambda^2}\left(\frac{\phi(\upsilon_i\lambda/\sigma)}{\Phi(\upsilon_i\lambda/\sigma} - \frac{\upsilon_i\lambda}{\sigma}\right) \tag{2.11}$$

where $\phi(.)$ is the density function of a standard normal random variable. As a result, we obtain estimates that are unbiased and inconsistent with the component of inefficiency μ_i. For more details on this process, see: (Lovell *et al.*, 1993), (De Borger e Kerstens, 1996), (Barbetta e Turati, 2001), (Bogetoft e Otto, 2010) and (Geys *et al.*, 2013).

Unlike non-parametric models (DEA or FDH), the SFA model has the advantage of allowing statistical inference; then we can test the specification as well as different assumptions on the efficiency term and all other estimated parameters of the production frontier (Mastromarco, 2008). Furthermore, by using panel data that contain more information, the SFA provides time-varying coefficients that measure the distance of public services in a specific region, in a given year, from the best public services provided using similar inputs in the sample of regions considered in this analysis (Sow e Razafimahefa, 2015). Therefore, the SFA allows the estimation of region-specific and time-varying coefficients.

The empirical literature seems unanimous in claiming that a great disadvantage of the stochastic frontier approach that penalises it consists in the necessity to specify a priory a functional form for the frontier to estimate while one of its advantages is to consider the role of stochastic noise or measurement errors and other factors outside the control of the decision-making unit in the definition of efficient frontier (Bogetoft e Otto, 2010) and (Boetti *et al.*, 2011). The first study of local government efficiency using SFA was proposed by Deller *et al.* (1988) and widespread by the global efficiency score studies of Hayes e Chang (1990), De Borger e Kerstens (1996) and Geys e Moesen (2009); Geys *et al.* (2013). In the latter, Geys *et al.* (2013) assess the cost efficiency of German local governments using a sample of 1021 municipalities in the state of Baden-Württemberg for the year 2001. In their study, one of the first on the assessment of overall 'global' efficiency for local German governments, they use the parametric stochastic frontier approach and take into account exogenous socioeconomic and political influences, with the aim of providing a prescriptive tool to make inferences on public policies towards local public finances. They find that the municipalities of Baden-Württemberg produce their output at around 12% to 14% higher costs than the most efficient municipalities in the sample, in the same institutional context, and that small municipalities appear to be inefficient. These results call for political programs aimed at improving cooperation between small municipalities or the aggregation of small neighbouring municipalities as happened in Italy.

While it is true that there has been a proliferation of studies on quantitative methods (DEA, FDH, and SFA) for measuring public sector efficiency in recent decades, it is also true that there are other studies that base their efficiency measurements on analysis of local government budget data (Gagliarducci e Nannicini, 2013) and (Santolini, 2020). In fact, in investigating the presence of spatial pattern in local government efficiency by using a sample of 246 Italian municipalities of Marche region over the period 1998 to 2008, Santolini (2020) measures government efficiency through the speed of payments, also used in the studies of Gagliarducci e Nannicini (2013), which considered

the speed of revenues collection as well as the speed of payments as performance measures to evaluate municipal efficiency. Following Santolini (2020), the speed of payments refers to the speed with which local authorities transform spending commitments into actual payments for local public goods and services, in the sense that faster payments mean greater government efficiency because a larger share of expenditure commitments is assumed to be made within the financial year. She first assesses the speed of payments for current spending as a category of public spending that involves short term budgetary decisions and can reflect an intense spatial correlation between geographically close municipalities. Then, she uses the Bayesian method to examine the nature of spatial dependence in the efficiency of municipal governments. The results highlight the presence of spatial interdependence in the speed of payments between geographically close municipalities; that is, the least efficient municipalities mimic efficient municipalities. These results are in line with the previous findings of Balaguer-Coll *et al.* (2019), who analysed the determinants of local government efficiency for municipalities in the Valencia region of Spain. They used the robust order-m method to determine the efficiency index, then examined the socioeconomic, political, and budgetary factors that could affect efficiency levels and estimated the spatial interdependence among jurisdictions. In our opinion, the dissemination of best practices among jurisdictions, through a learning process in which less efficient jurisdictions learn from efficient ones, reduces the cost of improvements and promotes a rapid transition from inefficiency to efficiency.

2.3.2 Qualitative analysis

The most widely used qualitative analyses include, for example, (1) the balanced scorecard that measures the performance and strategy of the management system applied to the public sector in the USA and Canada with the studies of Kaplan e Norton (1992), Kaplan e Norton (1996), Kaplan (2009), and Chan (2004); (2) the social services performance rating in England with the sudy of Revelli (2006) and (3) the self-assessed health in Italy with the sudy of Di Novi *et al.* (2019).

The Balanced scorecard was introduced into the literature by the studies of Kaplan e Norton (1992) and is based on a multi-company research project studying performance measurement in companies whose intangible assets play a central role in value creation. It was essentially about improving both tangible and intangible assets in parallel, with a strong focus on the latter. The idea was that if tangible assets have a direct impact on revenue and profits, then it may be possible to improve intangible assets at the same time with 1) investment in employee training leading to improvements in service quality; 2) improved service quality leading to increased consumer satisfaction; 3) increased consumer satisfaction leading to increased consumer loyalty; and 4) increased consumer loyalty generating increased revenue and margins. For interesting contributions see Kaplan e Norton (1992) and Kaplan e Norton (1996). The 2000s saw a branch of the empirical literature adapt the balanced scorecard to the public sector. However, there is a broad consensus

among economists on the challenges that would arise if the principles of the balanced scorecard were transposed to public administrations, thus necessitating adjustments in both the design and implementation of the balanced scorecard in the public sector (Kaplan, 2001) and (Niven, 2002). Chan (2004) proposed the adoption of the balanced scorecard to public administration and defined it as a performance measurement and strategic management system that translates an organisation's mission and strategy into a balanced set of integrated performance measures that tell a concise and comprehensive story of the organisation's achievement and performance towards its mission and goals. They surveyed a sample of 451 local governments in the United States and 467 in Canada through a questionnaire sent to their chief executives on financial performance, operating efficiency, consumer satisfaction, employee performance, innovation and change. Focusing on operating efficiency, the overall response rate was 20% and showed that 71.2% (unweighted average) of respondents had increased their efficiency. for more details see Chan (2004, p. 208-210). Along these lines, most developed Anglo-Saxon countries, members of the Commonwealth, have used the balanced scorecard to assess the efficiency of their governments. Many governments, including local governments in Australia, Canada, New Zealand, the United Kingdom, the United States, among others, have revised their plans, budgets, implementations and management programmes, goods and services provided, to meet the demands of the citizenry and of government for greater performance and accountability through the adoption of the balanced scorecard as a measure of government efficiency (Sharma e Gadenne, 2011). Efficient government requires a rethinking of management processes to assist administrators in their functions given the reduction in resources used, the reluctance of citizens to approve new taxes, and finally, the demand for greater accountability. In this sense, the balanced scorecard can be seen as an appropriate measure of government efficiency.

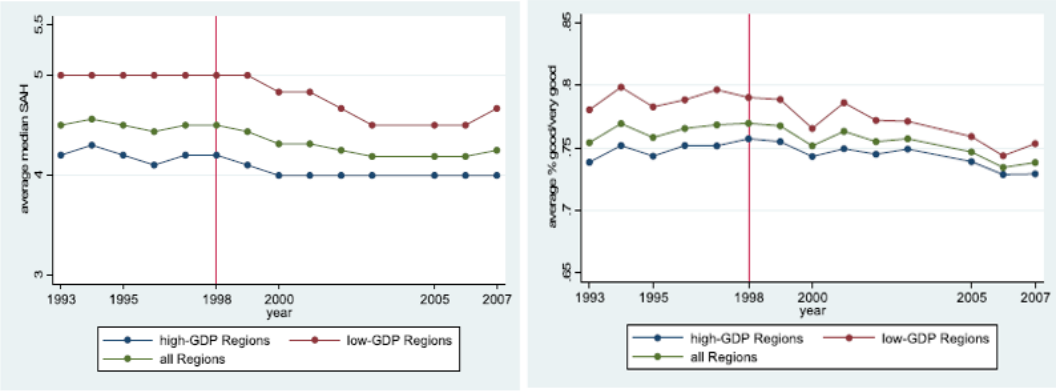
The performance ratings for social services were developed by the Social Services Inspectorate of the Department of Health in England in 2001. The ratings were derived based on performance indicator, inspections, reviews, and monitoring information for each board, and were based on a series of standards taken as a theoretical framework to guide judgement. They are also issued in conjunction with an improvement report for each city council and give a picture of the performance of each council performing their social service functions. Finally, the ratings aim to improve public information on current service provision and capacity for improvement at local, regional, and central level. Star ratings are used to synthesise the independent assessments of the Social Services Inspectorate on performance in all social services, on a scale from zero to three stars. Social services have broad responsibilities for the care and support of families in need and for the protection of children at risk: this means helping the elderly to live as independently as possible and supporting people with disabilities. Citizens have a right to know to what extent their councils discharge these responsibilities. The central government needs to know to what extent each council is achieving the improvement targets set by the social services.

Revelli (2006) analyses the efficiency of local government social spending

in the UK through the social services performance rating (SSPR) introduced by the Social Services Inspectorate of the Department of Health in 2001 with the aim of improving government efficiency by fostering competition in the provision of social services by the mean of well-informed citizenship about government performance. He reveals that local expenditure on social services to the person shows a positive spatial autocorrelation, since the policies of the localities that share a border seem to be more correlated than the distant ones.

In Italy, the National Agency for Regional Health Services (Agenzia Nazionale per i Serivzi Sanitari Regionali, AGENAS), an agency of the Ministry of Health, coordinates the activities of the 21 regional health services. In 2008, AGENAS established the National Observatory on Good Practices to encourage and support continuous improvement in quality and safety of care (Signorelli *et al.*, 2020). The main objective of AGENAS is to improve the efficiency and quality of the Italian NHS through the analysis and evaluation of health service outcomes. The National Observatory contributed to the creation of the National Outcomes Programmes with the mission of assessing the effectiveness, equity, safety and appropriateness of the health services provided by the Italian National Health Service as a whole.

In order to assess the general health status of the Italian population through the self-assessment health index (SAH), before and after the introduction of decentralisation in 1998, Di Novi *et al.* (2019) use individual-level data on the daily life of Italian households taken from a cross-sectional survey over the period 1994-2007 conducted by the Italian Institute of Statistics (ISTAT). The survey consists of a sample of twenty thousand Italian households, sixty thousand individuals living throughout Italy and is representative of the entire population. The SAH index has been used in the literature as a good predictor of mortality and morbidity (Balia e Jones, 2008) and (Di Novi *et al.*, 2019). In this survey conducted by ISTAT, the following question was asked: "would you say that in general your state of health is: very bad (1), bad (2), fair (3), good (4), very good (5)". To show the dynamics of health outcomes across regions, Di Novi *et al.* (2019) illustrate the evolution of the median value of the SAH and the percentage of individuals answering that they have "good" and "very good" health respectively in the period 1993-2007: The average of all regions (green line) and the averages of the sub-samples of regions with average GDP per capita (GDP PC) below and above the sample mean, i.e., the "low GDP regions in the red line" and the "high GDP regions in the blue line" are represented in each figure. In both figures, the median average SAH and the average percentage of "good" and "very good" responses are constant over time with a slight decrease in both high and low GDP regions. In Figure 2.3 (a), in 1993, the median mean SAH is 4.2 and 5 for high and low GDP regions respectively, while in 2007 it is 4 and 4.7. In Figure 2.3 (b), in 1993, the median percentage of individuals answering "good", and "very good" health is 7.4 and 7.8 for high and low GDP regions respectively, while in 2007 it is 7.3 and 7.6. Moreover, they show that the average SAH value in low GDP regions (high GDP regions) is always higher (below) than the national average. They also point out that the distance between the average SAH value in low and high



a b

Figure 2.3 – (a) Average median value of SAH. (b) Average % of individuals reporting "good" / "very good" health.
Source: elaboration of Di Novi *et al.* (2019, p. 4)

GDP regions is stable over the time period considered. They found a similar pattern for the evolution of the average percentage of individuals responding to "good" or/and "very good" health: the average percentage of individuals responding "good" or/and "very good" in low GDP regions (high GDP regions) is higher (below) than the national average. This evidence supports the view of those who think that the health decentralisation reform of 1998 has not increased disparities between regions (Rodríguez-Pose e Ezcurra, 2010).

2.4 Literature background

2.4.1 Fiscal decentralisation

Fiscal decentralisation is mainly about devolving revenue sources and expenditure functions to lower levels of government (De Mello Jr, 2000), in order to improve allocative efficiency (Oates, 1999), and increase of productive efficiency (Persson e Tabellini, 2000), since subnational governments are more responsive to local demands. Moreover, following the public finance principle of subsidiarity, the performance of the public sector can be improved by accounting for local differences in culture, environment, endowment of natural resources, and economic and social institutions (De Mello Jr, 2000). In fact, local governments possess better access to local preferences and then have an informational advantage over the central government in deciding which provision of goods and services would best satisfy the needs of citizen (Tiebout, 1956) and (Musgrave, 1959).

The theoretical and empirical literature in favour of fiscal decentralisation essentially focused on the efficient provision of local public services (Tiebout, 1956), (Brennan *et al.*, 1980) and (Besley e Coate, 2003). Sow e Razafimahefa (2015) add that the impact of fiscal decentralisation on the efficiency of public service delivery may be done into an adequate institutional environment and under certain conditions: effective autonomy of local governments; strong

accountability at various levels of institutions; good governance and strong capacity at the local level; a sufficient degree of expenditure decentralisation necessary to obtain a positive outcome; and the decentralisation of expenditure and revenue necessary to obtain favourable outcomes. Empirically, Sow e Razafimahefa (2015) examine a panel of 64 developed, emerging and developing countries during 1990 - 2012 and found that expenditure decentralisation needs to exceed a threshold of about 35% to improve public service delivery. They also find a positive impact of revenue decentralisation on public service delivery, indicating the need to accompany fiscal decentralisation with sufficient resource decentralisation. Moreover, De Mello Jr (2000) recalled that the potential benefits of devolving fiscal responsibilities to local governments are increased efficiency in service delivery and reduced information and transaction costs associated with the provision of public goods and services.

Tanzi (1999) highlights that another key reason for decentralisation in many countries has been the "disenchantment" of the electorate with the ability of central government to adequately meet the growing demands for public goods and services. Along this line, fiscal decentralisation gives voters more electoral control over the authorities Seabright (1996) and Persson e Tabellini (2000), since it encourages competition across local governments to improve public goods and services. Bordignon *et al.* (2004) argue that voters can use the performance of neighbouring governments to make inferences about the competence or benevolence of their own local politicians. Fiscal decentralisation may also lead to the efficiency-enhancing effects associated with Tiebout's competition in which the roles and responsibilities of local governments are clarified, as opposed to the central government (Alonso e Andrews, 2019). According to Tiebout (1956), citizens' awareness of the performance of their local governments and their neighbours can exert a downward pressure on the cost of producing public services. In other words, residents and firms can maintain the relationship between local taxes and service benefits at the desired levels through the threat of "voting with their feet" looking for a better deal elsewhere. From the political economy perspective, competition may help to control the size of government and solve the "common pool problem" that is, the tendency of agents to overuse and in some case destroy a common property resource (Martinez-Vazquez, 2011). Government accountability can also be increased through yardstick competition, in which local residents evaluate the performance of their local government by comparing results in neighbouring jurisdictions (Besley e Case, 1995).

However, there is a risk of a "race to the bottom" that is, the competition among jurisdictions will lead them to continue lowering taxes to attract new residents and firms and that taxes and public spending will eventually be pushed below the social optimum (Zodrow e Mieszkowski, 1986). Furthermore, if accountability is not broadly anchored in a local democratic process, but is based on rent-seeking political behaviour, local governments will be tempted to allocate higher decentralised spending to non-productive expenditure instead of capital expenditure Sow e Razafimahefa (2015) and more likely will run into large budget deficit in the expectation that central government will bail

them out (Rodden, 2002). This can hinder efficiency, economic growth, and overall macroeconomic performance (Rodríguez-Pose *et al.*, 2009) and (Grisorio e Prota, 2011). Therefore, the centralisation of control over local public services can be a means of avoiding debt formation, corruption, administrative duplication which contributes to inefficiency (Rodríguez-Pose e Gill, 2003).

In addition, the devolution of public service delivery to a small-scale local government (in term of size and endowments) can decrease efficiency and increase costs if economies of scale are important in the process of production and provision of some specific public goods and services (Sow e Razafimahefa, 2015). In fact, Alonso e Andrews (2019) use a two-stage analysis and studied the separate and combined effects of fiscal decentralisation and socio-economic deprivation on the productive efficiency of English local governments during the period 2002 - 2008 and find that decentralisation is positively correlated with productive efficiency; whereas socio-economic deprivation is negatively correlated with efficiency. De Mello e Barenstein (2001) used cross-country data for 78 countries and found that the governance becomes stronger as the share of non-tax revenues and transfers in total sub-national revenues increases.

Another important issue of fiscal decentralisation refers to the intergovernmental fiscal relationship among all the levels of government. The complexity of intergovernmental coordination emerges when lower levels of government enjoy greater autonomy in decision-making and requires the design and development of appropriate multilevel public finance systems in order to provide local public services effectively and efficiently while maintaining macroeconomic stability (De Mello Jr, 2000). In other words, without a focus on institutional clarity and transparency and failed coordination between levels of government, local governments can spend inefficiently and excessively, requiring bailouts from central government. In many cases, these bankruptcy policies tend to manifest themselves as a bias towards higher deficits and higher borrowing costs, given the risk premium associated with a higher probability of default (Poterba e Rueben, 1997) and (Fukasaku e De Mello, 1998). Thus, fiscal decentralisation can only amplify rather than reduce fiscal imbalances and undermine overall macroeconomic stability Prud'Homme (1995), unless local governments engage in fiscal discipline and the fiscal decentralisation programmes include incentives for prudent debt and expenditure management (De Mello Jr, 2000).

2.4.2 Economic growth

Fiscal decentralisation is widely considered to produce potential benefits in terms of government efficiency and economic growth Morgan (2002), although empirical evidence supporting that fiscal decentralisation increases government efficiency remains scarce (Martinez-Vazquez e McNab, 2003). According to Rodríguez-Pose *et al.* (2009), the deficit in empirical robustness is because government efficiency is defined in the sense of allocative efficiency which is difficult to quantify. In the literature, government size and economic growth are considered an alternative measure of government efficiency. For an early contribution see Brennan *et al.* (1980). In practice, compared to allocative and

productive efficiency, regional economic growth is relatively easy to measure since regional GDP and population data are available for many countries.

Many studies have shown that the efficiency of local government or large cities depends on their size. Florida (2019) argues that doubling the size of a city leads to more than a doubling of output but, requires less than a doubling of costs. For example, Germany's polycentric urban structure has shown the dependence of efficiency on city size; in Japan, three megalopolises - Nagoya (6,500,000), Osaka (17,300,000), and Tokyo (35,400,000) - have shown that efficiency increases with city size (Mel'Nikova, 2020). Indeed, Mel'Nikova (2020) also shows that excluding those cities in the sample of cities reverses the causal relationship.

The role of government in economic development and growth is undoubtedly important in an imperfect market environment and high information asymmetry (Chan *et al.*, 2017). Consequently, government intervention through efficient public spending serves to correct the market mechanism and ultimately promote long-term economic growth (Ghose e Das, 2013). The success or failure of a government intervention depends on its ability to reallocate resources to achieve economic goals. Ghose e Das (2013) argues that government spending plays an important role in the formation of physical and human capital, which can also be effective in boosting economic growth in the short term, when constraints on infrastructure or skilled labour become an effective constraint on increasing output. Based on the "Keynesian school of thought", Chan *et al.* (2017) shows that government intervention remains important and beneficial in the supply of public goods and services, and the imposition of income taxes leads to positive effects on economic development as it creates an equitable society and for better economic growth. The literature on endogenous growth also argued that increased public spending on public goods and services through greater tax collection contributed to long-term economic growth because it improved infrastructure services and corrected externalities (Barro, 1990). The expectation is that the revenue side of the public account can play a key role in the monitoring mechanism in order to regulate the allocation of public resources in important economic growth sectors to achieve economic development, higher economic growth and macroeconomic stability.

From an empirical perspective, however, the effects of government efficiency on economic growth generate inconclusive results. Starting with the economy of South-Eastern Europe[4], Alexiou (2009) using a panel of data from 1995 to 2005 finds that government spending on capital formation, development assistance, private investment and trade openness is positively and significantly correlated with economic growth in each country. Estimates obtained by Ghose e Das (2013) when conducting a panel co-integration test and using the dynamic ordinary least squares method on a sample of 19 emerging markets over the period 1970 - 2006 supported the idea that both domestic investment and government size (government efficiency) affect positively and significantly long-term economic growth.

[4]The seven South-Eastern European countries considered are: Albania, Bosnia, Bulgaria, Croatia, Macedonia, Romania and Serbia.

However, the impact of government efficiency on economic growth may not always be conducive to a positive relationship. Using a unit regression model on 32 developed and 51 developing countries from 1996 to 2006, Yongjin (2011) finds a positive and significant relationship between government efficiency and economic growth in developing countries and a negative and significant relationship in developed countries. Rajkumar e Swaroop (2008), instead find that the differential impact of government spending on education and health in determining economic growth depends on the quality of governance. In analysing the relationship between government quality (efficiency), economic growth and income inequality within Vietnam over the period 2006-2017, Hung *et al.* (2020) use a three-stage regression model and show that higher government efficiency stimulates economic growth and reduces income inequality among provinces.

2.4.3 Income disparities

The literature of the third millennium on government efficiency and regional disparities is mainly based on the "new economic geography" framework developed by Krugman (1991) who defines the two economic forces that influence regional disparities: centripetal and centrifugal forces. Krugman e Elizondo (1996) argue that in a closed market there are economies of scale in production because firms are located in areas close to large markets in order to minimise transport and transaction costs; although large markets are themselves created by those who work in the production sites. These above-mentioned factors generate centripetal forces that cause a few regions to develop while other regions lag behind and regional inequality arises in the economy. However, if trade reforms are implemented in the direction of market liberalisation, centripetal forces become weaker as firms can also depend on external demand, proximity to the large market becomes irrelevant and higher wages and land rents in the established market act as centrifugal forces forcing them to relocate to less established regions (Kar e Sakthivel, 2007). In this sense, government policies reduce regional income disparities between regions. The "new economic geography" approach seems to be consistent with the precursor studies of Kuznets (1955) and extended by Williamson (1965) that have shown a bell-shaped relationship between economic growth and income disparities. That is, in the first stage of economic development and growth, income disparities increase and then decrease in the next stage of development and growth. Analysing the Chinese case, Dollar (2007) argues that since the 1978 market-oriented reforms with an emphasis on efficiency based on comparable advantage, China has grown and consequently reduced the poverty rate from 64% at the beginning of the reform to 10% in 2004, despite an increase in income disparities, particularly between rural and urban provinces. It is worth noting that the case of China is very complex. Its spectacular economic growth and poverty reduction have been accompanied by huge increases in disparities that have generated frequent manifestations of social tension. In 2005, the "harmonious development" policy came into force; it is a balanced development across provinces through an investment plan (infrastructure, social protection

and governance reform) to stimulate growth and improve the living standards of residents in rural and underdeveloped areas of China (Fan *et al.*, 2011).

However, Paluzie (2001) argues that labour mobility can be facilitated in the economy with protectionist policies in order to mitigate regional disparities. On the other hand, after trade reforms, regions where firms are located gain competitive advantages over less developed areas where new firms are established, widening the existing disparities between the two areas. In fact, Paluzie (2001) predicts that centripetal forces will outweigh centrifugal forces in the post-reform period. That is, the relationship between government efficiency and regional income inequality decreases before the reforms and increases in the post-reform period.

The literature on government efficiency and income disparities seems to involve economic growth in a transitive framework. In fact, many studies assess the relationship between government efficiency and income inequality through economic growth. Using a panel data containing observations from 1950 to 2009 for 181 developed and developing countries through a pooled and fixed effects model, Valeriani *et al.* (2011) find a positive and significant impact of the quality of government on economic growth, reducing the gap in income disparities between localities for both developed and developing countries. The fixed effects model strongly confirms the results obtained from the pooled model. Hung *et al.* (2020) examines the relationship between government quality, economic growth and income inequality within Vietnam over the period 2006-2017, performs a three stage least squares estimation - generalised method of moments, and finds that an effective fight against corruption in Vietnamese society generates higher government quality, which in turn stimulates economic growth and reduces income disparities among Vietnam's provinces. These results are consistent with the findings of Lessmann (2009) who used a panel of data for 23 OECD countries from 1982 to 2000, applied instrumental variable estimation techniques and found that in a context of high government efficiency, economic growth plays an important role in reducing income disparities in developed countries. In contrast, Rodríguez-Pose e Ezcurra (2010) find that government efficiency and economic growth generate more income disparities in developing countries. Again, both theoretical and empirical literature do not provide a clear picture on the relationship between government efficiency and income disparities.

2.4.4 Well-being

Theories of well-being are classified into three categories: hedonistic, desire, and objective list theories. The hedonistic theories consist in "the greatest balance of pleasure and pain" (Crisp, 2001). Bentham (1996) show that mental states experience pleasure and pain and suggest that the value of experiences depends only on their duration and the intensity of the pleasure or pain present in them. This view has been overcome since the common sense suggests that options with inferior aggregate pleasure is preferable, following the idea that intellectual or aesthetic pleasures are superior to sensory ones (Mill, 1962). The desire theories overcome hedonistic issues and refer to well-being as "desire-

satisfaction". In another words someone is better off to the extent that his desire (current and comprehensive) is satisfied (Crisp, 2001). Hedonistic and desire theories are subjective theories since the level of well-being depends on subjective mental states and attitudes. The objective list theories refer to a list of elements that constitute well-being (Crisp, 2001). Such a list of elements may contain subjective factors such as the balance between pleasure-pain or desire-satisfaction, as well as factors independent of someone's attitudes such as relationality, knowledge, principles, etc (Kneer e Haybron, 2020). However, Crisp (2001) moves an interesting critic of the objective list theories which are, in fact, its common objection: "the objective list theories are elitist" because elites can consider some goods and services useful or good for people without worrying if they need them, want them or enjoy them. Those definitions of well-being just confirm our initial claim, that is the concept of well-being is complex and difficult to define and to analyse.

Ordinary people benefit from the public sector in terms of greater well-being through goods and services publicly provided as a result of the collection of taxes. Analysing government efficiency in responding to social, economic and environmental changes, Hessami (2010) uses a dataset covering 12 EU countries[5] from 1990 to 2000 and finds a bell-shaped relationship between government efficiency and well-being and that the effects of government efficiency on well-being depend on levels of corruption and decentralisation, as well as on people's ideological preferences and their position in the income distribution. Furthermore, he argues that higher levels of welfare could be achieved through spending more on education (productive spending) and less on social protection (unproductive spending).[6] Helliwell e Huang (2008) find that the quality of government impacts life satisfaction through job satisfaction, financial situation satisfaction, marital status, health satisfaction and relational situation satisfaction. In our opinion, these are the positive expected determinants of the overall well-being. Their results confirm that the government's ability to provide a trustworthy environment and deliver services honestly and efficiently depends on the type of country governance and whether it is a high-income country. Consequently, the balance changes when the government achieves acceptable levels of efficiency, trust and GDP PC, as is the case with emerging countries.

Although well-being and quality of life seem to express different concepts based on their philosophical and historical definitions, the economic approach does not distinguish between these two expressions when it comes to evaluating their quantitative measures (Liu, 1975). Interestingly, when it comes to measuring well-being, Campbell *et al.* (1976) introduces measures that involve a comprehensive assessment of the nature and quality of life experience. They also argue that "happiness" and "life satisfaction" fit together empirically because they can be used interchangeably to measure the same affective states and precisely the "global sense of well-being". Moreover, Easterlin (2003, p.

[5]These countries are Denmark, Luxembourg, Netherlands, Sweden, Ireland, Finland, United Kingdom, Austria, Belgium, Germany, France and Italy

[6]For an interesting contribution see Cyrenne e Pandey (2015).

11176) considers "the terms happiness, utility, well-being, life satisfaction, and welfare to be interchangeable".

Kokhanovskaya *et al.* (2019) point out that the system of government directly determines the degree of well-being and opportunities for a happy life for residents of a given country and argue that the government through public administration contributes to the satisfaction of material, social, cultural needs of different groups of the population. Therefore, specific political, legal, organisational and financial actions are implemented in the stages of administrative preparation and implementation of the necessary management decisions through the coordination and implementation of government policy. Another interesting feature of this analysis is the development of specific monitoring mechanisms to assess the efficiency of the activities of state authorities. That is, the introduction of professional rules and official regulations that reflect the indicators of the efficiency and effectiveness of the professional performance of individual civil servants and government bodies in which they serve.

3 Public health efficiency and income disparities: Evidence from Italian provinces

3.1 Introduction

In Italy, the evolution of the national health system is intimately linked to the creation of regional level of governments, and above all to the process of devolution of power from the central government to the regions. The central government defines the guidelines to ensure the basic benefit packages to Italian citizens and residents, while the regions have the task of organising and managing the health system at the local level, relying on local health authorities and hospitals, which have the task to provide the service.

The quality in terms of performance of the Italian health system appears to be linked to the quality of public sector institutions both at the central level and at the lower level of government. Since the unification of the country in 1861, the Italian regions have all had an identical central government, but this apparent institutional homogeneity seems to hide deep and persistent duality in the Italian economy between the developed regions of the Centre-North and the less developed regions of the South (Di Liberto e Sideri, 2015). In fact, the regions of the Centre-North have always been characterised by high labour productivity and therefore greater economic development, while those of the South have been characterized by a lower labour productivity which generates less economic development than the regions of the Centre-North (Zamagni, 1978; Daniele e Malanima, 2014).

The literature of the last forty years has investigated, on the one hand, the issues of regional disparities on a global level, considering more the member countries of the OECD and to a lesser extent those of the European Union; and on the other hand, it also analysed the health system of the member countries of the OECD, the European Union, and single states such as Italy. In this chapter, we investigate the impact of an efficient public health system on the existing disparities in the distribution of income within the regional level of

government in Italy. To our knowledge, no studies have analysed the impact of public health efficiency on regional income disparities. Our contribution in the health and regional economics literature is to analyse the relationship between government efficiency in the public health sector and income disparities at the provincial level of administration and to test whether this relationship holds through the channel of labour productivity.

The aim of this analysis is to demonstrate that the efficiency of public health system affects income disparities through an increase in labour productivity. We will show that if there is greater efficiency in the public health system, then there will be greater productivity of labour that will generate less income disparities at the provincial level of administration. The idea is that efficiency in the public health sector allows for faster cures and treatments, which allows people to return to work earlier, maintain high labour productivity and economic growth and, consequently, reduce income disparities (Zagler e Dürnecker, 2003; Cyrenne e Pandey, 2015). Following the same line, Bloom *et al.* (2004) state that health is a crucial aspect of human capital and, consequently, a key ingredient of economic growth as healthier workers are physically and mentally more energetic and robust, more productive and earn higher wages, and also less likely to leave work because of illness.

Many other authors indirectly draw the same conclusions. For instance Sen (1999) states that it would be just as unjust to claim that a higher income is not a factor contributing to better health and longer survival as it would be to say that it is the only factor contributing. On the other hand, improved health and survival contribute to a certain extent to the ability to earn a higher income. It should be pointed out that labour productivity is not examined in this chapter as we show that it is just the channel through which public health efficiency can reduce income disparities.

The peculiarity of this study is that regional income disparities are measured among provinces within a country rather than between regions at the supranational level, such as the OECD, as it is widely found in the literature, mainly because the economic interdependence among subnational governments within nations might be much stronger than between countries (Williamson, 1965). Sala-i Martin e Barro (1995) argued that differences among regions within a country in term of technology, preferences, and institutions are likely to be smaller than those across countries. Moreover, focusing the study on a single country allows to avoid the problems of data comparability and to control for external shocks, political regime, institutions and other exogenous factors (Grisorio e Prota, 2015). The Italian case is an excellent laboratory for analysis because there are large disparities within and between provinces, and it is relevant to analyse whether the efficiency of public sector, in particular that of health sector, which is one of the function delegated to the regions, can reduce these disparities.

The Italian provinces are considered as the greater level of geographical disaggregation for the analysis of public health efficiency and regional income disparities. Given that at the local level, hospitals can provide different health services and there can be different sizes of health institutions, using province

at this level of analysis allows a homogeneous comparison in the production of health services (De Nicola *et al.*, 2014). Scalzo *et al.* (2009) recalled that regional governments allocate healthcare resources at the province level of administration accounting for population needs.

Public finance discipline argues that public efficiency in health sector generates, in addition to benefits for the patients, also external benefits or positive externalities that determine an increase in labour productivity and, consequently growth in national income. So, the efficiency of regional governments in health sector can have a positive impact on the regional economic development. In fact, following Zagler e Dürnecker (2003), public health efficiency enables faster cures and treatments, which allow to return to work earlier and maintain high the quantity and quality of labour productivity. It should be remembered that the objective of the welfare state is to protect labours in industrial society against certain risks: unemployment, old age, and diseases, ensuring services and the level of income. Moreover, the choice of protecting health as a priority was political in Italy as well as in other countries of the European community because only by protecting that primary good the country's labour productivity can be preserved.

In this analysis, we check whether public health efficiency (PHE) has an impact on income disparities within Italian regions, through the transmission channel of labour productivity, over the period 2000 to 2016. To this aim, we first assess the existence of differences in performance and efficiency of provinces in the provision of health services through DEA. Second, we determine the taxpayer-weighted coefficient of variation (CV) of the personal income tax (PIT) and its Theil indexes, which are the provincial income disparities indicators. Third, we analyse both the relations between PHE and CV and Theil indexes through a fixed effects model. Lastly, we examine the relationship between public health efficiency and labour productivity (Labprod) indexes. The empirical analysis is made on a balanced panel of 102 Italian provinces over the period 2000 to 2016. It also controls for province-specific and time-specific effects to reduce the risk of omitted variables. Our findings show that PHE has a negative impact on income disparities at the provincial level of administration. These results are robust even when estimating the model with instrumental variables that control for endogeneity due essentially to reverse causality. Last but not least is the labour productivity channel, through which PHE has a negative impact on income disparities. Our findings also show that through the labour productivity channel, PHE needs to exceed a threshold of about 66% to reduce income disparities at the provincial level of administration. In fact, at the first stage, labour productivity decreases to the point of abscissa 0.66 where, at the second stage, it starts to increase with increasing efficiency. Another relevant result is that higher labour productivity actually reduces income disparities, taking into account the possible effects of other transmission mechanisms of the impact of PHE on income disparities that are not directly observed.

This chapter is structured as follows. In the second section, health system in Italy is presented. The third section presents the theoretical framework. In

the fourth section, indicators of public health efficiency are assessed. In the fifth section, provincial income disparities indexes are evaluated. The sixth section is dedicated to the econometric strategy. The seventh section presents the baseline results. The eighth section presents robustness check. The ninth section presents the the transmission channel and the tenth section presents the concluding remarks.

3.2 Health system in Italy

3.2.1 Origin

In Italy, healthcare was based on different structures after the national unification of 1861. The health care system relied on a multitude of health insurance funds that served different categories of work. In fact, there were health centers of the catholic church; charitable institutions nationalized by the new liberal fascist regime around the 1920s; provincial network for preventive medicine and public health; municipal provisions for economic and social assistance; autonomous associations of mutual aid for craftsmen and workers; and autonomous non-profit structures (Scalzo *et al.*, 2009). However, the early $20th$ century saw the spread of health insurance funds, which were responsible for covering workers. Employers and employees have become responsible for financing health care, contributing a percentage of their monthly salary to the health insurance funds related to their sector of activity, and that phenomenon has produced a fragmented health structure based on different health insurance funds given the variety of categories of work sectors. Scalzo *et al.* (2009) argued that, in 1878, there were more than 2,000 mutual funds with about 330,000 workers or members. They also affirmed that the public sector had a marginal role, limited to minor prevention programs and the provision of health care to the poor. During the fascist regime (1922-1943), several changes to the healthcare system were carried out. A Royal Decree of 1922 provided for free treatment of venereal disease; a Royal Decree N. 15/1923 guaranteed the right to hospital care for the needy, indigent or poor people; in 1926 several cancer diagnosis centers were created; in 1927 the provincial authorities in charge of the treatment of tuberculosis were established and insurance against tuberculosis became compulsory (Scalzo *et al.*, 2009, p.18). The National Institute for Local Authority Employees (Istituto Nazionale Assistenza Dipendenti Enti Locali, INADEL) was established in 1925 as the national body for the provision of health care to local authority employees. The regulatory framework for the trade union system enacted during 1926-1928 included mandatory health provisions for workers as a prerequisite for collective agreements. During the 1930s, health insurance funds became responsible for recovering workers and also their dependants. The 1940s saw the creation of two major health and social security institutions: the National Institute for Public Employees (Ente Nazionale Previdenza e Assistenza Dipendenti Statali, ENPAS), which was the national body responsible for social and health care insurance of public sector employees and the National Institute for Disease Control (Istituto Nazionale

per l'Assicurazione Contro le Malattie, INAM) for the health insurance of private sector employees. During the 1950s, financial solidarity among workers was extended to retirees of the same professional category. In 1958, an independent health ministry was established for the first time, and in 1968, public institutions providing hospital care were created as autonomous entities. In the early 1970s, Italy had nearly 100 health insurance funds, resulting from these historical developments (Scalzo *et al.*, 2009, p.19). Each fund had its own rules and procedures. Some provided direct care through their own facilities and others indirect care, reimbursing patients the cost of care provided by physicians and private facilities. The coverage was not only segmented between widely different funds, but was also characterized by important limitations. About 7% of the population was uninsured in the mid-1970s, including many unemployed, for instance, those who had previously worked in the informal economy (Scalzo *et al.*, 2009, p.19). According to the archives of the "Ministry of Health of 1975", population coverage in the 1970s was high but still incomplete, levels of entitlements and contributions varied widely and there was a north-south gap in performance levels (France e Taroni, 2005). Furthermore, health system had been affected by severe structural problems, such as organisational fragmentation, compartmentalisation of the level of care, unnecessary duplication of services, bureaucracy and rapid growth in expenditure (Scalzo *et al.*, 2009). Large insurance fund deficits led to a financial crisis, which the "invisible hand" of market forces failed to address and, therefore, prompted the central government to intervene. Also in this case the public sector intervenes for reasons of efficiency, equity, and stabilisation of the sector, which are the three main functions that called for the intervention of the public sector in the market economy (Musgrave, 1959).

At the same period of time, most of the Italian regions were created (1970) and, it is reasonable to think that this factor, together with the organisational and structural issues and, financial crisis of health insurance funds had led to the transition from a system based on health insurance to a system that aims at guaranteeing the provision of comprehensive health services to the entire population. With the Law N. 386/1974, dispositions were issued for the extinction of the debts of health insurance funds and the dissolution of the boards of directors of some of them, until the Law N. 349/1977 which completely abolished the mutualistic organisations having health assistance functions, transferring their functions to the regions, and the d.p.r N. 616/1977 allowed further decentralisation to the regions of administrative functions previously exercised by health insurance funds and central government (della Sanita, 1975). Soon after the National Health Service (hereafter, NHS) was created.

3.2.2 Evolution

The 1978 reform Law N. 833/1978 which established the NHS in Italy by replacing a system based on multiple social and health insurance funds was the first major health care reform after the second world war (Ferré *et al.*, 2014, p.120). The NHS created along the line of the British National Service, involved three interrelated goals: 1) universal health coverage and free access to uniform levels of health care for all Italian citizens and legally residing in Italy, accounting for human dignity, health needs and solidarity as guiding principle of the system; 2) tax-based financing more likely to control the growth of public health spending and to guarantee democratic public control over the management of the entire system; and 3) the expansion of public services also to develop disease prevention programs and mainly to reduce disparities in the geographical distribution of health care despite the gap in productivity, economic growth and distribution of welfare between north and south (France e Taroni, 2005; Scalzo *et al.*, 2009; Ferré *et al.*, 2014; Signorelli *et al.*, 2020). In fact, to promote integration between levels and categories of assistance at the local level, Local Health Units (Unità Sanitaria Locale, USL) have been created along the lines of the UK district health authorities for functions and reference populations, to ensure the public democratic control over the management of health care at the local level, characteristic of the Scandinavian countries (Scalzo *et al.*, 2009). However, weaknesses have emerged in the health system (as scandals of corruptions that involved governing parties have been publicly documented) such as the absence of financial control over spending by the central government, the politicisation of NHS organizations, conflicts between the three political levels of government, barriers to an efficient human resource management, and the lack of expertise and skills to manage health care organisations (Fattore, 1999; France e Taroni, 2005). Once again, these weaknesses among others, force the government to intervene, more likely under pressure from civil society, given the implications of politics and public officials in those scandals of corruption, and the result was the formulation and the approval of the second reform of health care (France *et al.*, 2005).

Legislative Decrees N. 502/1992 and N. 517/1993 have established the second reform, which introduced measures for the devolution of additional powers to regions, managerialism, and competition in health services provision (Fattore, 1999). The second reform introduced four important components: (1) regionalisation in which those legislations established the reduction of the role of municipalities and central government powers by transferring several functions in favour of the 19 regions and 2 autonomous provinces (Ferré *et al.*, 2014, p.121). For the first time, the basic benefit packages (*livelli essenziali di assistenza*, LEA) were defined by the central government and the regions were given new competences to strengthen their fiscal autonomy and responsibility, as well as new organisational powers. Hence, the central government guarantees the basic benefit packages and ensures that the regions receive adequate resources to provide them; (2) the second point referred to the role of management in the NHS, in which politicians were replaced by professional managers and USLs transformed into a hospital (*azienda ospedaliera*, AO)

and local health authorities (*azienda sanitaria locale*, ASL). The legislation made it mandatory to appoint general managers with university degrees and managerial experience. Barriers to effective decision-making and human resource management have been eliminated, the chain of responsibility within NHS providers has been simplified and new accounting systems have been introduced, with the aim of strengthening the management function in NHS organisations as a strategy of improving efficiency in the provision of services (Fattore, 1999); (3) The quasi-market for specialist care was based on three fundamental principles. First, patients had free choice over their preferred providers. Second, private accredited providers were included in a competitive market with public providers. Third, a fee-for-service payment system for outpatient care and a diagnosis-related group (hereafter, DRG) system for inpatient care were introduced. The latter was a translation and adaptation of the American Medicare DRG system to the Italian context to produce weights and tariffs for each group based on a small sample of hospitals (Scalzo *et al.*, 2009); (4) Opting out of the NHS by reducing contributions to the public system and choose private insurance schemes. However, this option was abolished by Legislative Decree N. 517/1993 (Scalzo *et al.*, 2009; Fattore, 1999).

Law N. 229/1999 introduced the third reform of the NHS, which included, among others, political measures aimed at overturning the orientation of the second reform of the NHS. The main objective was to review the market orientation of the NHS. For instance, the new legislation emphasises universality, the right of citizenship to health and its collective responsibility under the control of the central government. But this attempt was criticised and had a limited impact on the NHS, which increased its level of decentralisation rather than decreasing it. Furthermore, the 1999 reform sanctioned the leading role of the central government in formulating the basic regulatory framework to which the regions must comply in exercising their new autonomy. This regulatory framework had four main objectives: 1) promote strategic planning; 2) regulate competition between public and private suppliers; 3) assess the quality of care; and 4) promote cooperation between levels of care and health care businesses (Scalzo *et al.*, 2009, p.158).

The regional devolution process which started in 1992-1993 was further regulated and refined in 1997 through two laws aimed at guiding the transition to a federal state. That is, Law N. 59/1997, which regulated the transfer of powers to the regions, and the Legislative Decree N. 446/1997, which introduced sources of autonomous financing for the regions as a first step towards fiscal federalism. Furthermore, the Constitutional Law N. 3/2001 which introduced the direct election of regional governors and redistributed legislative powers between central and regional governments, assigned the right to health to the joint competence of central and regional governments. The Regions acquired ample legislative autonomy in health matters, while the central government defined the general framework of the NHS and again decided on the basic benefit packages to be universally guaranteed (Ferré *et al.*, 2014; France e Taroni, 2005). Nowadays, there are still differences in access to basic benefit packages between Italian regions. Figure 3.1 shows that 16 out of 21 regions reached

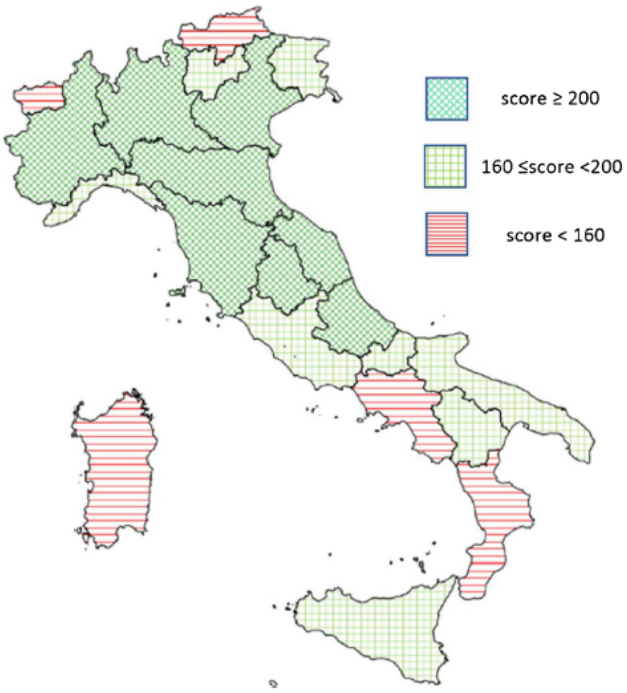


Figure 3.1 – The level of basic benefit packages reached in the Italian regions in 2017
Source: Ministry of Health, excerpted in article by Signorelli *et al.* (2020, p. 71)

and exceeded the minimum score set by the Ministry of Health (above 160), while five regions did not. Eight regions (Piemonte, Veneto, Emilia Romagna, Toscana, Lombardia, Umbria, Abruzzo and Marche) scored above 200, being the best in providing basic health services. Another 8 regions (Liguria, Friuli-Venezia Giulia, Basilicata, Lazio, Puglia, Molise, Sicilia and the Autonomous Province of Trento) scored between 200 and 160. The five regions that scored below the acceptable standards were Valle d'Aosta, autonomous province of Bolzano, Campania, Calabria and Sardegna.

3.2.3 Funding

The protection of health involves the use of significant public resources deriving from general taxation (revenue share in direct taxes, such as additional household income and wealth taxes (Imposta sul Reddito delle Persone Fisiche - IRPEF) and regional taxes on production (Imposta Regionale sulle Attività Produttive - IRAP); and indirect taxes, relating to sharing in value added tax revenues and excise duties on petrol); to which are added the resources deriving from the various forms of sharing in the health expenditure by the patients (tickets and other paid services), the revenue of the regions and transfers aimed at specific interventions. In Italy, the weight of regional government spending in subsidies and current transfers is very high, and about 80% on average of regional expenditure relates to health services (Piacenza e Turati, 2014).

The health reform of 1978 established the Italian national health service

(NHS) according to the principles of universal coverage and a health system entirely funded by the central government. As for the funding of the NHS, Piacenza e Turati (2014, p.201) puts it as follows: "Since its foundation in 1978, the funding of the Italian NHS followed (and still follows, at least to some extent) a sort of three-stage process. The first step is *ordinary funding*: the CG decides in December, with the Budget Law for the following year, the total amount of resources to be devoted to health care. It then makes up the difference between total funding and regional revenues (a blend of earmarked taxes and tariffs), providing the additional resources needed. The second step is the redistribution among the regions of total funding according to an 'appropriation formula', which involves also some bargaining between CG and RGs. Finally, the third step may be called *extra-ordinary funding*: the CG discretionally bails out RG deficits by deciding how much of the deficit to cover and when to intervene".[1] However, the 1990s reform have changed the territorial organisation of the health system with the goal of increasing the power of each region by applying the management theory in the provision of health services De Nicola *et al.* (2014), and have included several packages that changed the form of healthcare funding. In fact, the approach towards fiscal federalism has been initiated in 1997 with the abolition of social security contributions and the introduction of a regional tax funding system. General taxation has been allowed to play a complementary role; that is, to redistribute resources to regions with a narrower tax base to ensure adequate levels of health care for all residents (Scalzo *et al.*, 2009, p.39). Legislative Decree N. 56/2000 on fiscal federalism stipulates in Article 1 Comma d) the abolition of tax transfers established by Article 12, Comma 1, of Legislative Decree N. 502/1992, and subsequent amendments and integrations, relating to the financing of current and capital health expenditure in favor of regions with ordinary statute. In Article 1, Comma 4 of Legislative Decree N. 56/2000, it is stipulated that the cancelled transfers are compensated with the regional value added tax sharing; with the increase in the rate of the regional tax on household income and wealth, and the increase in the regional sharing in the excise duty on petrol, in the measures necessary to achieve this compensation. In Article 8, Comma 1, of Legislative Decree N. 56/2000, to ensure essential and uniform levels of health care in each region, the latter is bound to allocate an expense equal to the financial need for the regional health service. All the responsibilities and roles of public health are defined within the main national health reforms defined by Law N. 833/1978; Law N. 502/1992 and Law N. 56/2000 (Rechel, 2018). In analysing the organisation and financing of public health in Italy, it is necessary to consider two important aspects. The former refers to the regionalised structure of health care management and delivery, while the latter is associated with the common understanding of public health, primarily understood as publicly funded health services provided by the NHS (Poscia *et al.*, 2018). To take advantage of economies of scale, the number of ASL, decreased from 659 in 1992 to 195 in 2005, to 143 in 2013, and about 100 in

[1] CG stands for Central government whereas RGs stand for regional governments.

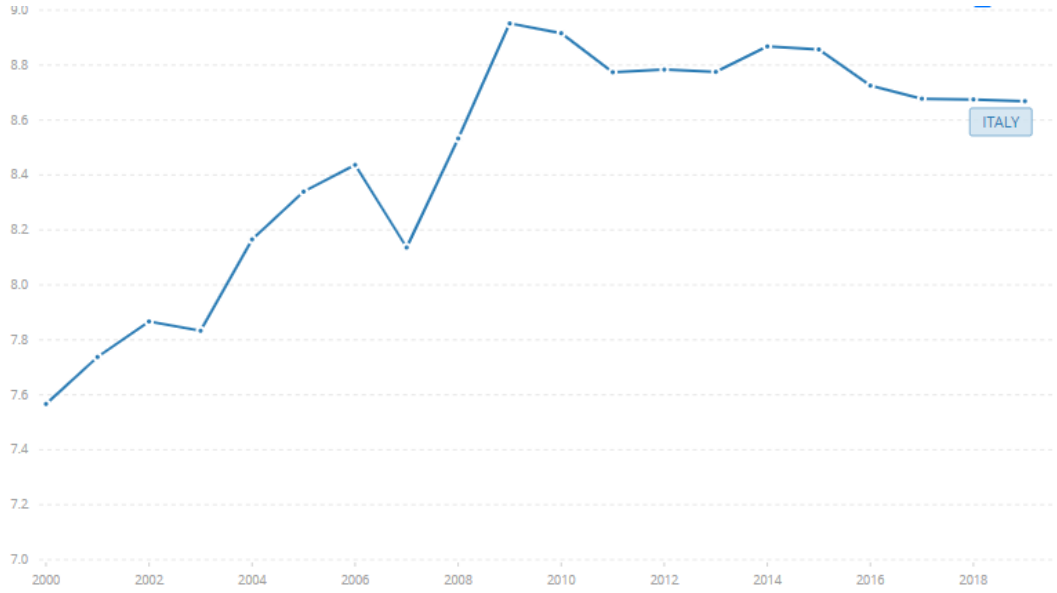


Figure 3.2 – Current health Expenditure of Italy as a percentage of GDP
Source: World Health Organisation Global Health Expenditure database (apps.who.int/nha/database)

2020.[2] Piacenza *et al.* (2010) noted that the merger and acquisition processes involve public and private hospitals, not only as a response to the reduction of beds, but also to exploit economies of scale and scope, and to improve public health efficiency.

In summary, the Italian NHS is essentially financed by national and regional taxes, plus partial co-payments for drugs and outpatient care. In 2018, Italy's healthcare expenditure represented 8.68% of GDP, amounting to 115.4 billion euro (Signorelli *et al.*, 2020). Figure 3.2 shows that the Italian NHS expenditure follows an increasing trend in the period 2000 - 2018, going from 7.57% of GDP in 2000 to 8.68% of GDP in 2018. During the financial crisis, it fell from 8.44% of GDP in 2006 to 8.14% of GDP in 2007, and then increased in 2008 (8.53% of GDP) and 2009 (8.95% of GDP). After 2009 it declined slightly to 8.68% of GDP in 2018.

However, the process of fiscal and administrative decentralisation, and patient mobility raise issues about the impact of different healthcare spending possibilities across regions (Levaggi e Zanola, 2004; Ferrario e Zanardi, 2010). Along their lines, poor regions that collect lower tax revenues may not be able to guarantee the same level of services as those provided by rich regions in terms of quality and quantity, contributing to the migration of resident patients towards the health services of the rich regions. The realty is that income disparities across regions do not directly influence the NHS, as there is a system of equalisation grants to provide the same set of quasi-universal services (Di Novi *et al.*, 2019). Equalisation schemes strengthen the dependence of rich regions on their own resources as inter-regional disparities increase, and

[2] Author's elaboration on the data of *Ministero della Salute.*

poor regions receive additive resources from central government. Italy is also a country characterized by strong structural and economic contrasts between different areas. The regional territories differ considerably in terms of extension, which is a significant feature of economies of scale in public production, density, structure, age of population and gross domestic product (Grisorio e Prota, 2015).

3.2.4 Health providers

Health and social services have long been considered emblematic of public provision and production, due to the presence of market failures. However, in order to cope with rising health expenditure in developed countries, their health systems have been subjected to 'privatisation reforms' aimed mainly at increasing efficiency and reducing the costs of service provision. The main policies are the establishment of 'quasi-markets' for health services or the modification of public reimbursement systems for public and private services provided.

In Italy, these policies have had a significant impact on the financing mechanism of local healthcare facilities operating within the NHS; there has been a shift from a cost-based ex-post payment for public facilities and bed-day rate for private facilities, to a prospective payment system (PPS) based on diagnostic related groups (DRGs) applied to both facilities. Public and private (for-profit and non-profit) providers compete both directly in regions where patients have the right to choose their provider or to move to another region, and indirectly in regions where Local Health Units negotiate for their patients with public and private providers (Barbetta *et al.*, 2007). Public providers are financed with public funds from general taxation and public transfers. Private providers, on the other hand, rely on a mix of public funds from services provided to citizens covered by the NHS and private resources from the purchase of services by citizens. In fact, Mapelli (2012) argues that, in 2010, the health services production was made 51% by public institutions and 49% by private institutions or self-employed physicians and that, the private sector provides 29% of goods and services to the NHS, while sells 20% to paying patients and voluntary insurances. It is worth emphasising that insurance funds have regained importance as a component of private health expenditure with the spread of occupational health funds for workers and their families, reintroduced by national collective bargaining or unilateral employer initiatives (Neri, 2019).

Over the last two decades, many authors have emphasised the legal nature and ownership of healthcare providers, whether public, private for-profit or non-profit, whose objectives, values and behaviour differ and can have an impact on patients' demand for healthcare services (Barbetta *et al.*, 2007; Mapelli, 2012). Barbetta *et al.* (2007) argue that ownership has a major impact in explaining the economic performance and efficiency of providers. Fundamentally, the private sector is characterised by the presence of residual claims that can be a powerful incentive for economic efficiency and cost reduction, while conversely, the public sector has no residual claims that can induce shirking and diminishing effort, thus reducing efficiency. On the other side, Mapelli (2012)

recalls that the actions of the public administration are guided by the principles of impartiality, i.e., non-discrimination towards patients and suppliers, uniformity of treatment and transparency in the expenditure procedure. This action is entrusted to public administration institutions and staff subject to administrative law regulations. By contrast, private sector action concerns the provision of services subject to regulations under common law. Private entities are characterised by the economic aims they pursue, they may be profit-making (autonomous physicians, companies) or non-profit institutions, with the former operating with the aim of making a profit from their activities that goes to remunerate the owners of invested capital and the latter with the aim of carrying out a social work for which they may also make a profit that must be reinvested in the institution.

Many scholars question the fact that the combination of cost containment and expenditure reduction policies in the public sector and the increased role of private spending have played an important role in the efficiency of the NHS (Frisina Doetter e Neri, 2018; Neri, 2019). In fact, Neri (2019) argues that between 2007 and 2014, the percentage of individuals who said they did not need medical examinations increased from 4.1 per cent to 7 per cent for three reasons: the excessively high cost of medical care, the remoteness of care facilities and long waiting lists. This has obviously affected a high share of low-income individuals, with the risk of changing the universalist character of the healthcare system in Italy. As a result, traditional inequalities in access to health services have deepened and seem set to increase, exacerbating differences between socio-economic and occupational groups.

3.3 Theoretical framework

Global health challenges including an ageing population, the lack of balance between cost containment while maintaining access and quality, the shift from acute to chronic diseases leading to a greater burden on medical resources, and the fragmentation of healthcare systems have prompted many developed countries to make major changes to their healthcare systems over the past four decades (Yaya e Danhoundo, 2015). Indeed, Italy has undertaken major health reforms in recent decades in order to provide effective and efficient health care to its citizens and residents. These include a huge focus on basic benefit packages, increased access to healthcare for the disadvantaged and vulnerable, integration between different sectors of the medical care division, fair competition between public and private healthcare providers, and the increasing use of health information technology.[3] Global health challenges worsened following the emergence of the Covid-19 pandemic at the beginning of the year 2020, which forced the entire world to observe a long quarantine period as well as the closure of economic activities and caused loss of income and increasing income inequality.

[3]For an interesting contribution, see Yaya e Danhoundo (2015) and Ozcan e Khushalani (2017).

Income disparities can be defined as a way in which income is unevenly distributed among the population. Economic theory suggests that the less equal the distribution, the greater the income inequality, and that income inequality is often accompanied by wealth inequality (Musgrave, 1989). The evolution of social disparities in relation to both wealth and income over the past two centuries has been described with non refutable precision by economist Piketty (2018). He looks for the current situation of disparities and the relationship between inequality and economic growth. His thesis is based on poor economic growth compared to the growth of capital resulting from the "fundamental contradiction of capitalism" $r > g$, where r represents the rate of return on invested capital and g the rate of economic and demographic growth. Piketty (2018) calls into question the free market as a determinant of $r > g$. He explains that $r > g$ generates inequality in the sense that accumulation is concentrated in periods of crisis and low growth, accentuating wealth in the hands of those who have a lot of it, taking them away from the lower middle classes. However, the globalised economic system with its mechanisms seems to be consolidating the existing gap in income disparities and it is well-known that in the case of market failure, the public sector must intervene.

The literature of the last three decades has investigated both theoretically and empirically the relationship between income inequality and health. Studies showing a consistent association between income inequality and health are conducted by Wilkinson (1992), McIsaac e Wilkinson (1997), Lynch e Kaplan (1997), De Vogli *et al.* (2005) and Wilkinson e Pickett (2006). In the latter, Wilkinson e Pickett (2006) review more than 150 empirical studies on this relationship and find that "health is less good in societies where income differences are greater" (Wilkinson e Pickett, 2006, p. 1768). Herzer e Nunnenkamp (2015) find that income inequality slightly increases life expectancy in developed countries while its effects on life expectancy are significantly negative in developing countries. Although there are many studies on the relationship between income inequality and the health of populations, in most cases the results have been inconclusive.

Since the association between income inequality and health can vary according to specific characteristics of certain areas, De Vogli *et al.* (2005) examine this association within Italy, a country characterised by huge regional income disparities between North and South regions.[4] They collect data on life expectancy at birth for the year 2001 from Istat. Data on Italian household income are collected by the Bank of Italy and measured through the Gini index from 1990 to 1998, where data are available. They find a strong negative relationship between income inequality and life expectancy. Even the Italian case study is not without criticism given the quality of the data used on their analysis.

Strauss e Thomas (1998) argue that health and income affect each other and are related to many factors that are difficult to measure, more likely because when conducting their study, data and in particular longitudinal surveys with good health measurements were not available. Indeed, they claim that many

[4]For more details see Daniele e Malanima (2014).

studies have been hampered by inadequate data. Moreover, in demonstrating the effects of income inequality on health, Ecob e Smith (1999) not only find a log linear relationship between income inequality and health, but also find an inverse relationship between income inequality and health, even if they have not deepened the latter.

This non-exhaustive review of the literature drives home the point that there is no substantial impact of income inequality on health, whether considering important variables commonly used in the literature such as life expectancy at birth and mortality or morbidity to assess the health of populations, or variables used to assess income disparities.

Health policies play an essential role in ensuring good health for people and consequently promoting development, reducing poverty and income disparities. This has been clearly explained by the study of (Brosio e Piperno, 2014), which illustrates the negative association between public health efficiency and income disparities. In fact, an earlier contribution by (Barker, 1995) provides evidence that the impact of health on income can work with a very long lag in the sense that early childhood health may have an impact on income not only through the acquisition of human capital, but also by triggering health problems in adulthood which interfere with work. These problems emerge most acutely in developing countries where accompanying facilities during pregnancy remain limited or non-existent in rural areas. For this reason, a minimum level of government-funded health service is necessary, as well as the efficiency of the health services provided. O'Donnell *et al.* (2015) analyse the relationship between health and income through the labour market channel and find that unhealthy workers increase income disparities by earning less and at worst may find themselves unemployed in developing countries; whereas these effects are mitigated in developed countries where there is higher social protection. In a somewhat similar vein, a recent study of (Cyrek *et al.*, 2019) show that an efficient public health spending generates a reduction of both income disparities and poverty. The combination of these factors leads us to our first hypothesis:

Hypothesis 1. Public health efficiency should reduce income disparities in Italian provinces.

Improving public health efficiency is a constitutive part of development. The idea is that healthy people can earn income more easily. When it comes to enhancing efficiency in health sector, there is no doubt that it can be helped by various actions, including health reforms that pursue efficiency and public policies such as the provision of epidemiological services and medical care (Sen, 1999). Thus, a good connection between health outcomes and economic progress and, consequently, the decline in income disparities can be weakened by various policy factors. Sen (1999) argues that much depends on how the extra income generated by economic growth is utilised, particularly whether it is used to adequately expand public services to reduce the burden of poverty and income disparities.

One more thing is added in the analysis that is, whether the impact of public health efficiency on income disparities can be achieved through the channel of transmission of labour productivity. The idea is that an efficient

public health service enables faster cures and treatments that allow to return to work earlier, maintain high labour productivity, economic growth and above all reduce income disparities. Healthier workers are physically and mentally more energetic and robust and consequently more productive, earn higher wages and are less likely to be absent from work because of illness (Bloom *et al.*, 2004).

While the theoretical and empirical literature appears to be unanimous on the positive and significant impact of health on labour productivity, there are nevertheless differences in the impact of health on labour productivity in developing and developed countries. In developing countries, the marginal productivity of health is likely to be higher than in developed countries. Generally, health levels are low in developing countries and the nature and incidence of diseases tend to be different. On the other hand, the employment structure in developing countries is such that work often depends more on strength and endurance and therefore good health (Strauss e Thomas, 1998). In developed countries, disabled people have more job opportunities than in developing countries. In addition, there are systems of protection of these categories and their insertion in the labour market.

Consider the rural areas of developing countries where most workers exert their activity in the fields and informal jobs and a minority of state officials. If their productivity is observable and is their only means of survival, it is more likely that in both cases a worker's prolonged health problems will have a negative and considerable impact on his performance and consequently on his salary or income. The same analysis carried out in urban areas produces the same results for similar reasons, although in different contexts: more than 80% of workers carry out informal activities in which it is very difficult to be replaced by a family member in case of illness. Thus, the strength and good health of the worker is a determining factor for his productivity. A similar analysis carried out in the industrialised countries can more likely be translated into the higher costs that an entrepreneur has to bear when he hires a worker who is constantly ill, assuming that his productivity is observable. Instead, assuming that labour productivity is not observable due to the high costs of monitoring and that health is not accounted for, in the long run alternative work contract forms are likely to be developed to minimise the problems associated with observability of productivity and healthier workers will move in areas that reward robust health (Strauss e Thomas, 1998). All these cases highlight the importance of an efficient health system, able to bring a worker back to health in a short time. For the seek of equity, the public sector must provide care to workers to help them mitigate the reduction in income due to the disease. This discussion leads us to the second hypothesis of this thesis:

Hypothesis 2. Public health efficiency should be expected to be labour productivity enhancing to the extent that it increases the quality and quantity of labour.

3.4 Indicator of public health efficiency

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 of three inputs and two outputs. The sample of 102 provinces is selected based on the full availability of data at provincial level, over the period 2000 to 2016. The assessment of public health efficiency will be done in a two stages multi-input and multi-output production process. In the first stage, an input-oriented BCC-DEA model will be made and in the second stage a bootstrap method will be applied to the BCC-DEA to improve the quality of the results.

The Italian provinces are the DMUs which convert multiple inputs in multiple outputs. The inputs variable refers to physicians and dentists, nurses, and hospital beds of public health institutions of each province. The outputs refer to all hospital days produced by hospitals located within a given province, both those related to resident patients and those related to patients residing in other provinces; the so-called active mobility. Istat evaluates these data on the basis of the "Hospital Discharge Cards". In fact, istat calculates the days of hospitalisation in public and accredited healthcare institutions by referring to the discharges or days of hospitalisation of discharged patients. Therefore, we consider the total number of discharges from public and accredited hospitals in each province as an excellent proxy for so-called active mobility. 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 e Zanola, 2004; De Nicola *et al.*, 2012, 2014). To measure technical efficiency, defined as the ability of a set of peer entities or DMUs to produce a given set of outputs with minimal inputs, the input-oriented variable return to scale BCC-DEA model is applied. The efficiency scores are calculated with respect to an empirical frontier Hauner e 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.

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 finite sample (Simar e Wilson, 1998). Only 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 analyzing 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 e Wilson, 1998). The bootstrap procedure is based on the idea of repeatedly simulating the data generation process (DGP), by resam-

pling and applying the original estimator to each simulated sample so that the resulting estimates mimic the sampling distribution of the original estimator $\hat{\theta}$, which in our case is estimating the PHE of Italian provinces. In other words, given the estimates $\hat{\theta}_{it}$ of the unknown true values of θ_{it}, a series of bootstrap estimates $\hat{\theta}^*_{it}$ is generated through the DGP. Therefore, for some unit i, the bias term is given by:

$$BIAS(\hat{\theta}_i) = B^{-1} \sum_{b=1}^{n} \hat{\theta}^*_{ib} - \hat{\theta}_i, \quad i = 1, 2, ..., n \tag{3.1}$$

where $\hat{\theta}^*_{ib}$ is the bootstrapped technical efficiency and B is the number of bootstrap replications. The corrected bias estimators of $\hat{\theta}_i$ are obtained from 3000 bootstrap iterations, and are given by:

$$\hat{\theta}^c_i = \hat{\theta}_i - BIAS(\hat{\theta}_i) = 2\hat{\theta}_i - B^{-1} \sum_{b=1}^{n} \hat{\theta}^*_{ib} \tag{3.2}$$

The goodness of the bootstrap depends on both the number of replications and the sample size (Simar e Wilson, 2000). Therefore, bootstrap is consistent when:

$$(\hat{\theta_i t} - \theta_{it})|\hat{\phi} \approx (\hat{\theta}^*_{it} - \hat{\theta_i t})|\phi^*; \quad i = 1, 2, ..., n; \quad t = 1, 2, ..., T \tag{3.3}$$

where $\hat{\phi}$ and ϕ^* represent, respectively, the observed and the bootstrap samples. 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 3.3. Map legends of Figure 3.3 are divided into six classes. However, for our purposes, the interesting results belong to class 1 with the darkest blue colour, that encompasses all the efficient provinces. The maps in Figure 3.3 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 3.3 depicts the bootstrap-PHE, 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 inpatients. These results are comforting, since some provinces well known in terms of efficiency in general, the provinces of Milano and Roma, also have the

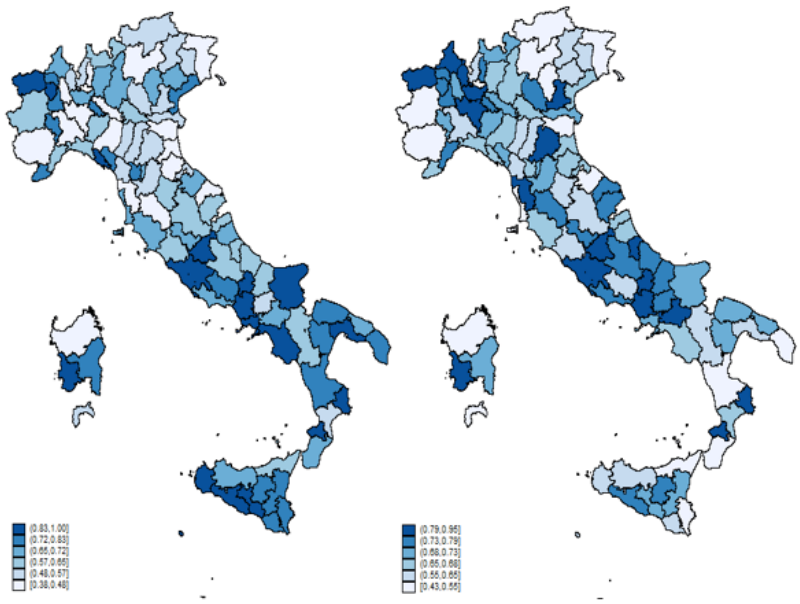


Figure 3.3 – The DEA and bootstrap-DEA of public health efficiency scores of the year 2016

Source: elaboration of author based on Health For All database

best efficiency scores. It should be remembered that some provinces are not in the sample. That is: the provinces of Monza e della 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 3.3), as the health system seems to function very differently in different environments, suggesting that local factors play an important role (Di Liberto e Sideri, 2015).

3.5 Provincial income disparities

The financial crisis of 2008 and the economic recession of the following years made the issue of income distribution re-emerge not only at the international level but also at the national level. Two positions have been identified from the economic and political debates on the subject. The first is supported by economists who identify the increase in inequality as one of the causes of the crisis. In fact, Pianta e Franzini (2016) argued that the rich have become much richer, the middle class has shrunk, the poor have slipped further into poverty; even globally despite the rapid growth of major emerging countries such as China and India where their respective governments are struggling against the explosion of internal inequalities. Stiglitz e Chiesara (2013) had achieved the same results by analysing inequalities in the United States and concluded that the wealth of the 1 percent of the population had overruled that of the 99

percent, stifling true dynamic capitalism. The second is supported by other economists who have questioned the consequences of the crisis in terms of income distribution, poverty, social cohesion, and well-being. In fact Acciari *et al.* (2013) argued that the increase in income inequalities would lead to over-indebtedness of the poorest parts of the population, driven by the emulation of the consumption models of the wealthiest classes in the United States.

In recent years, scientists have begun to use data from tax sources that allow to reconstruct long time series on income shares held by taxpayers in the wake of the precursor works of Piketty e Saez (2003). See also (Acciari *et al.*, 2013; Barbetta *et al.*, 2018). In this work we exploit the data of the tax returns with the aim of making an analysis of inequality in Italy. The spatial dimension of income disparities is certainly less explored than the longitudinal one. There are few studies that have made an in-depth analysis of the geography of inequalities in Italy due to the lack of data at the local level (Acciari *et al.*, 2013). Other studies, to remedy the lack of data at a local level or the small sample size of the survey on household budgets, combine the surveys from 1995 to 2000 and obtain estimates of the marked inequalities between the regions of the Centre-North and those of the South (Cannari *et al.*, 2003).

Following the approach of Acciari *et al.* (2013), it is essential to build a map of income disparities within and between the Italian provinces over the period 2000 - 2016 for two reasons. The first is linked to the dichotomous nature of economic and social activities between the provinces of the Centre-North, more productive, and closer to the large European markets, and the less productive provinces of the South distant from the large European markets Daniele e Malanima (2014), where the average national data can hide very different realities at the local level. The second reason derives from the first in the sense that some determinants of income inequality such as the productive structure and its consequences such as poverty, well-being, social cohesion are of a purely local nature.

We follow a different approach from that of Acciari *et al.* (2013), since the relationship between public health efficiency (PHE) and income disparities requires the whole income disparity indexes. We follow a similar approach to that of Rodríguez-Pose e Ezcurra (2010), when analysing a cross-country relationship between regional disparities and decentralisation. We also considered personal income tax (hereafter, PIT) rather than GDP, as it widely found in the literature, see Rodríguez-Pose e Ezcurra (2010); Kyriacou e Roca-Sagalés (2012); Sacchi e Salotti (2014), because it is more suitable for this analysis. It should be emphasised that the use of PIT data requires some precautions. Firstly, tax returns are affected by tax evasion, with potential distorting effects on the calculation of inequality ratios. True incomes would be underestimated in the lower deciles of distribution and for self-employed workers (Fiorio e D'Amuri, 2005; Marino e Zizza, 2012). The second aspect concerns the fact that incomes refer to individuals and do not allow the calculation of households' income (Acciari *et al.*, 2013). Furthermore, if on the one hand sample surveys allow to overcome some limitations of data from administrative sources, on the other hand they also present problems. The sampling variability can add

uncertainties to the estimates, the higher the sample size is and the more the respondents' answers can suffer from distortions (because the subjects may be reluctant to communicate some information) and inaccuracies (linked to a correct evaluation of the different sources of income).

3.5.1 Data description

The database consists of tax returns from sources of the "Ministry of Economy and Finance". These archives contain the declarations of all the subjects who have received, in the period considered, relevant income for the purposes of the personal income tax (PIT). [5] PIT is a progressive tax on individual incomes introduced in the Italian legislation in 1974 and discretionally modified almost every year in most of the relevant parameters; that is the marginal rate schedule, the tax allowances, and the tax credits. PIT provides about 25% of the total public revenues over the period considered, and approximates 158 billion euro in 2013 and, 165 billion euro in 2019, excluding regional and municipal surtaxes, which represent more or less 10% of the Gross Domestic Product over the period considered (Fiorillo, 2005; Barbetta *et al.*, 2018). Barbetta *et al.* (2018) argued that the original aim of the PIT was to define a comprehensive income tax "à la Schanz-Haig-Simons", adding up all possible income categories. These include labour and pension incomes, entrepreneurial incomes, property incomes, incomes from financial capital, plus a residual category trying to capture most of the capital gains, and all other income sources that cannot be summarized in one of the previous groups. But, in practice, the tax rules are such that most financial capital income is not included in the tax base and taxed separately with a substitute tax, which erodes the tax base. Therefore, labour and pension incomes represent more than 80% of the whole taxable income. In fact, according to the press release N. 107 of 27/05/2021 on the PIT and VAT returns for the tax year 2019 of the "Ministry of Economy and Finance", the income from employees and pensions represent approximately 83% of total declared income, with retirement income accounting for 30% of total income.

The data comes from the tax returns submitted by taxpayers or *single model* and *model 730*, or from the declarative models of the withholding tax, *model 770* for subjects who, for the income received, have not presented the return. The data were processed by the author in aggregate form at the provincial level over the period 2000 to 2016. The data relating to taxpayers were also processed and aggregated at the provincial level. The aggregated data at the provincial level reflect those inferable from other sources. In fact, the taxpayers surveyed by the "Minister of Economy and Finance" correspond almost perfectly or to more than 80% of the sum of employed persons estimated with ISTAT data and of pensioners surveyed by INPS (Barbetta *et al.*, 2018).

[5] data source: $https://www1.finanze.gov.it/finanze/analisi/stat/public/index$.

3.5.2 Income disparity indexes

A correct measure of income disparities should satisfy five axioms. The most famous is the Pigou-Dalton transfer principle; that is, the transfer of income from a poorer to a richer region should be recorded as an increase, or at least not a decrease in inequality. Income disparities indices should be scale independent; this should not change if the incomes of all regions change in the same proportion. The population principle should also be verified; that is, the measure of income disparities should be invariant with respect to population replication, in the sense that merging two identical income distributions should not change the measure of inequality. Income disparities indices should be symmetrical; that is, it should be independent of any other regional characteristics besides regional income. The last axiom is decomposability; that is, the measure of overall income disparities should be related to the measure of income disparities for subgroups, so that if inequality increases across all subgroups of the population, overall inequality should also increase. For more details, see (Bourguignon, 1979; Cowell, 1995; Lopez-Rodriguez e Faina, 2006).

The concept of inequality can be interpreted in terms of the variability of the individuals' income that make up the group analysed or in terms of concentration. As measures of inequality, the literature has proposed various indices to measure the variability or concentration of a phenomenon. However, not all indices meet all the axiomatic requirements. For example, the relative mean deviation index satisfies the Pigou-Dalton principle if and only if the transfer is from an individual with an above-average income to another individual with a below-average income. Instead, the variance is not independent of the scale. In fact, if all income y_i increases by a factor k, the variance increases by a factor k^2. Variance is particularly sensitive to high income values. The sensitivity to Pigou-Dalton transfers is always respected, because the second derivative is always positive. The Pareto principle, on the one hand, is respected if and only if the increase in income concerns an individual whose income is below the average and in this case, the first derivative is negative. If, on the other hand, an individual with an above average income benefits from the increase, the measure of inequality increases and, in this case, the first derivative is positive.

Among the indices that meet all the axiomatic requirements the coefficient of variation and the Theil indexes can be mentioned. The coefficient of variation is an index that does not depend on the scale on which incomes are measured while retaining the properties of variance, a strong sensitivity to transfers. The coefficient of variation (CV) is given by the ratio between the square root of the variance, the standard deviation, and the arithmetic mean:

$$CV = \frac{\sigma}{\mu},$$

where σ is the standard deviation and μ is the arithmetic mean. CV is a pure number because σ and μ are expressed in the same unit of measurement (Cowell, 2011).

Theil index derives from the concept of entropy of information theory, ac-

cording to which the information content of a message linked to an event E is a decreasing function of the probability of occurrence of the event itself. The information content of E can be expressed by a decreasing function in y, and let $h(y)$ be this function. Given n events $E1, E2, ..., En$ entropy can be defined as the weighted arithmetic mean of the information contents of the n events, with weights the respective probabilities:

$$H = \sum_{i=1}^{n} y_i h(y_i) = \sum_{i=1}^{n} y_i log(1/y_i),$$

In the case that all events have the same probability of occurring, the entropy assumes its maximum value:

$$H_{max} = \sum_{i=1}^{n} (1/n) logn = (n/n) logn = logn.$$

In the case of a degenerate distribution, in which $n-1$ events have zero probability of occurring while the last is the certain event, the entropy assumes its minimum value:

$$H_{min} = log1 = 0.$$

Since the entropy H assumes the maximum value in the case of equal distribution of income and the minimum value in the case of maximum concentration, if the entropy index is to measure inequality, the opposite is appropriate. Therefore, to obtain an index that assumes maximum value in case of maximum concentration of income and minimum value in case of equal distribution of income, it is sufficient to calculate the index as $H_{max} - H$, obtaining the Theil index:

$$Theil = H_{max} - H = logn - \sum_{i=1}^{n} y_i log1/y_i = logn + \sum_{i=1}^{n} y_i logy_i$$

$$= logn \sum_{i=1}^{n} y_i + \sum_{i=1}^{n} y_i logy_i = \sum_{i=1}^{n} y_i (logn + logy_i) = \sum_{i=1}^{n} y_i logny_i$$

The requirement of independence from the scale is guaranteed by the fact that the Theil index is calculated based on income shares. As regards the sensitivity to transfers, the derivatives must be calculated. For the first derivative:

$$\frac{\delta Theil}{\delta x_i} = \frac{(\sum y_i logny_i)}{x_i} = \frac{(\sum \frac{x_i}{x} logn \frac{x_i}{x})}{x_i} = \frac{1}{x} logn \frac{x_i}{x} + \frac{1}{x}.$$

Therefore, if there is a transfer of income r from a richer individual, that is the one occupying the $k-th$ position in the income rankings, to a poor individual h, with $x_k > x_h$, the effect on the Theil index is negative:

$$dTheil = \left(\frac{1}{x} logn \frac{x_h}{x} + \frac{1}{x}\right) dx_h + \left(\frac{1}{x} logn \frac{x_k}{x} + \frac{1}{x}\right) dx_k$$

$$= \left(\frac{1}{x} logn\frac{x_h}{x} + \frac{1}{x}\right)(r) + \left(\frac{1}{x} logn\frac{x_k}{x} + \frac{1}{x}\right)(-r)$$

$$= \frac{r}{x}\left(logn\frac{x_h}{x} - logn\frac{x_k}{x}\right) = \frac{r}{x}\left(log\frac{x_h}{x} - log\frac{x_k}{x}\right) < 0.$$

The second derivative is always positive:

$$\frac{\delta^2 Theil}{\delta x_i^2} = \frac{1}{nx_i} > 0.$$

Therefore, we can conclude that the coefficient of variation and Theil indices satisfy all the axiomatic requirements for an adequate measure of income inequality. For more details see (Theil, 1979).

To assess regional disparities within each region, we examine the degree of dispersion in the spatial distribution of per capita income within Italian peninsula, through the tax-payer-weighted coefficient of variation (CV), and Theil indexes (Theil) over the period 2000 to 2016 (Sacchi e Salotti, 2014; Kyriacou e Roca-Sagalés, 2012; Rodríguez-Pose e Ezcurra, 2010; Ezcurra e Pascual, 2008; Williamson, 1965). The data used are derived from the "department of finance" database of the "Ministry of Economy and Finance" and, contain information for the period over 2000 to 2016 on PIT and taxpayer of 102 provinces. The CV and Theil indexes are widely used in the literature focused on regional disparities because they are independent of scale, population size, number of regions and satisfy the Pigou-Dalton principle (Cowell, 1995). The tax-payers-weighted coefficient of variation, and Theil indexes can be written as follow:

$$CV = \frac{1}{\bar{y}}\left(\sum_{i=1}^{n} P_i(\bar{y} - y_i)^2\right)^{1/2}, \tag{3.4}$$

and

$$Theil = \sum_{i=1}^{n} P_i\left(\frac{y_i}{\bar{y}}\right) ln\left(\frac{y_i}{\bar{y}}\right), \tag{3.5}$$

where $\bar{y}$ is the average regions PIT per capita, y_i and P_i are the PIT per capita and taxpayer share of provinces, respectively, and n is the number of provinces. The CV, and Theil basically indicate the disparities among provinces within regions, taking into account their relative population weights, and have values between, respectively, the intervals [0, ln(N)] and [0,1], where the extremes 0 and LN(N) and 1 represent respectively maximum equality and maximum inequality (Kyriacou e Roca-Sagalés, 2012) and (Cowell, 2011). It should be remembered that, by including population shares in the analysis of these indexes, it helps to assign a different weighting to each province based on its size and thus, reducing the impact of the level of territorial disaggregation on the results (Rodríguez-Pose e Gill, 2004), (Shankar e Shah, 2003) and (Ezcurra e Pascual, 2008).

Figure 3.4 below, shows the maps of the two indices of provincial income disparities. Map legends are divided into six classes. Class 1, with the darkest blue colour includes the provinces where there is the highest level of income

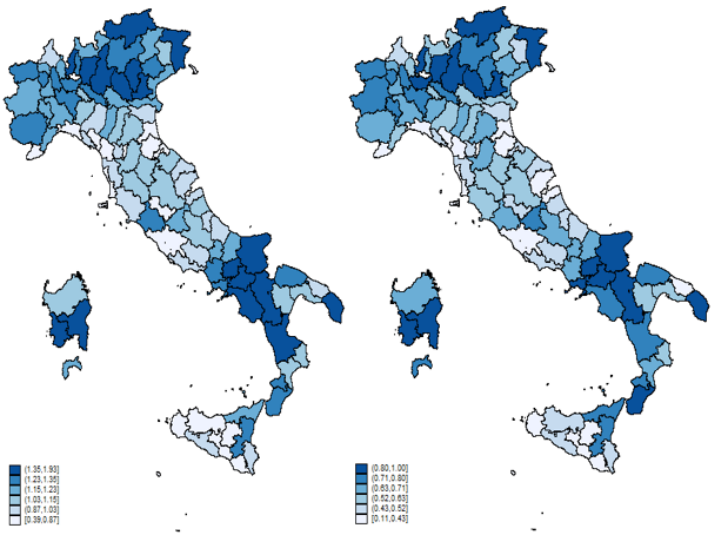


Figure 3.4 – Regional income disparities indexes (CV-Theil): average of the period over 2000 to 2016
Source: elaboration of author based on "Italian department of finance" data

disparities, while class 6, with the lightest blue colour includes the provinces with the lowest level of disparities. Class 2, 3, 4, and 5 with the blue colour include provinces with income disparities. The two maps represent different results from CV and Theil but follow the same path. So, I use the mathematical intersection of the two maps to identify the belonging of a given province to one of the six classes. A higher level of income disparities is found, respectively, in the provinces of Bergamo (1.93, 1.00); Brescia (1.77, 1.00); Foggia (1.65, 0.96); Udine (1.63, 0.98); Lecce (1.61, 0.85); Avellino (1.60, 0.92); Padova (1.52, 0.98); Potenza (1.50, 0.89); Nuoro (1.47, 0.80) and finally Benevento (1.44, 0.89) where the numbers in parentheses represent, respectively, the values of the disparity indexes (CV and Theil). The maps of Figure 3.4 also show a strong density of income inequality in the provinces of northern and southern Italy.

Instead, lower level of income disparities is observed, respectively, in the provinces of Trieste (0.39, 0.11); Prato (0.51, 0.20); Ragusa (0.65, 0.23); Massa (0.61, 0.26); Trapani (0.66, 0.25); Genova (0.62, 0.31); Roma (0.64, 0.33); Caltanissetta (0.73, 0.33); Lucca (0.78, 0.33); Forli (0.79, 0.38); Imperia (0.80, 0.39); Ravenna (0.83, 0.39) and infine Livorno (0.83, 0.40). In this case the weak density of income disparities is observed in some provinces of the Centre-North, South and Sicilia Island.

3.6 Econometric strategy

3.6.1 Model and estimation methodology

We construct a dataset using the data of the income disparity indexes calculated in the previous section, the data of bootstrap-DEA scores of PHE calculated in section four, and the data of control variables over the period 2000 to 2016. The data of the control variables are collected on Istat and OECD.stat database for the period from 2000 to 2016.

We estimate a fixed effects model, under the assumption of strict exogeneity because we need to control for those characteristics which remain fixed over time, then we can 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 e Baltagi, 2008). We also control for province-specific and time-specific effects to reduce the risk of omitted variables. Therefore, we cluster the sample of 102 provinces used in the model. In addition, time dummies are included to control for time effects whenever unexpected variation or special events may affect the outcome variable. In the case of the failure of strict exogeneity, there might be regulatory "bearings" or "buffer" measures to prevent that any shocks in a province or region spread to other provinces or regions and have an impact on the regressor. The Italian regions are equipped with emergency structures to cope with shocks that have already occurred in the past. For instance, the Italian civil protection is an organized structure that depends on the Presidency of the Council of Ministers, which aims to intervene promptly and effectively in the situation of natural disasters or emergency in the country.

It is worth pointing out that model estimation using a fixed effects estimates can suffer from reverse causality because public health efficiency (PHE) can be determined by rich regions with respect to poor ones, highlighting how income disparities can influence PHE; for more details on this concept, see the study by (Martínez-Vázquez *et al.*, 2017). Therefore, a 2SLS estimates is used to solve this problem. The validity of this approach is based on the quality of the instruments that should be correlated to the PHE scores and not correlated to the income inequality indexes (CV and Theil) as well as being orthogonal to the error term. Since it is difficult to find instruments for PHE that meet all these conditions at the same time, the lagged value of the PHE index is used as an instrument (Filippetti e Sacchi, 2016; Bartolini *et al.*, 2019). However, using lagged values results in the loss of observations and information which make the estimates less accurate.

The empirical analysis is conducted on a sample of 102 Italian provinces. Totally, there are 1.734 observations and 17 groups. The dependent variables CV, and $Theil$ are the income disparity indexes; they belong respectively to the intervals [0,ln(N)] and [0,1]. The main predictor of interest, $BEFF$, is the bootstrap-PHE scores and also belongs to the interval [0,1]. The main objective of this research is to investigate the causal effect of PHE on CV, and Theil over the period 2000 to 2016. The relationships between these indexes

are specified as follow:

$$CV_{it} = \alpha + \beta BEFF_{it} + \gamma X'_{it} + \eta_i + \delta_t + \theta_{it} \tag{3.6}$$

and

$$Theil_{it} = \mu + \nu BEFF_{it} + \gamma X'_{it} + \eta_i + \delta_t + \theta_{it} \tag{3.7}$$

where CV_{it}, and $Theil_{it}$ are the income disparity measures in province i at time t; α is a constant which captures the correction factor included in the model comparison; $BEFF_{it}$ is the bootstrap PHE 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 year-specific effects; X'_{it} is a vector of control variables which elements will be described in the next paragraph; and θ_{it} is the error term.

3.6.2 Control variables

The choice of control variables considers factors that can influence both income disparities and PHE and, consequently, the omission of which might bias the estimated impact of PHE on income disparities at provincial level. In recent decades, literature has paid increasing attention to the relationship between the level of economic development of each geographical area and the evolution of spatial disparities within that area (Petrakos *et al.*, 2005).

The first control variable in our study is per capita gross domestic product (GDP). Theoretically, GDP per capita also affects PHE, since the expenditure in health sector is financed by taxation and transfers stemming from the production. Furthermore, the relationship between the level of economic development of a given geographical area and the evolution of spatial disparities within that area is widely discussed in the literature (Petrakos *et al.*, 2005). In fact, Williamson (1965) argued that disparities may increase at low income levels and fall at higher income levels, following an inverted U-shaped relationship. The basic explanation is that, at an early stage of development, resources may be concentrated in some areas but, in later stages, resources shift to poorer areas due to the growing relevance of factors such as the emergence of new benefits of localisation in peripheral areas or jurisdictions, the presence of congestion costs or agglomeration diseconomies in more developed jurisdictions or technological diffusion processes (Kyriacou e Roca-Sagalés, 2012). Following Lessmann (2009), we can argue that richer countries have greater possibilities for redistributive policies that can reduce income disparities at the provincial level. All these arguments raise the possible existence of a non-linear relationship between the level of development and income inequality at the provincial level. Therefore, we also include the square of GDP per capita in the model.

The third control variable is a measure of the degree of openness to international trade. Standard practice defines the degree of trade openness as the ratio of total trade, that is, exports and imports over GDP. It is worth noting that almost all the economies of the Italian provinces have increased their volume of foreign trade in the period between 2000 and 2016. But the effects

of greater competition and increasingly integrated markets are unevenly distributed in the space, affecting the existing spatial disparities (Petrakos *et al.*, 2005). Therefore, following Daniele e Malanima (2014) we can assume that the impact of trade openness will be greater in the Northern area which is close to the largest European markets than in the Southern areas which are very far from those markets.

Furthermore, *new economic geography* models have highlighted the important role of agglomeration economies in explaining income disparities at the provincial level. See Krugman (1998) for more details. Agglomeration economies may be the result of spatial externalities and imply that proximity to large markets favours the accumulation of economic activity in certain areas (Fujita e Thisse, 1996). Due to the difficulty of adequately assessing the size of markets at the provincial level, measuring agglomeration economies is not an easy task. Therefore, following López-Bazo *et al.* (2004) we approximate the impact of agglomeration economies through the degree of dispersion of population density at the provincial level.

We define the sector dynamics as the share of export value in the sector with dynamic world demand on total exports. According to the ATECO 2007 classification, the dynamic sectors are CE- Substances and chemicals; CF- Pharmaceutical, chemical-medicinal, and botanical articles; CI- Computers, electronic and optical equipment; CJ- Electrical appliances; CL- Means of transport; M- Professional, scientific, and technical activities; R- Artistic, entertainment and fun activities; S- Other service activities.[6] Ateco is the Italian classification of productive economic activities. An economic activity can be defined as such when the resources used for its performance (capital goods, work, industrial techniques, or intermediate products) combine to produce certain goods or services; therefore, an economic activity has as requisites the presence of production factors, the production process, and the results of production (goods or services).

Starting from January $1^{st}, 2008$, National Institute of Statistic (ISTAT) adopted the classification of economic activities Ateco 2007, which constitutes the national version of the European nomenclature Nace Rev. 2, published in the Official Journal (Regulation (EC) No. 1893 / 2006 of the European Parliament and of the Council of 20/12/2006). Ateco 2007 was defined and approved by a specifically set up management committee. It provides for the participation, in addition to ISTAT which coordinates it, of numerous institutional figures: the ministries concerned, the bodies that manage the main administrative sources on companies (tax and chamber industry, social security institutions, etc.) and the main business associations. Thanks to the close collaboration with the Revenue Agency and the Chambers of Commerce, a single classification has been achieved. For the first time, the world of official statistics, the fiscal world and the commerce chamber sector adopt the same classification of economic activities. This result constitutes a significant step forward in the process of integrating and simplifying the information acquired and managed by the Public Administration (Vicari *et al.*, 2009)

[6] https://www.istat.it/it/archivio/17888.

Table 3.1 – *Summary of descriptive statistics of keys variables*

Variable	Obs	Mean	Std. dev.	Min	Max
CV	1,734	1.130947	.2705787	0.3400286	2.036903
Theil	1,734	0.614269	0.1947772	0.098977	1.0000
EFF	1,734	0.6455337	0.1820456	0.2806356	1.0000
BEFF	1,734	0.577221	0.1506949	0.2343641	0.9388368
LABPROD	1,734	14764.04	3556.29	6941.891	28322.51
GDPPC	1,734	26894.72	7139.048	14346	55813
GDPPCSQ	1,734	7.74e+08	4.16e+08	2.06e+08	3.12e+09
TRADE	1,734	0.508884	0.7295772	0.0025252	8.501.578
POPDENS	1,734	250.064	333.7503	36.63	2663.88
DYNSEC	1,734	0.2884352	0.2008244	0.0007897	0.9388702

Source: elaboration of the author.

Table 3.2 – *Correlation matrix among the main selected variables*

	CV	Theil	EFF	BEFF	GDPPC	GDPPCSQ	TRADE	POPDENS	DYNSEC	
CV	1.000									
Theil	0.9431	1.000								
EFF	0.0186	0.0097	1.000							
BEFF	0.0136	-0.0138	0.9783	1.000						
LABPROD	0.0260	0.0631	-0.1447	-0.1657	1.000					
GDPPC	0.0258	0.0879	-0.4149	-0.4413	0.4819	1.000				
GDPPCSQ	0.0485	0.1217	-0.3485	-0.3842	0.4796	0.9846	1.000			
TRADE	-0.1042	-0.0902	0.0439	0.0008	0.1019	0.2187	0.2206	1.000		
POPDENS	-0.0449	0.0493	0.1348	0.0417	0.1813	0.2468	0.3008	0.1823	1.000	
DYNSEC	-0.0316	0.0086	0.0234	-0.0077	0.0451	-0.0216	-0.0247	0.0361	0.1378	1.000

Source: elaboration of the author.

Table 3.1 presents descriptive statistics of the main variables of equation(3.6 and 3.7), in which it appears the number of observations, the mean, the standard deviation, the minimum and the maximum value of each variables.

To assess the statistical relationship among the main selected variables, we construct the correlation matrix to analyse the degree of correlation between the main predictor and the other regressors.

Table 3.2 allows to highlight that the bivariate correlations between the main predictor of interest and the other regressors are weaker. It also shows that the control variables are negatively correlated with the dependent variable CV, except for GDP per capita and GDP per capita square which are positively correlated. Instead, the other dependent variable Theil is positively correlated with the controls, except for TRADE which is negatively correlated. The correlation is also weaker among the controls, except for GDPPC and GDPPCSQ for which there is a strong correlation (0.9846). The disparity indexes CV and Theil are also strongly correlated with each other (0.9431).

3.7 Baseline results

The fixed effects estimation results are illustrated in Table 3.3 and Table 3.4. The panel regressions are conducted with a set of dependent variables (CV, and Theil), the predictor of interest, and control variables.

As can be seen in Table 3.3 and Table 3.4, the average causal effect of public health efficiency ($BEFF$) on income disparities (CV, and Theil) at provincial level of administration is captured by the main coefficient β, which is negative and highly statistically significant.

In model (1) of Table 3.3 and 3.4, the coefficients -0.0683 and -0.0472 are, respectively, the expected change in the expected value of CV, and Theil associated with a one-unit increase in observation $i's$ value of BEFF. The rationale under this interpretation is that within unit changes in BEFF are associated with within unit expected changes in CV and Theil. In other words, a one unit increase of BEFF observed in province i is associated with a reduction of respectively 0.0683, and 0.0472 in the expected value of CV and Theil.

The control variable GDP per capita is positively correlated with regional income disparities in model (2) to (6) of both Table 3.3 and 3.4, and is almost statistically significant in all model specifications, except for model (2) of Table 3.3 in which it is not statistically significant. GDP per capita square is negatively correlated to the dependent variable in all model specifications of Table 3.3 and 3.4 and it is not statistically significant in models (5) and (6) of Table 3.3 and 3.4. We also found no tangible evidence of an inverted U-shape relation between GDP per capita and income disparities, more likely because the level of overall income is not that low across provinces. Trade openness is negatively correlated with regional income disparities in all model specification, and it is statistically significant in models of Tables 3.3 and 3.4, except for model (4) of Table 3.3. That is, the growing process of economic integration between the provinces can have a positive impact in relative terms on the disadvantaged provinces of the south and the island if the role of trade

Table 3.3 – *Fixed effects estimates of regional income disparities (CV)*

	(1)	(2)	(3)	(4)	(5)	(6)
BEFF	-0.0683***	-0.0666***	-0.0668***	-0.0652***	-0.0621***	-0.0621***
	(0.0184)	(0.0182)	(0.0186)	(0.0190)	(0.0178)	(0.0179)
GDPPC		1.94e-06	1.23e-05**	1.21e-05**	1.13e-05**	1.13e-05**
		(1.30e-06)	(6.07e-06)	(6.09e-06)	(5.61e-06)	(5.59e-06)
GDPPCSQ			-1.78e-10*	-1.79e-10*	-1.50e-10	-1.52e-10
			(1.02e-10)	(1.02e-10)	(9.37e-11)	(9.36e-11)
TRADE				-6.68e-03	-8.53e-03*	-8.42e-03*
				(5.41e-03)	(4.93e-03)	(4.97e-03)
POPDENS					3.40e-04***	3.20e-04***
					(1.03e-04)	(1.01e-04)
DYNSEC						-0.0501**
						(0.0222)
Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes
Time Effect	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1734	1734	1734	1734	1734	1734
R^2	0.0113	0.0154	0.0214	0.0224	0.0266	0.0316

Standard errors clustered at provincial levels of administration in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 3.4 – *Fixed effects estimates of regional income disparities (Theil)*

	(1)	(2)	(3)	(4)	(5)	(6)
BEFF	-0.0472***	-0.0449***	-0.0451***	-0.0433***	-0.0421***	-0.0420***
	(0.0142)	(0.0137)	(0.0138)	(0.0140)	(0.0132)	(0.0133)
GDPPC		2.59e-06***	9.45e-06**	9.25e-06**	8.96e-06**	8.93e-06**
		(9.28e-07)	(4.10e-06)	(4.14e-06)	(4.03e-06)	(4.03e-06)
GDPPCSQ			-1.19e-10*	-1.20e-10*	-1.08e-10	-1.09e-10
			(7.11e-11)	(7.19e-11)	(7.27e-11)	(7.27e-11)
TRADE				-7.57e-03**	-8.31e-03**	-8.27e-03**
				(3.73e-03)	(3.63e-03)	(3.58e-03)
POPDENS					1.36e-04	1.30e-04
					(1.24e-04)	(1.23e-04)
DYNSEC						-0.0146
						(0.0119)
Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes
Time Effect	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1734	1734	1734	1734	1734	1734
R^2	0.0128	0.0300	0.0363	0.0394	0.0410	0.0420

Standard errors clustered at provincial levels of administration in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

increases (Ezcurra e Pascual, 2008). Population density is positively correlated with income disparities in all model specifications of Table 3.3 and 3.4, and it is highly statistically significant only for the model 3.6. The same result is observed for the sectoral composition of economic activity variable DYNSEC. This result is in line with the literature of Krugman (1998). Lastly, this analysis shows that the level of specialisation is negatively correlated with income disparities, and is statistically significant only for the model 3.6. It also reveals that the sectoral composition of economic activities does not play its role of supporting growth processes at the provincial level of administration. This result is not in line with the literature. See (Ezcurra e Pascual, 2008; Paci, 1997).

3.8 Robustness checks

We study the results obtained in the previous section by investigating to what extent the relationship between the public health efficiency and regional income disparities can be done, accounting for the issue of simultaneous equation models or reverse causality. The instrumental variables (IV) estimation method seems to be a suitable tool to address this issue, as well as the endogeneity concerns as we assume strict exogeneity in the fixed effects model. Angrist e Pischke (2009) argued that the story of IV moves in two interactions, first in a restricted model with constant effects; then in a framework with unrestricted heterogeneous potential outcomes, in which case, causal effects must also be heterogeneous, and the introduction of heterogeneous effects enriches the interpretation of IV estimands without changing the mechanics of the core statistical methods used, which is in practice the Two-Stage Least Squares (2SLS). The 2SLS model is the following:

$$BEFF_{it} = X_{it}^{'}\pi_{10} + \pi_{11}Z_{1it} + \pi_{12}Z_{2it} + \zeta_{1it}, \tag{3.8}$$

which is the first-stage, and where $[X_{it}^{'}\pi_{10} + \pi_{11}Z_{1it}]$ is the population fitted value from the first-stage regression of $BEFF_{it}$ on X_{it} and $Z_{it}(Z_{1it}; Z_{2it})$. I consider Z_{1it} and Z_{2it} as the first and the second lag of the main predictor of interest $BEFF_{it}$. In that framework, Z_{it} and X_{it} are uncorrelated with the reduced-form error ζ_{2it}, the coefficient on $[X_{it}^{'}\pi_{10} + \pi_{11}Z_{1it} + \pi_{12}Z_{2it}]$ in the population regression of CV_{it} on X_{it} and $[X_{it}^{'}\pi_{10} + \pi_{11}Z_{1it} + \pi_{12}Z_{2it}]$ equals μ, where $\mu = \frac{\pi_{21}+\pi_{22}}{\pi_{11}+\pi_{12}}$. So, the first-stage fitted values are consistently estimated by

$$\hat{BEFF_{it}} = X_{it}^{'}\hat{\pi_{10}} + \hat{\pi_{11}}Z_{1it} + \hat{\pi_{12}}Z_{2it}, \tag{3.9}$$

where $\hat{\pi_{10}}$, $\hat{\pi_{11}}$ and $\hat{\pi_{12}}$ are OLS estimates from equation 3.9.
The coefficient on $\hat{BEFF_{it}}$ in the regression of CV_{it} on X_{it} and $\hat{EFF_{it}}$ is called the 2SLS estimator of μ. In other words, the 2SLS estimates can be constructed by OLS estimation of the *second-stage equation*:

$$CV_{it} = \delta^{'}X_{it} + \theta\hat{BEFF_{it}} + [\theta_{it} + \theta(BEFF_{it} - \hat{BEFF_{it}})], \tag{3.10}$$

The resulting estimator is consistent for μ, since the covariates and the first-stage fitted values are uncorrelated with both θ_{it} and $(BEFF_{it} - \hat{BEFF_{it}})$. It

is worth emphasizing that this statement is also valid for the regional income disparity index Theil.

Table 3.5 – *Income disparities: two stage least square estimates (CV)*

	(1)	(2)	(3)	(4)	(5)	(6)
BEFF	-0.114***	-0.113***	-0.110***	-0.107***	-0.0996***	-0.0990***
	(0.0335)	(0.0322)	(0.0332)	(0.0338)	(0.0319)	(0.0322)
GDPPC		1.80e-06	1.33e-05**	1.31e-05**	1.23e-05**	1.22e-05**
		(1.33e-06)	(5.79e-06)	(5.79e-06)	(5.45e-06)	(5.46e-06)
GDPPCSQ			-1.99e-10**	-2.00e-10**	-1.69e-10*	-1.72e-10*
			(9.60e-11)	(9.66e-11)	(8.94e-11)	(8.97e-11)
TRADE				-5.10e-03	-6.65e-03	-6.54e-03
				(5.68e-03)	(5.27e-03)	(5.32e-03)
POPDENS					3.12e-04***	2.97e-04***
					(1.05e-04)	(1.05e-04)
DYNSEC						-0.0392**
						(0.0186)
Kleibergen-Paap LM	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Kleibergen-Paap Wald	208.151	205.502	206.365	205.532	224.256	225.084
Observations	1632	1632	1632	1632	1632	1632

Standard errors clustered at provincial level of administration in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

By relaxing the assumption of strict exogeneity considering the first lag of the main predictor of interest as instrument, the results of Tables 3.5 and 3.6 show that public health efficiency affects income disparities at provincial level and, the estimated coefficient associated with the former is negative and highly statistically significant. In fact public health efficiency reduces income disparities by 0.114 for CV and 0.0818 for Theil. The coefficients of CV and Theil are about, respectively, 59.91% and 57.70% greater than those obtained for CV and Theil in the fixed effects models specified by equations (3.6) and (3.7).

The instrument appears to be valid as the $F - test = 225.08$ with a $P - value = 0.0000$ in the first stage, for both CV and Theil shows. The Kleibergen e Paap (2006) test does not accept the null hypothesis of underidentification of the model since its $p - value$ is equal to zero. The rejection of the null hypothesis allows us to affirm that the model is identified in all specifications. Moreover, Kleibergen e Paap (2006) Wald statistic is greater than 10 in all specifications model, meaning that the null hypothesis of weak identification is also rejected. Again, the model is identified. Therefore, the results of the 2SLS estimation seems to support the causal effect interpretation of models specified by equations (3.6) and (3.7). These results are also important because they show that the problem of reverse causality has been overcome.

TABLE 3.6 – *Income disparities: two stage least square estimates (Theil)*

	(1)	(2)	(3)	(4)	(5)	(6)
BEFF	-0.0818***	-0.0801***	-0.0777***	-0.0739***	-0.0715***	-0.0713***
	(0.0252)	(0.0243)	(0.0247)	(0.0250)	(0.0240)	(0.0241)
GDPPC		2.42e-06**	1.02e-05***	1.01e-05**	9.76e-06**	9.76e-06**
		(9.37e-07)	(3.81e-06)	(3.83e-06)	(3.81e-06)	(3.82e-06)
GDPPCSQ			-1.35e-10**	-1.36e-10**	-1.26e-10*	-1.27e-10*
			(6.59e-11)	(6.65e-11)	(6.80e-11)	(6.81e-11)
TRADE				-6.57e-03*	-7.09e-03*	-7.06e-03*
				(3.89e-03)	(3.75e-03)	(3.72e-03)
POPDENS					1.04e-04	1.01e-04
					(1.11e-04)	(1.11e-04)
DYNSEC						-9.73e-03
						(0.0110)
Kleibergen-Paap LM	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Kleibergen-Paap Wald	208.151	205.502	206.365	205.532	224.256	225.084
Observations	1632	1632	1632	1632	1632	1632

Standard errors clustered at provincial levels of administration in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

3.9 Transmission channel

The theoretical hypothesis under the transmission channel is that Public Health Efficiency (PHE) is labour productivity enhancing. That is Hypothesis 2. The relationship between labour productivity and PHE is specified as follow:

$$LABPROD_{it} = \phi + \beta 1 BEFF_{it} + \beta 2 BEFF_{it}^2 + \gamma X'_{it} + \eta_i + \delta_t + \theta_{it}, \quad (3.11)$$

where $LABPROD$ is the logarithm of the labour productivity. The labour productivity index is defined as the ratio of Personal Income Tax (PIT) and Employment level of province i at time t. Also in this case, standard errors are robust and clustered at the province level to capture potential serial correlation in the residual error term. This empirical model is crucial for our analysis because it is the channel through which the main hypothesis holds.

Table 3.7 shows that the coefficient of the main predictors of interest $BEFF$ and $BEFFSQ$ are, respectively, negative and positive, and highly statistically significant. They are also robust as the F test shows that the coefficients $\hat{\beta}1$ and $\hat{\beta}2$ are jointly different from zero. So, there is a nonlinear relationship between public health efficiency and labour productivity, but a quadratic relationship. Given the results obtained, it is necessary to define a turning point which corresponds to a point of minimum. It is the point of abscissa 0.6632. Therefore, as efficiency increases, labour productivity decreases to the point of abscissa 0.6632 where it begins to increase as efficiency increases. The public health efficiency range is between [0.23; 0.94] with a standard error of 0.0231 defined by the delta method and a 95% confidence interval of (0.62; 0.71).

This result highlights that PHE needs to exceed a threshold of about 66.32% to reduce income disparities at provincial level of administration. The

control variables of the model are all highly statistically significant except for the population density variable. The value of the turning point is not so negative and suggests that the positive impact of public health efficiency on labour productivity requires consistent efforts in terms of quality and quantity of services offered by the decentralised health system to citizens and especially to workers. In this sense the channel of labour productivity appears to be one of the mean through which PHE reduces income disparities.

It is more likely that disease prevention campaigns, including seasonal ones, and more efficient insertion of physician and nursing staff into the national health system to cover the long waiting lists and acceptable cost of medical care contribute to establishing a direct and positive relationship between public health efficiency and labour productivity. In any event, these results are consistent with the literature discussed in the previous chapter.

Table 3.7 – *Fixed effects estimates of labour productivity (LABPROD)*

	(1)	(2)	(3)	(4)	(5)
BEFF	-2.090***	-1.084***	-1.154***	-1.157***	-1.043***
	(0.539)	(0.398)	(0.399)	(0.399)	(0.397)
BEFF2	1.731***	0.946***	1.003***	1.014***	0.920***
	(0.442)	(0.314)	(0.315)	(0.318)	(0.315)
GDPPC		6.87e-05***	1.22e-04***	1.21e-04***	1.21e-04***
		(3.43e-06)	(1.86e-05)	(1.95e-05)	(1.93e-05)
GDPPCSQ			-9.22e-10***	-9.29e-10**	-9.13e-10**
			(3.23e-10)	(3.70e-10)	(3.66e-10)
TRADE				-0.0476**	-0.0483**
				(0.0238)	(0.0236)
POPDENS				1.00e-05	1.50e-04
				(8.96e-04)	(9.03e-04)
DYNSEC					0.326***
					(0.0812)
Fixed Effect	Yes	Yes	Yes	Yes	Yes
Time Effect	Yes	Yes	Yes	Yes	Yes
F test ($\hat{\beta}1 = \hat{\beta}2$)	0.0071	0.0071	0.0071	0.0071	0.0071
Observations	1734	1734	1734	1734	1734
R^2	0.0187	0.284	0.293	0.295	0.306

Standard errors clustered at provincial level of administration in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

In order to control for the possible effects of other transmission mechanisms of the impact of PHE on income disparities not directly observed, we estimate through a 2SLS model the relationship between LABPROD and CV/Theil, again considering the lagged value of LABPROD as instrumental variables.

Table 3.8 presents the results of the 2SLS estimations in which the negative impact of labour productivity on income disparities at the provincial level of administration emerges. In fact, labour productivity reduces income disparities by 4.34% for CV and 3.18% for Theil, and both coefficients are highly statistically significant. Furthermore, the instrument appears to be valid, as shown by the F-test = 439.93 with a P-value = 0.0000 in the first stage for both CV and Theil. The Kleibergen-Paap LM and Keibergen-Paap Wald tests show that the models are identified. The rationale is that higher labour productivity actually reduces income disparities. Thus, public health efficiency has a positive impact on labour productivity, which in turn has a negative impact on income disparities. In other words, public health efficiency increases labour productivity which in turn reduces income disparities at provincial level of administration.

TABLE 3.8 – *Income disparities: two stage least square estimates (CV and Theil)*

	CV	CV	CV	Theil	Theil	Theil
	(1)	(2)	(3)	(4)	(5)	(6)
LABPROD	-0.0434**	-0.0490**	-0.0495**	-0.0318***	-0.0354***	-0.0367***
	(0.0192)	(0.0192)	(0.0194)	(0.0113)	(0.0117)	(0.0118)
GDPPC	5.17e-06**	1.94e-05***	1.84e-05***	4.89e-06***	1.46e-05***	1.43e-05***
	(2.29e-06)	(5.94e-06)	(5.67e-06)	(1.55e-06)	(4.20e-06)	(4.17e-06)
GDPPCSQ		-2.46e-10***	-2.11e-10**		-1.70e-10**	-1.56e-10**
		(9.05e-11)	(8.50e-11)		(6.51e-11)	(6.69e-11)
TRADE		-9.62e-03	-0.0113**		-9.78e-03**	-0.0105**
		(5.95e-03)	(5.51e-03)		(4.13e-03)	(4.04e-03)
POPDENS			3.65e-04***			1.50e-04
			(1.11e-04)			(1.24e-04)
DYNSEC			-0.0228			0.00241
			(0.0231)			(0.0131)
Kleibergen-Paap LM	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Kleibergen-Paap Wald	439.927	507.195	458.335	439.927	507.195	458.335
Observations	1632	1632	1632	1632	1632	1632

Standard errors clustered at provincial levels of administration in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

3.10 Concluding remarks

These results confirm our theoretical hypotheses but are not in line with the existing literature investigating the reasons behind the persistent socioeconomic backwardness of southern Italy. Some provinces of southern Italy, in fact, have experienced greater efficiency of their local health system and a low level of income inequality, as well as the central-northern provinces. However, these findings also draw the attention of local authorities which play an important role in the design and implementation of policies to stimulating the efficiency

of local public health which allows an increase in labour productivity which, in turn, reduce income disparities for both individuals and for communities.

In this study, we ascertain the efficiency of public health, measured through bootstrap-DEA, as a powerful tool for reducing provincial income disparities measured through CV, and Theil indexes through the transmission channel of labour productivity. The results obtained through a fixed effect models show that the efficiency of the public health reduces regional income disparities, on a sample of 102 Italian provinces over a period 2000 - 2016. To improve the precision of the results, we take into account the potential endogeneity of the main predictor of interest and perform a 2SLS estimates, which substantially confirm and meliorate the fixed effects results. In fact, the coefficients obtained through 2SLS tend to be almost 58.80%, in average (unweighted average), larger than those obtained through the fixed effects, in all model specifications. The key contribution of this thesis goes beyond the traditional causal effect of the two entities presented in this study and, it is related to the well-discussed role of the central government intervention in the market economy, the devolution to the local administration of an important task such as health service at lower level of government, and finally, the collaboration between central government and sub-national government in implementing health policies. As pointed out by Sacchi e Salotti (2016), the overall finding qualifies the existing theoretical requirements, namely the negative relationship between provincial income disparities and decentralised spending of the social welfare and, in particular, the health service.

Lots of improvements have been carried out since the creation of the Italian national health service in 1978. The most important appear to be the right combination of public and private sector in the provision of health following the guiding principles of universality, equity, and solidarity. The public governance of the system can be interpreted as the modern form of health organisation, which with the minimum expenditure of resources can perform well and guarantee protection from diseases for all the citizens throughout the country. In recent years, the balanced mix between public and private production allows a wide freedom of choice to patients in a competitive environment, which can only stimulating continuous improvements in the quality of services, and thus keep up the productivity of the health sector.

4 Public health efficiency and well-being in Italian provinces

4.1 Introduction

The literature of the last two decades has explored the concept of well-being, the definition of which is controversial. Easterlin (2003) considers the terms happiness, utility, life satisfaction, well-being and welfare to be interchangeable and focuses on the psychology and economic theories of well-being, which is related to the topic of this chapter. From this controversy emerged an extensive literature on the various indicators of well-being, understood as happiness, life satisfaction, quality of development, quality of life and progress. The common denominator of these indicators is their stated intention to overcome what has been for more than half a century the indicator "par excellence" of economic progress, quality of life and well-being, namely gross domestic product (GDP). GDP is considered an unsatisfactory measure of progress, understood as a sustainable model of well-being Stiglitz *et al.* (2009), and a measure of the mere volume of commercialised economic activity Stiglitz *et al.* (2010). In fact, GDP is an aggregate measure that allows compensation in terms of well-being between rich and poor, hides distributional problems, requires the identification of a weighting system different from those set by the markets and does not consider those goods and services without markets which are equally necessary for the well-being of people Segre *et al.* (2011). Furthermore, GDP is considered only as a measure of production flows without considering stocks, such as human and social capital that have proved to be relevant for the well-being of the individual. Another criticism of great relevance to GDP is that it does not measure the degree of involvement and participation of civil society in the definition of well-being.

In the economic literature, as has been amply shown in the first chapter, other indicators have been constructed. Some with the aim of integrating information contained in GDP with the monetisation of those goods and services without a market; others with the intention of aggregating economic, social and environmental variables into composite indicators that do not contain GDP.

In fact, the indicator of economic and sustainable well-being (ISEW) which has been transformed into the Genuine Progress Indicator (GPI) Daly (1994), turns out to be one of the most advanced attempts to create an indicator of economic and sustainable well-being (Segre *et al.*, 2011). Both the ISEW and the GPI correct the standard GDP to integrate the wide range of factors important for people's well-being (Calcagnini e Perugini, 2019a). Other indicators such as the Canadian Index of well-being (CIW) and the Better Life Index (BLI) not only do not contain GDP, but include economic and social variables along with disposable income and wealth for CIW and median disposable income and income distribution for the BLI (Burchi e Gnesi, 2016).

In this chapter we propose a link between public health efficiency and another geographic variable namely provincial well-being differences within Italy. In particular we consider the extent to which public health efficiency can affect well-being broadly defined as happiness, life satisfaction, quality of life, quality of development, or progress (Easterlin, 2003). We argue that public health efficiency is likely to increase well-being at the level of provincial administration. We also argue that the public health efficiency can reduce income disparities through the transmission channel of an increase in labor productivity that, in turn, will result in an increase in the overall well-being of the individual and the communities. In addition, we identify a mechanism that is likely to amplify the general well-being, namely the decentralisation process. In other words, it is the devolution of certain functions previously held by central government to regional and local governments. As an alternative, following Kyriacou e Roca-Sagalés (2014), the existence of power-sharing whereby central and sub-national governments cooperate and co-decide on policies at national level is expected to increase the effectiveness and efficiency of public health for the benefit of overall well-being throughout the country.

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 e Perugini (2019a) found that the provinces of the Centre-north have a good level of well-being compared to the southern provinces. Since the health condition is one of the main determinants of well-being, we want to check if an efficient and effective public health can increase well-being at provincial levels of government.

It is now 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, as explained in Chapter II, 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 e Perugini, 2019a).

In this chapter, we investigate the impact of an efficient and effective public health system on well-being at the provincial levels of government. To our knowledge, no study has analysed this topic before. Another peculiarity of this study is that we build a time series with the measure of the provincial index of well-being over the period 2000 to 2016 in order to carry out a panel data analysis. Previous works are based on cross-sectional analysis through ordinary

least squares (OLS) with regard to the estimation of well-being in relation to other indicators (Bruni e Stanca, 2008; Calcagnini e Perugini, 2019a).

To assess the relationship between public health efficiency and provincial index of well-being (PIW), we first construct provincial index of well-being following the methodologies used by Segre *et al.* (2011) for the construction of the quality of regional development index. Given that the evaluation of the performance of provinces in the provision of health services through bootstrap-data envelopment analysis is been done in the second chapter of this thesis, we directly analyse the relationship between public health efficiency and provincial index of well-being (PIW) through a fixed effects model, controlling for province-specific and time-specific effects to reduce the risk of omitted variables. Our empirical analysis is done on a balanced panel data of 102 Italian provinces over the period 2000 to 2016. Our findings show that PHE is positively and significantly correlated to PIW.

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 and of a better well-being of people within the province. Two-Stage Least Square (2SLS) estimate is a good tool for addressing the problem of reverse causality. Since it is very difficult to find Public Health Efficiency (PHE) instruments that meet all the conditions of valid instruments at the same time, following Reed (2015) we use the lagged values of PHE as instruments to avoid simultaneity.

The structure of this chapter is the following. In the second section, a theoretical framework is presented. The third section is dedicated to the measure of provincial index of well-being. The fourth section is dedicated to the econometric strategy. The fifth section presents the baseline estimation results. The sixth section presents the robustness checks and the seventh section provides the concluding remarks.

4.2 Theoretical framework

In recent years, a consensus has emerged that the metrics of progress and prosperity traditionally used in economic debates, 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 recognised that the meaning of progress is about improving people's quality of life and requires looking not only at the functioning of economic systems but also at the diverse experiences of individuals and their communities (O'Donnell *et al.*, 2014). Some academics argue that it was Bob Kennedy's famous speech at Kansas University in 1968 that formalised 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 e Tobin (1972) and Daly e 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 e 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 perspective.

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 functionings and capabilities. 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 functionings and capabilities instead of people's income or commodities.

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 a 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 e Gnesi, 2016; Calcagnini e 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 e Perugini, 2019b).

Cylus e 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 e 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 e Laamanen (2010) find 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 e Romano, 1996) in the provision of public health care, in which middle income individuals prefer higher public spending at the margin than low income 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 health care alternative is available. In Italy, according to the Ministry of the economy, public health spending is increasing and in 2017 reached 113.6 billion euro (+11.9% compared to 2013). For more details, see also Signorelli *et al.* (2020).

Von Heimburg e 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 e 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 (Marmot, 2020). Following the principle of "health and well-being for all" and "leaving no one behind" (Von Heimburg e 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, capacity approach of Sen,[1] and "health and well-being" for all as key public values in societal development.

The Italian approach of 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 economic literature seems to be deficient in establishing a direct link between the public sector providing efficient health services and well-being.

[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 Available at: *http* : *//www.gcph.co.uk/assets_*0000_4174_*BP*_11_*Built_environment_and_health_updated.pdf*.

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

Good health can be seen as the starting point as it puts individuals in a position to aspire to a certain level of well-being according to their abilities and capacities (capability approach of Sen).

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 restore 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 efficient public health 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, we 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 our third and final hypothesis:

Hypothesis 3. Public health efficiency should increase the overall well-being at provincial levels of administration.

[4]Source: $https://www.ilsole24ore.com/art/covid-e-crisi-post-pandemia-ansia-e-stress-nove-studenti-dieci-AEiGCDaB?refresh_ce = 1$

4.3 Provincial index of well-being

The provincial index of well-being (PIW) is an index of progress used in this analysis instead of any other index because it is based on a sustainable well-being approach that considers a good quality of development. Another important reason is that the selection of indicators and dimensions of the well-being index was 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 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 legitimation Rondinella *et al.* (2017), allowing citizens to play an active role within the community and to give legitimacy to their choices. Therefore, in order to give full democratic legitimacy to our provincial index of well-being, we considered that public participation based on the deliberations of civil society actors is necessary. We also find this sustainable well-being approach 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 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 into 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 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 e Perugini, 2019b).

4.3.1 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 unemployment rate, Theil index, crime rate, and young people who neither study nor work. We will see in the next section how we deal with this issue.

These 7 dimensions are defined as follows:

1- Environment

In this dimension, the environmental impact deriving from the forms of production, distribution and consumption is assessed, especially taking into account the policies adopted to mitigate the negative effects in people's daily lives. This dimension is made up of 7 variables; on the one hand there are those variables that summarize how human activity produces negative consequences on the quality of the ecosystem: (1) the population density, which indicates at the provincial level the number of resident populations per m2 of surface and evaluates the impact of crowding of local areas on the quality of life and well-being of people. The data on the resident population and on the surface are from Istat source. According to Calcagnini e Perugini (2019b) and Segre *et al.* (2011), this variable is a good proxy for the levels of waste and emissions production, resource consumption, congestion, and anthropogenic pressure on the territory; (2) air quality, measured through carbon dioxide emissions. In the provincial capital municipalities, there are fixed air quality monitoring stations (one for every hundred km2 of municipal area); Source: Istat, environmental data in the cities, and finally (3) the motorisation rate which is considered as a proxy of the impact generated by mobility and pollution deriving from road traffic. Source: Istat, Aci data, public vehicle register.

The second group of environmental variables describes the implementation of policies that aim to limit or mitigate the negative consequences of human activities on the environment: (4) the separate collection of municipal waste, measured as a percentage of the latter on the total urban waste; (5) the demand for local public transport, expressed in terms of annual passengers per inhabitants. The data refer to the provincial capital municipalities; (6) the availability of urban green areas in the provincial capital municipalities, in

terms of m2 per inhabitant and finally (7) the density of urban green areas in the provincial capital municipalities, expressed in relation to the municipal area. The source of the data is Istat, elaborated on environmental data in the cities. All these indicators contribute to obtaining a picture of the environmental sustainability of the economic model developed in each province from the period 2000 to 2016. The Environment dimension results from the simple average of the seven variables that make it up and can be expressed by the following equation:

$$Env_i(t) = \frac{1}{7}\Big(PD_i(t) + AQ_i(t) + MR_i(t) + RE_i(t) + PT_i(t) + UG_i(t) + UD_i(t) \Big) \tag{4.1}$$

where Env stands for environment; PD for population density; AQ for the number of air quality monitoring stations in cities; MR for motorization rate; RE for recycling or separate waste collection; PT for local public transport; UG for urban green or green area in the cities and UD for density of urban green areas.

2- Economy and Labour

This dimension groups variables sensitive to the condition of work, to the distribution of income and to the business risk essentially linked to the financing risk. This dimension is made up of three variables: (1) the unemployment rate, as employment represents the major problem of advanced economies and affects a series of social and psychological considerations Monni (2002), such as the affirmation of the individual in society in terms of recognition and dignity. It is certainly for this reason that the first article of the Italian Constitution states: "Italy is a democratic republic, founded on work ...". The unemployment rate can be defined as the number of job seekers over the total labour force of people aged 15 and over. The source of the data is OECD.stat, for the period 2000-2016; (2) the inequality in income distribution is measured by the Theil index. It is an inequality index often used to evaluate the distribution of personal income tax (PIT) at the provincial level. It is used here instead of GDP per capita following the "beyond GDP" concept developed by the branch of literature which think that a good index of quality of life, life satisfaction or well-being may not contain GDP in its construction. For instance the Canadian Index of Well-being and the Better Life Index do not contain the GDP in their construction (for Economic Co-operation e Development, 2011) and (Smale, 2012). The data was elaborated by the author based on the data of the "Ministry of Economy and Finance for the period 2000-2016; and finally (3) the business risk. It is the rate of decline of cash loans given by the ratio between the flow of adjusted non-performing loans and performing loans. Istat reminds us that starting from March 2011 the information on adjusted non-performing loans and on the rates of forfeiture of cash loans are published according to new and precise calculation methods. The new times series are constructed taking into account the company concentration phenomena that affected the reporting bodies, the credit transfer operations to and from the

reporting system.[5] The source of the data is Istat for the period 2000-2016. The economy and labour dimension also results from the simple mean of the three variables that make it up and it is expressed as follows:

$$Ecolab_i(t) = \frac{1}{3}\Big(UR_i(t) + TI_i(t) + BR_i(t)\Big) \tag{4.2}$$

where *Ecolab* stands for economy and labour; UR for unemployment rate; TI for Theil index, and BR for business risk in the sense of financial risk.

As can be seen we also decided not to include Gross Domestic Product per capita among the variables of the "Economy and Labour" dimension following Segre *et al.* (2011) who argues that: "GDP is in fact definitely relevant for reaching a higher well-being, but it is a mean to improve the different aspects that characterise development, it is not considered a virtue itself" (Segre *et al.*, 2011, p. 52).

3- Health

This dimension is concerned with the general health of the population, the quality of the services supplied and the proximity of health centres. The variables that make up this dimension are: (1) the fertility rate, the data was recalculated starting from 1999 considering the definitive Istat archives; therefore, there may be slight differences from the previous version of Health for All (HFA). For the provinces of Sardegna, the indicator referred to the year 2006 was calculated considering the population as of January 1st, 2007. The source of the data is Istat, new survey of those registered in the registry of birth, for the period 2000-2016; (2) the mortality rate, the data comes from the Istat administrative investigation on the causes of death for the period 2004-2016 and finally (3) life expectancy at birth of male and (4) life expectancy at birth of female, both express the average number of years a child born in a given calendar year can expect to live. Source: Istat, survey on deaths and causes of death. The health dimension is given by the simple mean of the four variables that make it up and it is expressed by the following equation:

$$Health_i(t) = \frac{1}{4}\Big(FR_i(t) + MR_i(t) + LEM_i(t) + LEF_i(t)\Big) \tag{4.3}$$

where FR stands for fertility rate; MR for mortality rate; LEM and LEF for life expectancy at birth for male and female, respectively.

4- Rights and Citizenship

This dimension analyses phenomena of a social nature and active citizenship such as access to services for children and the elderly, services for the social inclusion of young people and disadvantaged people, socio-economic and cultural inclusion of migrant citizens. The variables that summarize this dimension are: (1) childcare services expressed in terms of municipalities that have

[5]For further information, see the Statistical Bulletin of the Bank of Italy, II quarter 2011.

activated childcare services or nursery schools, supplementary and innovative services, in relation to the total of municipalities in the province. The nursery school is a service aimed at early childhood (0-3 years), aimed at promoting the psycho-physical, cognitive, affective, and social development of the child and at offering support to families in their educational task, open for at least 5 days and at least 6 hours a day for a period of at least 10 months a year. This category includes nursery schools, company nurseries, sections 24-36 months aggregated to kindergartens ("spring sections") and integrated nurseries. The category of supplementary services, on the other hand, includes educational services carried out in the home context, play spaces and parent-child centres for children from 0 to 3 years of age and contributions for the "Tagesmutter" service are included; [6] (2) elderly people treated in social assistance home care out of the total elderly population (65 years and over). The source of data: Istat; (3) frequency of long accidental interruptions of the electricity service (average number per user). Long accidental interruptions are defined as those without notice of more than three minutes. The data underwent a revision of the time series from 1998 to 2003 and were published on the website of the electricity and gas authority. Source: Istat, electricity and gas authority; (4) integration of migrant citizens expressed as the ratio of resident migrant citizens to the resident population. This data was processed by the author based on Istat data and finally (5) homicide rate understood as voluntary homicides consumed per 100,000 inhabitants. The crimes detected are those reported by the police to the judicial authorities and are available for the provinces that are the seat of prefectures-UTG, that is 103 provinces up to 2010 and 106 from 2011.[7] The 2011 data of Milan, Bari, and Ascoli Piceno are not comparable with those of previous years, since the latter also respectively include the values of the three new provinces established in 2009. The voluntary murders carried out are of three types: for the purpose of theft or robbery, of the mafia type, for terrorist purposes. The data relating to crimes reported starting from 2004 are not homogeneous with respect to those of previous years, due to profound changes in the detection system, as well as variations in the survey universe. In fact, since 2004 in addition to the crimes reported in Judicial authority by the *Polizia dello Stato, Arma dei Carabinieri and Guardia di Finanza* (which fed the paper model 165 in use until 2003), including those reported by the *Corpo Forestale dello Stato*, the *Polizia Penitenziaria*, the *Direzione Investigativa Anti-Mafia* and other offices. Further differences derive from a different

[6] Tagesmutter is a German word which means Nanny.

[7] The prefectures - UTG are those that were commonly known by the name of Prefectures - peripheral organs of the Ministry of the Interior and representative offices of the Government in each province - are now called Prefectures - Territorial Offices of the Government (Uffici Territoriali del Governo, U.T.G.). To the Prefectures - U.T.G. all the functions exercised at the peripheral level by the State are delegated, excluding those relating to some Administrations (Foreign Affairs, Justice, Treasury, Finance, Public education, Heritage, and Cultural Activities). Furthermore, they carry out a propulsive action, of direction, of mediation and intervention, of consultancy and collaboration, also with respect to local authorities, in all fields of "doing administration", in execution of regulations or outside of codified procedures, promoting the process of simplifying the administrative procedures themselves. Rif. Ministero dell'Interno, www.prefettura.it.

definition of some types of crime and from a more exact determination of the time and place of the crime committed. Source: Istat, elaborations on data from the Ministry of the Interior, Department of Public Security. The variables that summarize the rights and citizenship dimension can be defined by the following equation:

$$Rcit_i(t) = \frac{1}{5}\Big(CS_i(t) + EC_i(t) + EI_i(t) + MI_i(t) + CR_i(t)\Big) \tag{4.4}$$

where $Rcit$ stands for rights and citizenship; CS for childcare services; EC for elderly care; EI for electricity interruptions; MI for migrant citizens integration and CR for crime or homicide rate.

5- Education and Training

The increase in schooling has produced, over the years, a constant increase in the level of education of the Italian population.[8] However, the last 5 years have been characterized by a continuous decrease in the population in schools of different types and levels. In fact, the participation rate in the training system, which also includes those enrolled in the vocational education and training chain, has decreased.[9] In this context, the government can increase investment in education, training and vocational training with the aim of increasing the lifelong learning and skills of individuals. The variables that summarize this dimension are: (1) people with at least a diploma aged between 25-64 by province and geographical area; (2) graduates and other tertiary qualifications aged 25-39 by province and geographical area and finally (3) participation in continuing education by province and geographical area. Source of data for the three variables: Istat, survey on the labour force for the period 2004-2016. The variables which summarize education and training dimension are defined as follows:

$$Edutra_i(t) = \frac{1}{3}\Big(Diplom_i(t) + Gradua_i(t) + Form_i(t)\Big) \tag{4.5}$$

where $Edutra$ stands for education and training; $Diplom$ for people with at least diploma; $Gradua$ for people with at least bachelor and $Form$ for people participating in continuing formation.

6- Gender equity and Equal opportunity

The dimension of gender equity and equal opportunities highlights the issues of gender and generational turnover at the institutional level, in a context in which there are serious inequalities to the detriment of young people and women, and the policies in place to mitigate these phenomena. The variables that summarize this dimension are: (1) the absolute difference between the male employment rate and the female employment rate of people aged 15-64.

[8] Istat, "Annuario statistico Italiano" 2017, p.224.
[9] Istat, "Annuario statistico italiano" 2017, p. 216.

The employment rate is calculated by comparing the employed in the 15-64 age group to the labour force of the corresponding age group. The source of the data is Istat, for the period 2004-2016; (2) female municipal administrators by province and geographical area. The policy goal is to increase the number of women in the decision rooms. Source: Istat, elaboration on Ministry of the Interior data for the period 2004-2016, Registry of local administrators and finally (3) young people who do not work and do not study by province and geographical area. The source of the data is Istat, survey on the workforce for the period 2004-2016. The Gender equity and equal opportunity dimension is summarized by three variables and it is defined as follows:

$$Gender_i(t) = \frac{1}{3}\left(EGD_i(t) + FMA_i(t) + YP_i(t)\right) \tag{4.6}$$

where *Gender* stands for gender equity and equal opportunity; EGD for employment gender difference; FMA for female municipal administrators and YP for young people who do not work and study.

7- Democratic participation

The last 20 years have seen a progressive reduction in the direct and indirect participation of citizens in the democratic life of the country, both nationally and locally.[10] Elections are an adequate measure of democratic participation. This trend is confirmed, among other things, for participation in European elections. To reverse this trend, the political authorities must favour opportunities for discussion with citizens, since civil society can contribute to developing social responsibility and civic awareness Rondinella *et al.* (2017) to create social cohesion and limit the distances between administrators and citizens. The variables that summarize this dimension are: (1) the municipal administrators with less than 40 years of age per province elected during the 2004-2016 period. The source of the data is Istat, elaboration on data from the *Ministry of the Interior* - Registry of local administrators and (2) the voter turnout or electoral participation carried out during the period 2004-2016. The data was elaborated by the author based on the data of the *Ministry of the Interior*. The variables that summarize democratic participation dimension are defined as follows:

$$Dem_i(t) = \frac{1}{2}\left(MA_i(t) + VT_i(t)\right) \tag{4.7}$$

where *Dem* stands for democratic participation; MA for municipal administrators less than 40 years old and VT for electoral participation.

Table 4.1 below reports the descriptive statistics of all the indicators divided into their respective dimensions in which the number of observation, the average, 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 standardization process necessary.

[10] Istat, "Annuario statistico italiano" 2017, p.392.

Table 4.1 – *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
Motorization 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

4.3.2 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, we merely mention a few. For example, as regards the *environmental* 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* dimension. Remaining in the social sphere, 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 in overall well-being.

On the other hand, we see strong, positive and complementary links between some variables. 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* dimension and the *Gender equity and Equal opportunity* one and rate of young people who neither work nor study represents a specification of the unemployment rate. In other case, the indicators of the *Health* 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 *Education and Training* dimension 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.

Table 4.2 – *Correlation matrix of variables of the PIW*

	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	-0.052	1

4.3.3 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, with the exception of the unemployment rate, the Theil index, electricity cuts, 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 whose 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 we 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. 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 is able to 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).

4.3.4 Construction

To aggregate a set of values of a different nature into summary values, Segre *et al.* (2011) and Calcagnini e 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

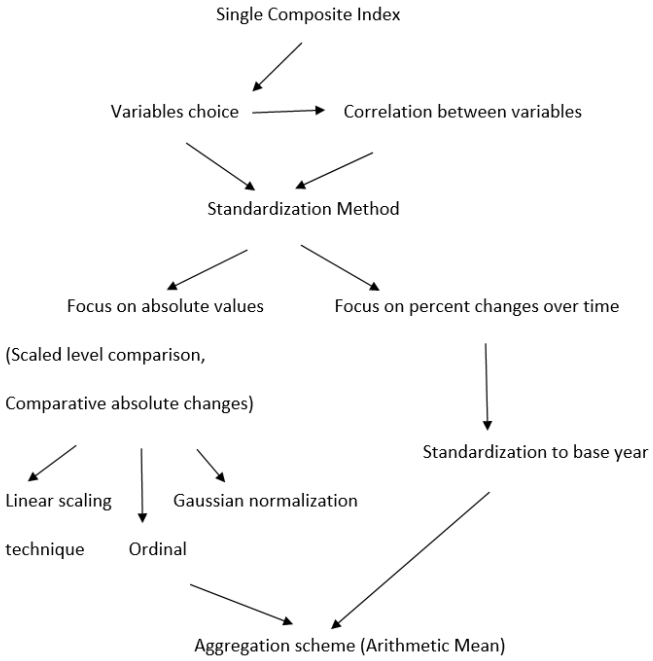
highest and lowest values of the distribution represent the maximum and minimum, respectively, by assigning the value 100 to the maximum and 0 to the minimum. This procedure, however, collides with a series of problems: first, it cannot be demonstrated with certainty that the province that does best is the one that does well since an absolute objective has not been identified. Secondly, there is the question of the presence of the 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, we follow Segre *et al.* (2011) and Calcagnini e Perugini (2019b) who have chosen to standardize 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:

$$z_{i,j} = \frac{x_{i,j-\mu_j}}{\sigma_{x_j}}, \tag{4.8}$$

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 of mean 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 we 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 e 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 4.1 shows the construction process of the PIW based on the work of Salzman (2003) which is similar to the process followed by Segre *et al.* (2011) and Calcagnini e 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 Chapter, the logical choice requires the standardisation method to 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 4.1 – Provincial Index of Well-being: Construction methodology

Figure 4.2 shows the average provincial index of well-being in 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 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 located in the South macro area. Our findings are in line with the results obtained by Calcagnini e Perugini (2019a,b), since the geographical distribution of well-being index highlights the existence of two macro areas.

In summary, like the quality of 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.

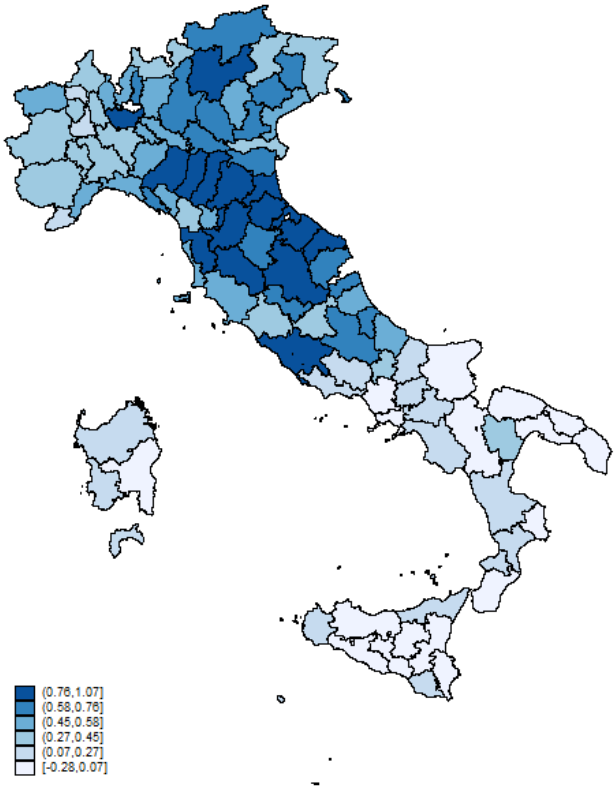


Figure 4.2 – The average of provincial index of well-being over the period 2000 to 2016

4.4 Econometric strategy

4.4.1 Empirical model and estimation methodology

This analysis studies the period over 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 calculated in section three, Public Health Efficiency (PHE) bootstrap-DEA score data calculated in section four of chapter II, and control variable data that will be described in the next section. 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 e Perugini, 2019a). Consequently, the results are not much affected by variables measured over different time intervals.

We estimated equation (9) through fixed effects model (FE) under the

assumption of strict exogeneity since there is a need to controlling 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 e Baltagi, 2008). We also control for province-specific and time-specific effects to reduce the risk of omitted variables. Therefore, we cluster the sample of 102 provinces of the model. Moreover, time dummies are included to control for time effects as often as 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 emergency in the country. In fact, at the Global Platform for Disaster Risk Reduction (GPDRR) 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, countries, along with their cultural heritage, health, likelihoods, 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. Last but not least is the work that civil protection is carrying out throughout the national territory in this particular moment of emergency due to the Covid-19 pandemic. In the Italian panorama research studies are financed by institutions through universities and research centres to understand these phenomena and to provide policy implications that minimise the damage.

The empirical analysis is performed on a sample of 102 Italian provinces. The dependent variable PIW belongs to the interval [-1.53;1.77] and the main predictor of interest BEFF, the bootstrap-PHE 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 or well-being at provincial level of administration over the period 2000 to 2016. The relationships between these two indexes is specified by the following equation:

$$PIW_{it} = \alpha + \beta BEFF_{it} + \gamma X'_{it} + \eta_i + \delta_t + \theta_{it} \tag{4.9}$$

where PIW_{it} is the index of well-being in province i at time t; α is a constant which captures the correction factor included in the model comparison; $BEFF_{it}$ is the bootstrap PHE 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 which elements will be described in the next paragraph; and θ_{it} is the error term.

4.4.2 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 level of provincial administration. 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 e Perugini, 2019a; Burchi e Gnesi, 2016; Segre *et al.*, 2011).

The control variables are income, taxes, transfers, elderly rate and institutional quality index. As for income, Calcagnini e 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 e Stanca, 2008). Indeed, the results of Easterlin (1974)'s works had opened the debate on the famous happiness-income paradox. Easterlin 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 also 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 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 (Zamagni, 2006). In fact, Bradburn (1969) had found that social relationships are one of the strongest correlations of positive emotions. Bruni e 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 e Leary (1995) essential for health and well-being. Easterlin (2003, p. 11177) have 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 which is the main topic of this

chapter.[11]

The relationship between taxes and well-being 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 e 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. Series of articles report a negative correlation between average levels of fiscal moral and the size of the shadow economy (Halla, 2012) and (Torgler e Schneider, 2009). Another important issue recalls the attention on the relationship between 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 (Smith, 1991). Spicer *et al.* (1976) argued that 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) shows 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 subnational 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 e 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 well-being of an increasingly large segment of the population, the elderly (Ateca-Amestoy e Ugidos, 2013). The elderly rate can be defined as the proportion of elderly people aged 65 or more year over of the whole resident population. Public finance argues that the quality of life 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) and (Baumeister e 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

[11] Even though we are aware that those notions are not conceptually identical.

debts (Ateca-Amestoy e Ugidos, 2013), and (3) finally social goods in the sense of relationality with their family or with the neighbourhood. Wahrendorf *et al.* (2006) argues in that sense that the quality of the interchange and the intensity of reciprocity are the key variable 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 e 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.

Table 4.3 shows the descriptive statistics of the key variables of equation 4.9, in which the number of observations, the mean, the standard deviation, the minimum and the maximum values of each variables can be seen. The correlation matrix is also constructed to analyse the degree of correlation between the dependent variable and the other regressors. Table 4.4 illustrates the relationship between the dependent variable and the regressors. There is a weak correlation between PIW and the main regressor of interest (0.06). The correlation between PIW and the other regressors are low. Among regressors, the unique interesting correlation is between IQI and RPCVA (0.78) showing a strong and positive link between these two variables.

Table 4.3 – *Descriptive Statistics*

Variables	Obs	Mean	Std. dev.	Min	Max
PIW	1734	0.42	0.45	-1.62	1.86
BEFF	1734	0.858	0.15	0.23	0.94
GDPPC	1734	26894.55	7139.048	14346	55813
Taxes	1734	0.48	0.79	0.004	32.28
Transfers	1734	0.26	0.14	0.00	20.89
Elderly rate	1734	0.21	0.03	0.10	0.29
IQI	1734	0.57	0.25	0.00	1.00

Source: elaboration of the author.

TABLE 4.4 – *Correlation matrix among the main selected variables*

	PIW	BEFF	GDPPC	Taxes	Transfers	Elderly rate	IQI
PIW	1.000						
BEFF	-0.2943	1.000					
GDPPC	0.4781	-0.4413	1.000				
Taxes	0.0784	-0.009	0.0597	1.000			
Transfers	-0.1159	-0.0459	-0.2225	-0.1232	1.000		
Elderly rate	0.4882	-0.2712	0.1964	-0.0189	0.1986	1.000	
IQI	0.6866	-0.5485	0.7661	0.0487	-0.1138	0.4607	1.000

Source: elaboration of the author.

4.5 Baseline results

Table 4.5 presents the fixed effects estimate results of equation 4.9, 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 4.9 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 in 102 group of 14 observations.

The results of the estimate are reported in Table 4.5. To assess the impact of public health efficiency on well-being, we first estimate the model without controlling for the rest of the well-being determinant (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.

Table 4.5 – *Fixed Effects estimates of provincial index of well-being*

	(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	-7.05e-04	9.37e-05	-1.36e-03
					1.83e-03	1.73e-03	1.22e-03	1.38e-03
Transfers						0.147	0.132	0.0544
						0.123	0.0888	0.0858
IQI							1.108***	0.455***
							(0.178)	(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
Observations	1734	1734	1734	1428	1428	1428	1326	1326
R^2	0.0234	0.347	0.351	0.353	0.353	0.355	0.475	0.604

Standard errors clustered at provincial level in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

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 e Perugini, 2019a). Column (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. Taxes coefficient remains positive and 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 (2012) findings. Transfers is positively correlated with well-being but its coefficient is not statistically significant. The results are in line with Bird e Tarasov (2004)'s one (column 6). Instead, column (7) and (8) report an increase of 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 e Leary, 1995) findings and Helliwell (2011)'s analysis, respectively.

4.6 Robustness checks

4.6.1 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 e 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 (4.9) makes this cause of endogeneity a relatively minor concern.

In order 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, we use the lagged values of the public health efficiency as instruments (Reed, 2015). De facto the lagged values of PHE are related to its current values but are not independently related to the quality of development or well-being.

Table 4.6 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 is 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.

The Kleibergen e 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 underidentified, 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). A rejection of the null hypothesis means that the ma-

Table 4.6 – *2SLS estimates of provincial index of well-being*

	(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	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Kleibergen-Paap Wald	208.15	205.50	206.37	205.32	204.33	207.33	213.48	200.79
N	1632	1632	1632	1428	1428	1428	1326	1326

Standard errors clustered at provincial level in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

trix is full column rank and the model is identified. Kleibergen e 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 e Donald (1993) test for weak instruments is not valid while, a correspondingly robust Kleibergen and Paap Wald rank F statistic is appropriated. Stock e Yogo (2002) have compiled the critical values for the Kleibergen e 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 (4.9), the null hypothesis that the equation is weakly identified is rejected since their value are all greater than 10, meaning that all the specification models are identified. The overidentification restriction test does not lead to rejecting the hypothesis of 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.

4.6.2 Sensitivity analysis

Min-max linear scaling transformation

Over the past two decades, a large number of 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 essentially 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 e 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 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 sensitive analysis is different from that developed by Segre *et al.* (2011) and Calcagnini e Perugini (2019a) to test the robustness of the regional quality of development index (QUARS); since we 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 we use for its construction consists in the first case of standardising all the variables to base year 2000 through the minmax linear scaling technique, then aggregate the standardized variables within their respective dimensions through an arithmetic mean and finally aggregate 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 4.7 reports the 2SLS estimates of the provincial index of well-being considering the minmax aggregation, which shows that public health efficiency still has a positive and significant impact on well-being even if the coefficients

Table 4.7 – *2SLS of 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
N	1632	1632	1632	1428	1428	1428	1326	1326

Standard errors clustered at provincial level in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

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 of model (1) of the previous subsection. So, public health efficiency increases well-being at provincial level, considering also the min-max linear scaling transformation.

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 efficiency and public health well-being.

The results are reported in Table 4.8 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 the light of these analyses that public health efficiency increases well-being at provincial level of administration.

TABLE 4.8 – *2SLS estimates of PIW without Health*

	(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	-2.38e-03	5.82e-04	-7.92e-04
					(1.68e-03)	(1.69e-03)	(1.23e-03)	(1.13e-03)
Transfers						0.0127	0.149*	0.0735
						(0.114)	(0.0846)	(0.0808)
IQI							0.959***	0.344**
							(0.174)	(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
N	1632	1632	1632	1428	1428	1428	1326	1326

Standard errors clustered at provincial level in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

4.7 Concluding remarks

The burgeoning interest in quality of development, quality of life, or life satisfaction has certainly produced efforts to increase the quantity and quality of well-being data, research, and policy analysis (Calcagnini e 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 researchers and policy makers.

Despite differences in methodologies and theoretical approaches, all studies show an attempt to overcome the use of gross domestic product (GDP) as a measure of well-being (Burchi e Gnesi, 2016), Calcagnini e Perugini (2019b), Monni (2002) and Segre *et al.* (2011). 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.

We focused on the relationship between public health efficiency and well-being. We have estimated an empirical model and its coefficient shows that public health efficiency maintains a significantly positive effect on well-being. Indeed, when we estimate the model through a fixed effects estimates, the coefficient is high (0.646) and increase in size and magnitude when estimating the model through 2SLS estimates (0.870) and through 2SLS but, removing *Health* dimension in the construction of a provincial index of well-being (0.713). Conversely, this coefficient is low (0.216) when we estimate the model through 2SLS, but considering a provincial index of well-being deriving from the min-max linear scaling transformation. Therefore, we 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 (Zamagni, 1978), (Daniele e Malanima, 2014) and (Di Liberto e Sideri, 2015). However, these findings should also attract the attention of local authorities, whose 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 e Stanca, 2008) and (Calcagnini e 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.

5 Conclusion

Government efficiency shows beneficial effects in the economy. In this thesis, the importance of relative efficiency in health was explored. The idea is that an efficient health system is supportive of labour productivity and can determine a reduction in economic gaps among provinces and certainly an improvement of well-being. The national health service guarantees essential services and leaves the satisfaction of less important needs to the pay market or supplementary mutuality. The consumption of these services is linked to the patient's personal income (Mapelli, 2012). Despite criticism and public dissatisfaction, among other things linked to long waiting lists, the national health system has achieved levels of excellence during time in quality of life and avoidable mortality. However, special attention must be paid to the issue of inequalities between regional healthcare systems. In fact, the regional nature of the health service poses sustainability problems in the southern Italian regions that have low fiscal capacity relative to their expenditure needs, despite equalising transfers from the central government. As a result, the services offered are unsatisfactory and encourage the migration of patients to the better equipped and more efficient regions of Northern Italy. This aspect is so relevant because the regions in the South of Italy are those where labour productivity is very low and consequently incomes are low and the level of well-being low, compared to the regions in the Centre-North. In order to improve the governance of these systems, it is necessary to create the conditions for economic and sustainable development, as well as to strengthen cooperation between the authorities responsible for budgetary and health policies and to use a wide range of budgetary planning tools to support efficiency, transparency and accountability. In addition, efficiency can also be measured by conducting systematic and formalised ex-ante and ex-post evaluations of reforms, based on factual data so that health system performance can be assessed.

Efficiency requires appropriate financial resources not only to finance the efficient provision of health service, but also for better remuneration of doctors and nurses and other hospital staff so as to mitigate the flight of doctors and nurses to the more attractive countries of Northern Europe. This recognition of the health personnel, especially doctors and nurses, is not only due

for improving their working conditions, but also for the professionalism and efficiency demonstrated during these two or so years of the COVID-19 pandemic. In fact, a study by Pecoraro *et al.* (2020) confirms that most Italian regions have efficiently managed intensive care unit facilities, allowing hospitals to treat patients without the risk of having an overabundance of inpatients and a shortage of beds.

The efficiency of regional health systems, considered as their capacity to promote and protect the health of citizens, as well as their capacity to guarantee effective accessibility to care, cannot be separated from an adequate level of funding. Therefore, in considering the budgetary constraints on the public finance front, it appears essential to encourage a governed diversification of funding sources, for example, by promoting and organising private health expenditure with the aim of freeing up new resources. The best-performing regional health systems already operate within this diversification logic, although the lack of an organic design does not allow the potential of this approach to be fully exploited (Vecchietti, 2017). In fact, all regions with high health indicators as well as low waiting times are characterised by an increasing recourse of their populations to high-cost private healthcare. The regions of the North-East are those where both public and private health care coexist the most. Perhaps an in-depth, organic study of the advantages and disadvantages of private healthcare over public healthcare is needed. However, the thorny issue of waiting lists as well as the psychosocial health problems that emerged after the emergency period of the COVID-19 pandemic present new challenges to the National Health Service, which must be ready to face.

In this thesis, we have shown that more efficient public health system generates more productivity, less disparity in income distribution and more well-being of populations and communities in the Italian provinces. In testing our hypotheses, we realised that the impact of an efficient public health service on income disparities and well-being depends on several factors, and especially that it produces different effects in developed, emerging and developing countries. It would therefore be appropriate to conduct similar empirical studies in some European Union countries such as Germany, France, Spain, Switzerland and Austria and in some African countries such as Nigeria, Ethiopia, South Africa, Ghana and Cameroon.

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