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The Relationship between Local Government Efficiency and Quality of Life: an Empirical Analysis of Italian Municipalities

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Abstract

This thesis investigates the relationship between local government efficiency and Quality of Life (QoL) across Italian municipalities, with Italy serving as empirical sample representing for developed countries with welfare-oriented public policies. The study aims to assess whether municipalities that achieve higher technical efficiency in delivering public services present a higher QoL for citizens as well.

The framework developed to address the research question employs Data Envelopment Analysis (DEA) to generate efficiency and QoL scores, followed by linear regression models used to examine the relationship between these two dimensions, considering additional external variables representing contextual factors.

The analysis reveals significant regional disparities, with Northern Italian municipalities generally displaying higher QoL outcomes compared to their Southern counterparts. In terms of efficiency, an original model was developed compared to those in the literature, less dependent on municipal spending which, as observed in this study, tends to favor municipalities that spend less. The results suggest that higher technical efficiency does not always translate equally into a high QoL, as this relationship might also depends on the wealth level of the areas analyzed: municipalities' role appears to be more relevant in less prosperous regions.

Through an in-depth analysis of the elements that measure municipal efficiency and their direct connection and impact on QoL, this research provides insights into the role the public sector can play in fostering an environment conducive to citizen well-being. The results ultimately lead to policy recommendations aimed at supporting local governments' decision-making based on current conditions, with the goal of increasing the positive impact of public services on citizens.

Keywords: Quality of Life, Technical Efficiency, Local Government, Municipalities, Public Services, Data Envelopment Analysis

Abstract in lingua Italiana

La seguente tesi si concentra sul rapporto tra l'efficienza delle amministrazioni locali e la Qualità della Vita (QdV), utilizzando i comuni italiani come campione empirico rappresentativo dei Paesi sviluppati. Lo studio mira a valutare se i comuni che raggiungono una maggiore efficienza tecnica nell'erogazione dei servizi pubblici presentino anche una qualità della vita più elevata per i cittadini.

Il framework sviluppato per rispondere alla domanda di ricerca utilizza la Data Envelopment Analysis (DEA) per generare punteggi di efficienza e di QdV, seguiti da modelli di regressione lineare usati per esaminare la relazione tra queste due dimensioni al variare di ulteriori variabili esterne, rappresentanti fattori contestuali.

L'analisi della QdV rivela significative disparità geografiche, con il Nord Italia che generalmente mostra risultati maggiori rispetto al Sud. In termini di efficienza invece, è stato sviluppato un modello originale rispetto a quelli presenti in letteratura, meno dipendente dalla spesa comunale che, come osservato in questo studio, tenderebbe a favorire eccessivamente i comuni che spendono meno. I risultati suggeriscono che una maggiore efficienza non sempre si traduce ugualmente in una QdV elevata in quanto potrebbe dipendere anche dalla ricchezza delle aree analizzate: il ruolo del comune risulta infatti più rilevante nelle zone meno prospere.

Attraverso un'indagine approfondita degli elementi che misurano l'efficienza comunale e del loro legame e impatto diretto sulla QdV, questa ricerca fornisce indicazioni sul ruolo che il settore pubblico può svolgere nel promuovere un ambiente favorevole al benessere dei cittadini. I risultati conducono infine a proposte di policy per supportare il decision making dei governi locali sulla base delle condizioni attuali, al fine di aumentare l'impatto positivo dei servizi pubblici sui cittadini.

Parole chiave: Qualità della vita, Efficienza tecnica, Comuni, Governi Locali, Servizi Pubblici, Data Envelopment Analysis

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Introduction

If you think about it, people frequently find themselves reflecting on what makes a place truly great to live in. The answer though is rarely objective and seem to be a highly subjective matter depending on their tastes, cultural background and influences. It could be the air quality, job opportunities, access to healthcare, reliable public transportation, or the chance to enjoy cultural landmarks, beautiful beaches or a mix of these factors. For instance, an Italian teenager might be willing to sacrifice the punctuality of public transportation or lower social benefits if it means living near stunning coastlines or rich cultural heritage sites. On the other hand, an old Swedish man would not be able to live like this. For him, efficient healthcare and timely buses outweigh the appeal of historical landmarks or access to outside sport leisure centers.

While personal preferences and external factors certainly play a role in where we choose to live, the task of assessing and comparing the Quality of Life (QoL) across different locations goes beyond individual tastes. To truly understand where and why certain places offer higher Quality of Life for their citizens, it is essential to objectively measure and synthesize various dimensions—some of which may be more or less important to different people. By grouping and analyzing these factors, it becomes easier to compare regions and cities in terms of well-being, making it possible to cut through subjective biases.

That is why, since the beginning of the last century, social scientists and researchers have been trying to assess and comprehend what are the critical determinants affecting communities and societies standard of living development. Historically, the first way to give a scale to social well-being across different areas has been measuring it using economic tools such as Gross Domestic Product (GDP) or GDP per capita (Kuznets, 1934), limiting in this way the analysis in purely economic terms.

Social scientists, but also us as citizens, know that economic variables are definitely not enough to measure QoL across different countries, regions or communities, so a step forward is necessary to include non-economic measures into play. This has also been demonstrated in the so-called "Easterlin paradox" showing that economic growth (i.e., GDP growth) is not necessarily accompanied by the corresponding growth in well-being (Easterlin & O'Connor, 2020). That is why, starting from the late 20th century, many scholars and institutions (i.e. OECD, European Commission, United Nations) have tried to develop new ways to assess QoL considering also non purely economic metrics (environmental, social,...). Also, several newspapers worldwide are trying to develop comprehensive and synthetic indicators to assess the QoL in different contexts. Particularly, in the Italian context, the most relatable source is the Quality of Life ranking published every year by the Confindustria owned newspaper Il Sole 24 Ore, which yearly selects 90 indicators that placed together try to cover the totality of the Quality of Life of the Italian population around the peninsula provinces.

This reasoning though, even if practically applied just in the last fifty years, has been part of philosophical discussion already more than two thousand years ago. Indeed, in his exploration of the ideal life, Aristotle somehow argued about QoL introducing the concept of *eudaimonia*, often translated as "flourishing" or "well-being" (Aristotle, 2006). For him, *eudaimonia* represented the highest human good, a state of living that could only be achieved through the practice of virtue and active participation in the life of the community and not only by material and physical possessions. This idea was deeply embedded in the context of the Greek polis, where citizens engaged in public life, contributing to and taking benefits from the collective good (Nussbaum, 1992). The *polis*, with its institutions and governance structures, was not merely a backdrop for individual lives but a vital component in shaping the conditions necessary for citizens to achieve *eudaimonia* (Miller, 1995).

Nevertheless several hundreds of years have passed, these concepts are very modern and can easily relate to the way we live life within our community. Just as the Greek polis was essential for fostering the well-being of its citizens, today's governments, particularly local ones, play a crucial role in creating the conditions for modern *eudaimonia*. Indeed, in many developed countries, local governments are usually responsible to provide a range of services that are considered public (or

semi-public) goods, non-excludable and non-rivalrous, meaning that no one can be excluded from their benefits, and one person's use does not diminish their availability to others (Samuelson, 1954).This services, ranging from public safety, healthcare, and education to infrastructure and environmental management, not only are fundamental to the collective and individual well-being of citizens (Bovaird & Löffler, 2003) but also their equitable and efficient distribution is crucial for maintaining social cohesion and public trust (Ostrom, 1990) . For instance, public safety ensures that citizens feel secure in their daily lives, while public education equips individuals with the knowledge and skills necessary to pursue personal and professional opportunities (Musgrave & Musgrave, 1959).

With this in mind, it is straightforward to understand how many aspects of citizens QoL depends on these services and how managing them efficiently, with the proper best practices, might actually contribute to increase well-being, even if this was not always the main priority of public servants. In facts, the traditional model of public administration, grounded in Max Weber's principles, placed a strong emphasis on bureaucratic procedures and the strict adherence to rules prioritizing processes and formal regulations over outcomes. In contrast, the emergence of the New Public Management (NPM) paradigm, championed by scholars such as Christopher Hood (Hood, 1991) and Osborne and Gaebler (Osborne & Gaebler, 1993), represented a significant shift. NPM redirected the focus from process-oriented governance to results-driven management, emphasizing the performance of public organizations in delivering services and achieving tangible outcomes for citizens. This marked a transformation from managing inputs and procedures to evaluating success based on the results and impact on the public. Indeed, from a managerial perspective, these organizations operate under a highly challenging dual-objective dimension. From an internal perspective, they aim to maximize efficiency by minimizing costs. Their objective is to deliver public services to a population distributed across a defined area while adhering to budget constraints and ensuring minimal expenditure. However, from an external perspective, municipalities also have the responsibility to maximize the value delivered to citizens, hence spending more for higher value goods and services. This duality creates a unique challenge, as their objective function must balance both cost minimization and value maximization.

These arguments suggest that could be interesting to study the relationship between several well-being and Quality of Life aspects and the performances of local governments (particularly municipalities) and to empirically understand what is their correlation. The two main research questions that this paper will try to answer to are:

1. **What is the relationship between Italian local government technical efficiency and citizens' QoL improvement (i.e. effectiveness) ?**
2. **How do contextual variables (social and demographic, political, financial, economic, geographical and institutional factors) affect this relationship in the Italian context?**

In order to do so, Italy has been used as the subject of the empirical investigation. The goal though, is to try and generalize the results obtained in broader contexts, at least representing the situation in developed countries highly relying on social welfare and in government activities to increase citizens well-being.

First a brief description of the Italian institutional context will be presented, mainly trying to clarify what are the government responsibilities at different hierarchical levels (Chapter 1). Then, a comprehensive literature review on the theme of local government technical efficiency and QoL measurement will be presented, particularly focusing on Italian studies (Chapter 2). Then the paper will go deeper in the analysis itself and so methodologies, data used and the conceptual framework utilized are discussed (Chapters 3, 4 and 5). Finally, results will be presented (Chapter 6) and critically analyzed (Chapters 7 and 8). Finally, in the last Chapter (9) conclusion, limitations and further research opportunities will be presented to the reader.

1 | Institutional background

After its constitution in 1946, the Italian Republic was reorganized into several local government apparatus diving responsibilities and service provision in accordance with the needs of citizens and ease in providing them public services. Indeed, according to Art. 114 of the Italian Constitution (Fondamentali, 1948), the Italian administrative structure is composed of five hierarchical layers: the Italian State (Stato), Regions (Regioni), Provinces (Provincie), Metropolitan Municipalities (Città metropolitane) and Municipalities (Comuni). Particularly, the provision of public services, and its responsibility, is divided among the different local governments and it is important to understand who is responsible for what when assessing local government efficiency and/or any possible increase (or unfortunately decrease) in Quality of Life.
Particularly, the central State has exclusive power in the following matters:

- Foreign policy and international relations of the State; relations of the State with the European Union; right of asylum and the legal status of citizens of non-EU countries;
- Immigration;
- Relations between the Republic and religious denominations;
- Defense and the Armed Forces; State security; weapons, ammunition, and explosives;
- Currency, protection of savings, and financial markets; competition protection; monetary system; State tax and accounting system; harmonization of public budgets; equalization of financial resources;
- State bodies and related electoral laws; national referendums; election of the European Parliament;

- Organization and administrative structure of the State and national public entities;
- Public order and security, excluding local administrative police;
- Citizenship, civil status, and registries;
- Jurisdiction and procedural rules; civil and criminal law systems; administrative justice;
- Determination of the essential levels of services concerning civil and social rights that must be guaranteed throughout the national territory;
- General rules on education;
- Social security;
- Electoral legislation, governing bodies, and fundamental functions of Municipalities, Provinces, and Metropolitan Cities;
- Customs, protection of national borders, and international health protocols;
- Weights, measures, and determination of time; statistical and IT coordination of data from State, regional, and local administrations; intellectual property;
- Protection of the environment, ecosystem, and cultural heritage.

The remaining responsibilities lie with other levels of local government, which are usually in charge of services that have a more direct impact on the daily lives of citizens.

In the first layer we find **Regions** (*Regioni*). Regions in Italy hold significant legislative and administrative powers, particularly in areas requiring higher coordination and regulation. First, the regions manage the organization and delivery of health services, including hospitals, clinics and public health initiatives. Second, they are responsible for the implementation of policies and programs to support business and industry, as well as some areas of education in vocational training and adult education. Finally, the regions are also responsible for managing regional transport networks, including regional railways and major roads, and for some environmental and social services. Also, Article 116 of the Italian Constitution, grants some regions (*Regioni a Statuto Speciale*) more autonomy than ordinary ones. This article specifically applies to five regions, Sicily, Sardinia, Trentino-Alto Adige, Friuli

Venezia Giulia, and Valle d'Aosta, which have additional powers in areas like education, healthcare, environment, and, in some cases, fiscal management. These areas operate under special statutes approved by constitutional law, allowing them to tailor policies and resources to meet local needs, respecting unique cultural, linguistic, economic, and geographical characteristics.
In the middle one, **Provinces** (*Provincie*), even if significantly reformed and reduced in autonomy by recent legislative changes (Law 56/2014), still maintain some administrative roles such as coordination of municipalities or management of services that needs to be delivered beyond the boundaries of a single municipality such as provincial roads and secondary education.
Finally, **Municipalities** (*Comuni*), which will be the local government level of this analysis, represent the last hierarchical level and they are the primary administrative units responsible for services directly affecting citizens' daily lives. The main issues they are responsible for are:

- **Environmental protection & waste management:** including environmental protection, waste disposal, and water service management (often contracting out to private companies or establishing Public Private Partnerships (PPP) in order to deliver the service). For instance, main expenses in this are concern: hydro-geological instability; maintenance of public green spaces and the enhancement of the natural environment; street and square cleaning; waste collection and disposal; aqueduct, water systems, and wastewater treatment; landscape protection forestry, and woodland activities; reduction and monitoring of air and noise pollution.
- **Local public transport and local roads:** manage local public transportation within the municipality. Main expenses in this area are related to: local public transport by road, such as buses, or through trams and subways; construction and maintenance of roads, bike paths, and related infrastructure; and municipal expenses for maritime, river, or lake transport.
- **Urban planning and development:** oversee zoning, building permits, and urban development projects. Main expenses in this area are related to: urban planning, including the development of the master plan; public and local residential housing; and social housing programs.

- **Social services:** provide services such as childcare, elderly care, and social housing. Main expenses are related to: services for children and minors, including the construction and management of municipal nurseries and agreements with private ones; services for individuals at risk of social exclusion, such as low-income individuals, victims of violence, and refugees.
- **Local policing:** management of the municipal police which primarily handle local law enforcement, traffic control, and public order.
- **Education (ancillary services):** Municipalities manage the day-to-day operations of primary and early secondary schools. Main expenses are related to: municipal spending on preschools (; municipal spending on primary, middle, and high schools; and other expenses to ensure the right to education.
- **Culture, Sports, and Leisure:** municipalities organize and invest in facilities that enable citizens to better access cultural and sport related activities. Main expenses are related to: sports facilities, events, and sports organizations; cultural facilities and activities (e.g. libraries, concerts etc..).

Furthermore, **metropolitan municipalities** (*Città Metropolitane*), a peculiar type of municipalities, have additional responsibilities compared to ordinary ones, focusing on strategic development, metropolitan transportation, environmental sustainability, and economic coordination. They oversee the integrated planning and management of public services, transportation networks, and infrastructure across a broader urban area, ensuring cohesive development. In Italy, metropolitan municipalities are fourteen: Torino, Milano, Venezia, Genova, Bologna, Firenze, Roma, Bari, Palermo, Catania, Cagliari, Reggio Calabria, Messina and Napoli.
Municipalities (and metropolitan cities) have a high degree of autonomy in decision-making, especially when it comes to local governance, planning, and financial management regarding the areas cited above (Environmental protection & waste management, Local public Transport and local roads, Urban planning and development, Social services, Local policing, Culture, sport and leisure and Education). At the same time, though, they need to comply to several legal and financial constraints designed to ensure compliance with national and regional laws and maintain fiscal discipline.
First, they must **adhere to budget constraints** imposed by the Internal Stability Pact (*Patto di Stabilità Interno*) , which has been replaced by the "Equilibrium of

Budget" framework since 2016. This national framework sets out financial balance objectives for local authorities, limiting their ability to spend and incur debt. In particular, they must balance revenues and expenditures (Law No. 243/2012) and are permitted to incur additional debt only for capital investments, not for operational purposes, thus preventing the use of debt for ongoing expenses. Also, there are additional specific restrictions on spending related to **personnel and service contracts (public procurement)**. Not only hiring is subject to spending limits designed to control public sector wage bills (Law No. 190/2014, the "Stability Law") but also, in order to manage public procurement, they need to comply several with national and European regulations.

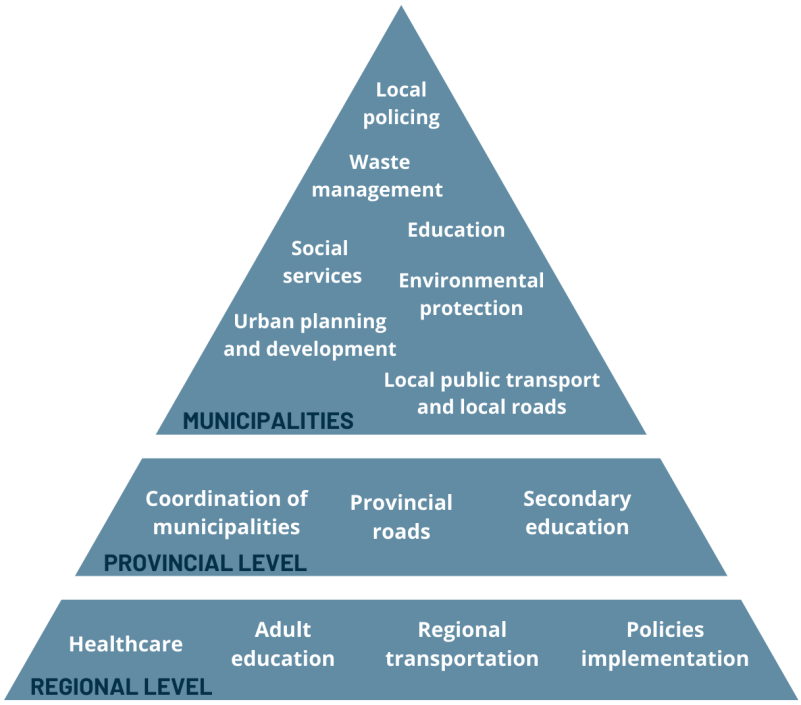


Figure 1.1: Accountability division on the three levels main levels under the Italian State

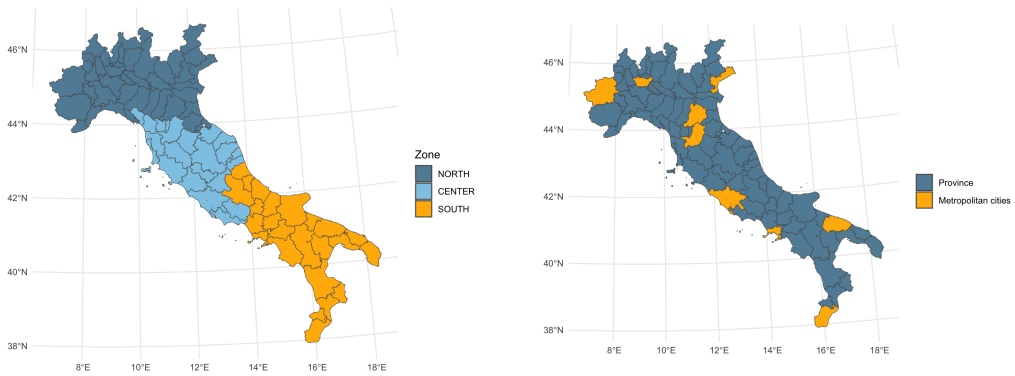
Finally, municipalities are subject to several legitimacy control. For instance, The Court of Auditors (*Corte dei Conti*) can intervene if there are irregularities or inappropriate use of public resources, imposing sanctions or requiring adjustments (Legislative Decree No. 267/2000, known as the "Consolidated Law on Local Authorities") or regions have administrative oversight over municipal actions, particu-

larly when those actions involve delegated or transferred functions from the region. All these controls oblige municipalities ensure the transparency of their financial operations publishing their yearly budgets Legislative Decree No. 33/2013, on transparency and publicity) and a three year planning on new hiring and capital expenses (Legislative Decree No. 267/2000).

1.1. Socio-demographic, economic and geographical overview of Italy

A quick socio-demographic, economic, and geographical analysis of Italy is essential to reveal the most significant regional disparities in terms of population density, altitude, the Gini index, and GDP per capita. This section highlights the main differences between the country's different regions.

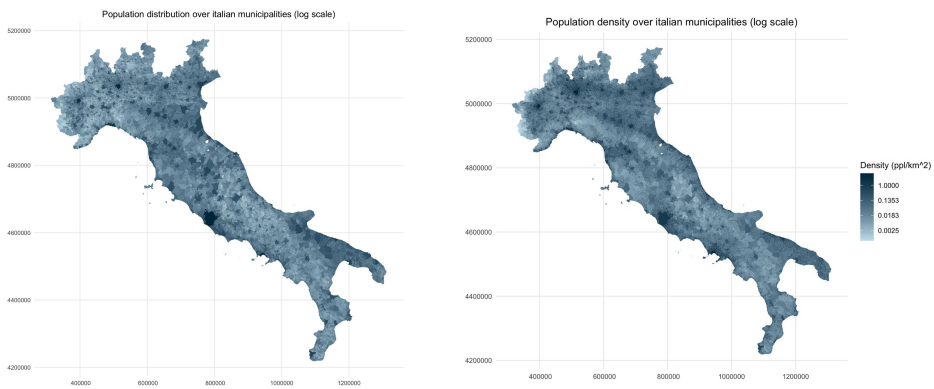
The Italian peninsula is divided geographically into three main zones: the North, which includes Piemonte, Lombardia, Liguria, Emilia Romagna, Trentino-Alto Adige, Veneto, Friuli Venezia Giulia, and Valle d'Aosta; the Center, with Toscana, Umbria, Lazio, and Marche; and the South, which comprises Abruzzo, Puglia, Campania, Calabria, Sicilia, Sardegna, Molise, and Basilicata. The metropolitan cities are distributed fairly evenly across the territory.



(a) Italian zones (b) Metropolitan cities

Figure 1.2: Geographical zones and metropolitan cities

From a demographic perspective, as shown in Figure 1.3, the Northern provinces tend to be more **densely populated**, particularly in economically developed and industrialized regions such as Lombardia, Piemonte, and Veneto. By contrast, southern provinces, particularly in more rural or economically underdeveloped areas, show lower densities. Provinces like Cosenza in Calabria have a population density of under 200 people per square kilometer, reflecting the limited economic opportunities and outward migration trends that characterize much of southern Italy. Even in metropolitan areas like Bari in the South, the population density reaches only 316 people per square kilometer, considerably lower than comparable northern metropolitan areas. Central provinces, while more urbanized, reflect intermediate densities, such as Rome, with 788 people per square kilometer. This balance in central Italy, as seen in provinces like Florence (281 people per square kilometer) and Perugia (194 people per square kilometer), illustrates how the Center serves as a transitional zone between the densely populated, industrial North and the more rural, sparsely populated South. These figures reflect the broader economic and demographic patterns that influence population distribution across Italy, with economic opportunities driving higher concentrations of people in the North, while the South remains less densely populated.



(a) Geographical distribution - Population

(b) Geographical distribution - Density

Figure 1.3: Population and Density maps

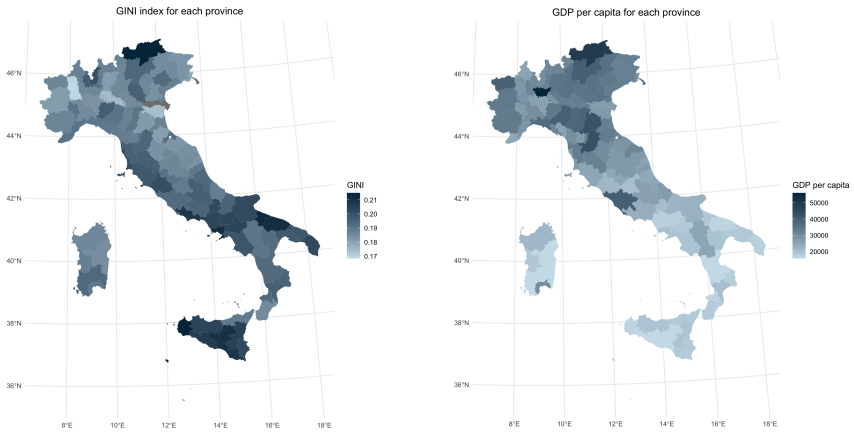
Income inequality, as measured by the **Gini index**, and **GDP per capita** (Figure1.4) also highlight the persistent regional economic disparities between the North,

Center, and South of Italy. In southern Italy, higher Gini coefficients, such as 0.212 in Barletta-Andria-Trani, 0.211 in Napoli, and 0.210 in Bari, indicate greater income inequality compared to the North. These provinces, which suffer from weaker economic structures and higher unemployment rates, have long struggled with income distribution issues. This disparity is closely tied to their lower GDP per capita, with provinces like Bari (€16,600) and Cosenza (€16,100) reflecting the South's historical economic underdevelopment, which is marked by a reliance on agriculture, limited industrial activities, and underinvestment in high-value sectors.

In contrast, Northern Italy is characterized by high GDP per capita figures, such as Milano's €56,000, and Bologna's €42,500. These provinces benefit from diversified economies that combine manufacturing, high-tech industries, and robust service sectors typical of regions like Emilia-Romagna, Veneto and Lombardia.

The central regions present a middle ground, with moderate Gini indices and GDP per capita values that are closer to those of the North.

The connection between income inequality and GDP per capita across Italy underscores how the economic foundations of each region shape their social outcomes. The wealthier northern provinces, with higher GDP per capita, generally manage to distribute income more equitably, resulting in lower Gini coefficients. In the South, where economic underdevelopment limits growth opportunities, the combination of lower GDP per capita and higher income inequality reinforces a cycle of poverty and limited upward mobility. Central regions, with their more diversified economies, display intermediate trends but are still influenced by the broader north-south divide, where geographic location and economic history play critical roles in shaping both income inequality and overall wealth.



(a) Geographical distribution - GINI index

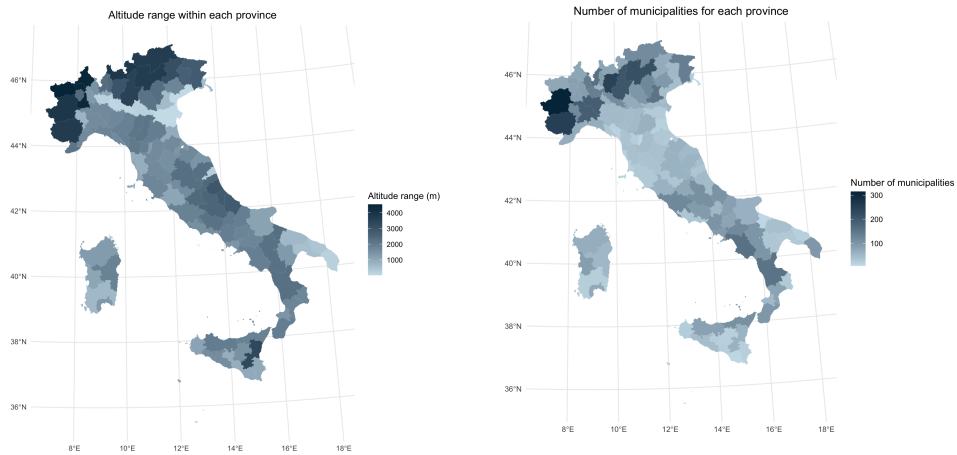
(b) Geographical distribution - GDP pro capita

Figure 1.4: GINI and GDP maps

From a geographical viewpoint, altitude variation can been considered the plethora of different conditions in which municipalities operate (Figure 1.5a). Northern provinces are characterized by larger altitude differences due to the presence of the Alps, as seen in Sondrio, Aosta, Verbano-Cusio-Ossola,Vercelli and Torino, where the altitude variation reaches a staggering almost 4000 meters. This stands in stark contrast to flatter southern provinces like Foggia, where the variation is only 522 meters. Central regions like Perugia show intermediate altitude differences of 2,305 meters, reflecting the Apennine mountain range that runs through the area. Such differences affect infrastructure, accessibility, and the types of economic activities each region can support.

Finally, the number of municipalities across Italian provinces shows significant regional variation (Figure 1.5b), reflecting differences in governance structures and population distribution. Northern provinces, especially in Piemonte and Lombardia regions, generally have a higher number of municipalities, with Cuneo, for example, having 250 municipalities, and Torino with 312, making them two of the most administratively fragmented areas in Italy. Similarly, Brescia in the North has 206 municipalities, reflecting the tendency toward more localized governance in this region. In contrast, southern provinces tend to have fewer municipalities. For instance, Barletta-Andria-Trani has only 10 municipalities, and Enna has 20, reflecting a more centralized governance structure in the South. Provinces like Cosenza, with

155 municipalities, are exceptions but still feature fewer municipalities compared to provinces in the North. Central Italy shows a mixed picture, with provinces like Rome having 121 municipalities but also cases like Florence or Perugia having respectively 44 and 59 municipalities. On one hand, smaller municipalities may offer more personalized services, closer interaction with citizens, and quicker decision-making at the local level. On the other hand, it can lead to inefficiencies due to duplication of services, higher administrative costs, and difficulties in coordinating policies across municipalities. In contrast, while centralization can improve efficiency in terms of cost reduction and streamlined decision-making, it can also lead to slower response times to local issues, less tailored services, and the potential for overburdened administrative bodies managing larger territories.



(a) Geographical distribution - Altitude Range

(b) Geographical distribution - Number of Municipalities per province

Figure 1.5: Altitude and number of municipalities maps

2 | Literature review

In order to answer the research question defined above two major literature themes need to be investigated. The first regards how to properly assess and measure performances in a local government context, particularly regarding technical efficiency and ways decision makers have to deliver more value with less expenses. On the other hand, the second concerns the issue of measuring QoL in a local context (e.g communities, municipalities, cities, provinces...) trying to understand properly what are the less biased determinants affecting it in a positive or negative way. Furthermore, it is fundamental to investigate if there are any literature studies already connecting these two main domains and explore methods already utilized in order to build around the state of the art, finding a solid theoretical framework to conduct our empirical analysis and properly fill any literature gap.
In order to do so, three main Scopus query searches, followed by a snowball approach in the most relevant papers, have been conducted. The first query has been utilized to identified publications on efficiency and more generally performances of local governments:

TITLE ("local government" OR "municipalit*") AND TITLE ("efficiency" OR "performance*") AND (LIMIT-TO (DOCTYPE , "ar"))

This search, has been fundamental to address the theme from a global perspective, particularly identifying two major literature review studies, Narbón-Perpiñá and De Witte (2018a) and Narbón-Perpiñá and De Witte (2018b), which inspired and guided the construction of this Literature Review analysis.

This research was followed by a narrower one going more vertically on the efficiency theme in the Italian institutional context:

TITLE ("local government" OR "municipalit*" OR "regions" OR "cities") AND TITLE-ABS-KEY ("efficiency") AND TITLE-ABS-KEY ("italy" OR "Italian") AND (LIMIT-TO (DOCTYPE , "ar"))

Finally a search on the interception between efficiency in local government and QoL has been conducted:

(TITLE-ABS-KEY ("Quality of Life" OR "QoL" OR "livability" OR "well-being" OR "wellbeing" OR "living conditions" OR "standard of living") AND TITLE-ABS-KEY ("municipalities" OR "local government" OR "local authorities" OR "local communities") AND TITLE-ABS-KEY (efficiency)) AND (LIMIT-TO (DOCTYPE , "ar"))

This query was utilized for two main reasons. First try to define the concept of Quality of Life and what are determinants increasing or decreasing it. Then it was also exploited in order to assess the state of the art of the research question.

Following this research methodology introduction, in this chapter a comprehensive literature review of the main themes is going to be presented. Particularly in section 2.1 the paper investigates methods , variables utilized and findings regarding efficiency in local government. Given the nature of this study, the focus will be on Italian based empirical analysis. Then, in section 2.2 the relationships between QoL and local government efficiency will be assessed.

2.1. Measuring efficiency in local governments

For what concerns assessing efficiency in local government, several empirical studies have been conducted over the last decades. Starting from the late 20th century, scholars were driven by early empirical works of Eeckaut et al. (1993), De Borger et al. (1994), De Borger and Kerstens (1996a) and De Borger and Kerstens (1996b) on Belgian municipalities, Athanassopoulos and Triantis (1998) on Greece, de Sousa and Ramos (1999) for Brasil and Hayes and Chang (1990) on USA municipalities, in creating a new field of research whose aim is to understand what are the determinants impacting local government efficiency utilizing mathematical, statistical and

econometrics techniques. Following these, in the first twenty years of this century there was a push on research across many developed countries.

Regarding **Asia and Pacific countries**, studies were conducted in **Australian regions** (A. Worthington, Dollery, et al., 2000; A. C. Worthington & Dollery, 2001; A. C. Worthington & Dollery, 2002; Woodbury & Dollery, 2004; Dollery & Johnson, 2005; Fogarty & Mugera, 2013; Marques et al., 2015; Tran & Dollery, 2020), **Indonesia** (Yusfany, 2015), **Japan** (Nijkamp & Suzuki, 2009; Haneda et al., 2012; Amatatsu et al., 2012; Nakazawa, 2013; Nakazawa, 2014; Otsuka et al., 2014), **Malasya** (Ibrahim & Karim, 2004), **South Korea** (Sung, 2007; Seol et al., 2008)) and **Taiwan** (Liu et al., 2011).
For what concerns **South and North America**, on **Brazilian** (Sousa & Stošić, 2005; de Sousa et al., 2005), **Chile** (Pacheco et al., 2014; Pacheco et al., 2021; Molinos-Senante et al., 2023) and **USA** (Grossman et al., 1999; Moore et al., 2005).
In **Africa**, **Morocco** (El Mehdi & Hafner, 2014) and **South Africa** (der Westhuizen & Dollery, 2009; Mahabir, 2014; Monkam, 2014; Adedeji Amusa & Fadiran, 2024) have been examined. In **Turkey** (Kutlar et al., 2012) and in the **United Kingdom** (Revelli, 2010; Andrews & Entwistle, 2015).
Finally, in **Europe**, for **Belgium** (Eeckaut et al., 1993; De Borger et al., 1994; De Borger & Kerstens, 1996a; De Borger & Kerstens, 1996b; Coffé & Geys, 2005; Geys, 2006; Geys & Moesen, 2009b; Geys & Moesen, 2009a; Ashworth et al., 2005), **Czech Republic** (Stastna & Gregor, 2011; Št'astná & Gregor, 2015), Finland (Loikkanen & Susiluoto, 2005; Loikkanen et al., 2011), **Germany** (Geys et al., 2010; Kalb, 2010; Bönisch et al., 2011; Kalb et al., 2012; Bischoff & Siemers, 2013; Kalb et al., 2012; Asatryan & De Witte, 2015; Lampe et al., 2015), **Greece** (Athanassopoulos & Triantis, 1998; Doumpos & Cohen, 2014; Pougkakioti & Tsamadias, 2020)), **France** (Seifert & Nieswand, 2014), **Macedonia** (Nikolov & Hrovatin, 2013), **Norway** (Revelli & Tovmo, 2007; Borge et al., 2008; Bruns & Himmler, 2011; Sørensen, 2014; Helland & Sørensen, 2015), **Portugal** (Afonso & Fernandes, 2003; Afonso & Fernandes, 2006; Afonso & Fernandes, 2008; Da Cruz & Marques, 2014; Cordero et al., 2017; Basílio et al., 2020) , **Serbia** (Radulovic & Dragutinović, 2015), **Slovenia** (Pevcin, 2014a; Pevcin, 2014b), **Spain** (Prieto & Zofio, 2001; Balaguer-Coll et al., 2007; Giménez & Prior, 2007; Balaguer-Coll et al., 2010a; Balaguer-Coll et al., 2010b; Bosch Roca, 2012; Balaguer-Coll et al., 2010c; Benito et al., 2010; Zafra-

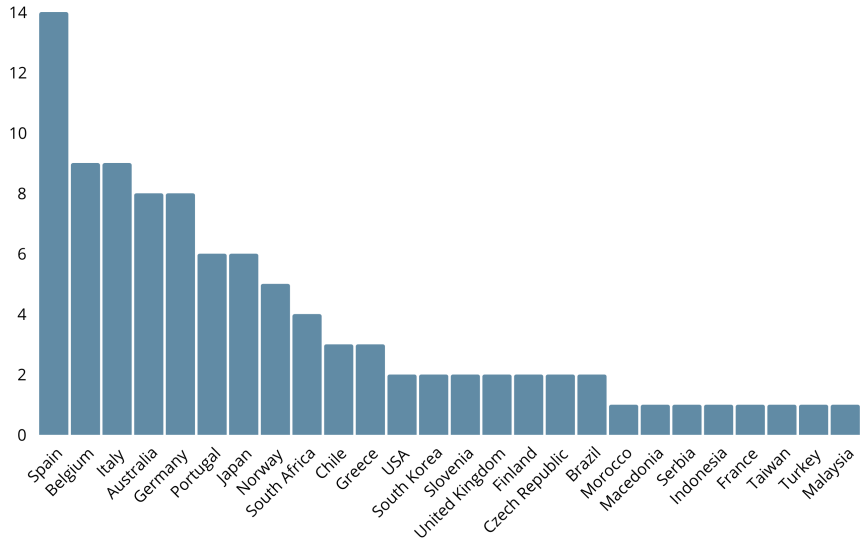


Figure 2.1: Papers on global local governemtn efficiency - Worldwide distribution

Gómez et al., 2010; Balaguer-Coll et al., 2013; Cuadrado Ballesteros et al., 2013; Arcelus et al., 2015; Pérez-López et al., 2015) and **Italy** which will be studied with more in detail in the following chapters.

These studies, retrieved from the article search query explained above, are widely spread across different countries/levels of local government and, since they are mostly empirical, based on real data coming from institutions and national research centers, are highly influenced by the laws and responsibilities each local government has in every country. Indeed, following the two most cited systematic literature review on the theme, Narbón-Perpiñá and De Witte (2018a) and Narbón-Perpiñá and De Witte (2018b), differences are not only related to the **country** or level of governance the research has been conducted, but also the **methodological approach** utilized, the **inputs and outputs variables** available and the **contextual factors**, environmental variables, affecting local governments performances (Narbón-Perpiñá & De Witte, 2018b). Hence, to conduct this study in the Italian context it is also crucial to address the issue of variable and methodology selection in order to build a robust research framework.
Moreover, since local governments usually provide several services to citizenship, one could choose to assess performances either from a global perspective or vertically just in one or more of the service area provided (De Borger & Kerstens, 1996a; lo

Storto, 2016) or by functional areas such as general administration or planning (lo Storto, 2016).
This chapter aims at classifying Italian empirical studies on local government efficiency following the Narbón-Perpiñá and De Witte (2018a) and Narbón-Perpiñá and De Witte (2018b) classification framework: methodology, input/output variables and environmental factors utilized.

2.1.1. Major Italian studies

In the Italian context, several papers try to tackle this challenge at different governance levels (regional, provincial, municipal ...) either from a particular perspective, assessing vertically just one service provided, or globally creating a macro indicators monitoring efficiency.

Global studies

From a **global perspective**, Italian studies focus on different levels of local governance which goes from municipal level to regional one. Some publications explore the performance of municipalities. Luca and Modrego (2021) not only assess efficiency performances but also investigates whether inter-municipal cooperation among small Italian municipalities leads to improved administrative efficiency. They find an average efficiency score of 85.6%, with municipalities in Northern Italy generally having greater scores, and no no significant impact of municipal unions on improving local government efficiency. Also, lo Storto (2016) aims to evaluate the cost efficiency of major Italian municipalities and investigate the relationship between municipal efficiency and the quality of public services provided to citizens. The average efficiency scores were 69.6% (CRS model) and 82.5% (VRS model), with Southern municipalities generally achieving higher DEA scores . The analysis revealed that many municipalities suffer from decreasing returns to scale, indicating inefficiencies due to their large size. Conversely, some smaller municipalities experienced increasing returns to scale, suggesting that they could benefit from expanding their operations. More specifically, D'Inverno et al. (2018) aims to evaluate the public spending efficiency of Tuscan municipalities and understand the determinants affecting this

efficiency focusing on the municipal size impacts on public expenditure efficiency. They find that the mean global efficiency score for Tuscan municipalities was 0.44 with larger municipalities being more efficient. Also mountainous regions and high tourism level regions present worse performances.
Agasisti et al. (2016) investigates the fiscal efficiency of municipalities in Lombardy, Italy, focusing on their ability to provide essential public services efficiently. The analysis finds significant room for improvement, average efficiency score of 0.67, indicating that municipalities could achieve the same level of output while reducing resources by approximately 33%. Also they find that larger municipalities tend to have higher efficiency scores compared to smaller ones.
Agasisti and Porcelli (2023) evaluate the efficiency of Italian municipalities over the period 2010-2018 and identify the main institutional, financial, and economic characteristics correlated with their efficiency scores including how efficiency levels have evolved over time.They find that efficiency improvements between 2010 and 2018 indicate that local governments generally became more efficient during this period with an average efficiency score between 0.70 and 0.80. Also, Northern municipalities generally achieve higher efficiency scores, while Southern regions tend to perform lower although there are some exceptions such as Puglia.
Santolini (2020) identifies and analyzes spatial patterns in local government efficiency, demonstrating how municipalities in the Marche region are influenced by their neighbors through mechanisms like political yardstick competition and the diffusion of best practices.
Perugini (2024) investigated the relationship between local government efficiency and economic growth at the municipal level in Italy. The study found evidence that government efficiency has a significant positive impact on income growth. Northern Italy generally perform better in terms of efficiency, which correlates with higher economic growth in these regions. In contrast, municipalities in Southern Italy are less efficient, but when they improve their efficiency, they experience more significant economic growth and smaller municipalities tend to benefit more from efficiency improvements compared to larger municipalities.

Municipal level is not the only layer of local government assessed by the researchers, indeed also the regional level is often tackled in the literature: Padovano and Ricciuti (2009) investigates whether higher political competition leads to better economic performance in Italian regions, selecting higher quality politicians who implement

more efficiency-oriented policies. Also, Piacentino and Vassallo (2011) finds that efficiency change is the main driver of regional divergence in productivity.

Particular studies

Apart from the global perspective efficiency measurement in local government there is a huge thematic field also tackling performances vertically on one or more services provided.

Regarding **Environmental and Waste Management services**, Romano and Molinos-Senante (2020) investigate the eco-efficiency of municipal waste management in Tuscan municipalities, finding that publicly owned firms witness superior performances. Municipalities with publicly owned waste operators exhibited the highest eco-efficiency scores, with an average score of 0.703. Indeed, privately operated municipalities had an average eco-efficiency score of 0.972, but this high score came with greater variability compared to public operators and mixed ownership models showed the lowest eco-efficiency scores, with an average score of 0.668. These municipalities displayed the most room for improvement in cost management while maintaining service quality. Agovino et al. (2018) examine waste management practices across Italian provinces from 2004 to 2011, revealing significant spatial correlations. The average efficiency score across all models was relatively moderate, ranging from 0.665 to 0.836. The study found that provinces with strong waste management performance tend to positively influence their neighboring provinces. Additionally, it highlights that effective collaboration between local institutions and citizens plays a crucial role in achieving better waste management outcomes. Lo Storto (2016) developed a comprehensive index to measure the ecological efficiency of cities by evaluating ecological performances of 116 Italian provincial capital cities in 2011, with an average ecological efficiency score was 60.91%.The study found that Northern cities generally performed better than Southern cities. The proposed index shows better discrimination power compared to the ranking provided by the Sole24Ore. Lombardi et al. (2021) study the efficiency of urban waste services in Italian municipalities also exploring the role of waste tariffs in the transition towards a circular economy. The average eco-efficiency score was 0.684.The study also high-

lights significant regional disparities in efficiency. Municipalities in Northern Italy, particularly in the North-East, tend to perform better in terms of both technical and scale efficiency compared to those in the South and the Islands. They also reveal that cities experience economies of density up to a certain threshold of population density. Fusco and Allegrini (2020) evaluates the impact of spatial interdependence on the cost efficiency of waste management services in Italian municipalities. Specifically, it investigates how neighboring municipalities influence each other's efficiency in managing waste service. density economies in waste management, where larger municipalities or those with denser populations tend to achieve greater cost efficiency. The study highlights significant spatial interdependence among neighboring municipalities in terms of cost efficiency and also the presence of density economies. Ferraro et al. (2023) investigates the economic and environmental performance of waste management services in the 353 municipalities of the Campania region. It aims to measure municipal efficiency in waste collection and disposal, considering both linear and circular economy paradigms. What they find is that usually efficient municipalities in economic terms often neglected environmental sustainability and that those with a high economic performance without environmental damage are primarily found outside the metropolitan areas. For Model I (economic efficiency), the average score was 0.285 and For Model II (combined economic and environmental efficiency), the average score was 0.416. Romano et al. (2021) compares the dynamic eco-efficiency of Italian municipalities with publicly owned, privately owned, and mixed ownership solid waste utilities. It aims to determine how ownership influences productivity change over time. They find that private utilities showed the most improvement in eco-productivity but publicly owned waste operators drive technological advancements.

For what concerns **Tourism activities** Suzuki et al. (2011) assess and try to find ways to improve the efficiency of Italian tourist regions. There is a clear North-South divide in efficiency, with Northern regions generally performing better than Southern regions. Particularly in the South, can improve their performance by adjusting both input reductions (e.g., better management of cultural heritage) and output augmentations (e.g., increasing tourist bed-nights). Cuccia et al. (2016) investigates whether the inscription in the UNESCO World Heritage List (WHL) affects the technical efficiency of the supply of tourism goods and services and, consequently,

the competitiveness of tourism destinations in Italian regions. They find that cultural and environmental endowments positively affect the performances but at the same time that the presence of UNESCO sites negatively impacts the technical efficiency of these regions mainly due to the high expectations generated by WHL inscriptions, which may not be met due to inadequate local policies.

There are also studies which tackle vertically the **Education** area and the activities related to it (ancillary services). Agasisti et al. (2011) evaluate the efficiency of university departments in the fields of science, technology, and medicine in the Lombardy region of Italy. Specifically, it examines changes in research productivity from 2004 to 2007 and identifies factors that potentially affect efficiency. DEA scores were between 0.745 and 0.786, average scale scores was 0.937. These findings indicate that while many departments in Lombardy are efficient in their scale of operations, there is room for improvement in technical management to reach the efficiency frontier. Sibiano and Agasisti (2013) investigates the efficiency of public spending on education across Italian regions, focusing on lower secondary education. It aims to determine how effectively regions utilize their resources to achieve educational outcomes and identify the factors that influence efficiency. The study confirms a significant North-South divide in educational efficiency. Rella et al. (2024) argues about how the level of digitalization in municipalities affects the efficiency of universities in Italy. The unconditional DEA scores (without considering the digitalization level of municipalities) showed that the average efficiency score for universities in 2018 was 0.634, which increased to 0.747 in 2020. In the conditional DEA (where the digitalization level of the municipalities was considered), the efficiency scores were consistently higher. For example, in 2018, the average conditional efficiency was 0.773, and in 2020, it increased to 0.860. This shows that the level of digitalization has an important impact.

Finally, **Social services** provision has been studied by lo Storto (2020) which examines the efficiency and effectiveness of social service provision by 103 major Italian municipalities. It aims to understand the efficiency-effectiveness relationship and identify factors influencing overall municipal performance. The results indicate substantial room for improvement across many municipalities of the peninsula. The study evaluates both efficiency (how well resources are used) and effectiveness (how

Figure 2.2: Italian Papers by type

well services meet targets). It found that when it comes to social services provision no clear trade-off between efficiency and effectiveness, meaning that improving one does not necessarily come at the cost of the other. Instead, efficiency and effectiveness are complementary, allowing municipalities to enhance both simultaneously. Northern Italian municipalities generally performing better than their Southern counterparts but also hat larger municipalities (in terms of population) tend to perform better in terms of both efficiency and effectiveness. However, the size of the municipality's territory has a negative impact on overall performance. Vidoli et al. (2023) investigates the optimal size of Italian municipalities for efficient social service delivery, considering spatial spillover effects and the endogeneity between service output and its cost. It aims to determine the cost efficiency of municipalities and how it is influenced by spatial and contextual factors. The average cost efficiency score for Italian municipalities was 61%, with a median score of 59%. Also several disparities from Southern and Northern municipalities were found. Frenda et al. (2021) aims to evaluate the technical efficiency of social protection expenditures across Italian regions investigating how efficiently regions utilize their resources to provide social protection services. They found an average efficiency score of 0.547.

In the following subsections a vertical analysis on papers focused on the Italian context will be conducted taking into consideration three levels of analysis: methodology, inputs/outputs variables and environmental factors they controlled for.

A. Global Perspective
Padovano & Ricciuti 2009, Piacentino & Vassallo 2011, Agasisti et al. 2015, lo Storto 2016a, D'Inverno 2018, Luca & Modrego 2021, Santolini 2020, Agasisti & Porcelli 2023, Perugini 2024
B. Particular Perspective
B.1 Environmental & Waste Management
Romano & Molinos-Senante 2020, Agovino et al. 2018, lo Storto 2016b, Lombardi et al. 2021, Fusco & Allegrini 2020, Ferraro et al. 2023, Romano et al. 2021
B.2 Tourism
Cuccia et al. 2016, Suzuki et al. 2011
B.3 Education
Agasisti et al. 2011, Sibiano & Agasisti 2013, Rella et al. 2024
B.4 Social Services
lo Storto 2020, Frenda et al.2021, Vidoli et al. 2023

Table 2.1: Italian studies on local government efficiency

2.1.2. Methodologies

In the literature, two main methodological families have been exploited to analyze efficiency in local government: non-parametric and parametric techniques (Narbón-Perpiñá & De Witte, 2018a).

Non-parametric Approaches

Among the first group, Data Envelopment Analysis (Charnes et al., 1978), hereafter **DEA**, and Free Disposal Hull (Deprins et al., 1984), hereafter FDH, are the most commonly used techniques given their flexibility and easiness in handling multiple inputs/outputs. Particularly, among the Italian studies analyzed, DEA is the most used technique, applied in several different variants. Piacentino and Vassallo (2011) uses DEA to construct production frontiers, allowing decomposition of labor productivity growth into several components: efficiency change as change in the distance from the best-practice frontier, technological progress as shifts in the production frontier and capital deepening as movements along the frontier due to changes in the level of physical capital. Suzuki et al. (2011) uses a DEA model that includes Euclidean Distance Minimization (EDM) and fixed input factors. This approach minimizes the distance between actual outcomes and the production pos-

sibility frontier, providing a weighted projection function for efficiency improvement. They also extend the DEA model to include fixed input factors that cannot be altered in the short term, such as natural and historical constraints. Agasisti et al. (2011) employs DEA and Malmquist Index to compute efficiency scores of university departments over time, utilizing both constant returns to scale (CRS) and variable returns to scale (VRS) models. Additionally, the Kruskal-Wallis test is employed to analyze the potential determinants of efficiency changes. Lo Storto (2016) employed multiple DEA models and Shannon's entropy index to measure ecological efficiency. Agovino et al. (2018) uses Moran's Index and Moran scatter-plots other than the usual DEA approach to test for spatial autocorrelation and identify spatial clusters. D'Inverno et al. (2018) uses a three-stage DEA-based approach complemented by Tobit regression analysis in order to control for contextual variables. First it runs an input-oriented DEA model with VRS to minimize input usage while maintaining output levels. Then, it runs multiple DEA models for each specific municipality service offered and it tries to combine them into one optimized weight. Romano and Molinos-Senante (2020) exploit a DEA Meta-frontier approach to calculate eco-efficiency scores considering both desirable and undesirable outputs. Also, they utilize non-parametric tests (Kruskal-Wallis and Mann-Whitney U Tests) to control for context variables. lo Storto (2020) employs Network DEA (NDEA) to evaluate the efficiency and effectiveness of social service provision by municipalities in two stages: initially utilizing financial resources to build infrastructure, and subsequently using this infrastructure to deliver social services. A Translog Production Function is then applied to explore the relationship between overall performance, efficiency, and effectiveness components, helping to detect any potential trade-offs between these aspects. Lombardi et al. (2021) uses DEA to measure the efficiency of urban waste systems, considering both CRS and VRS. Ferraro et al. (2023) uses two input-oriented DEA models to assess efficiency of Campania municipalities in delivering waste management services: the first for economic efficiency and the second jointly for economic and environmental performances. Finally, Rella et al. (2024) employs DEA and the Malmquist Productivity Index to evaluate the efficiency of Italian universities. An output-oriented DEA model with VRS is used to compare the input-output ratios of universities, while a Conditional DEA (C-DEA) incorporates the digitalization level of municipalities as an environmental variable.

DEA, like all non-parametric techniques, has inherent limitations in conducting

statistical inference and addressing the influence of outliers. To mitigate these challenges, many researchers-following the work of Simar and Wilson (1998), Simar and Wilson (2000), Simar and Wilson (2008)-have employed **bootstrapping methods** to enhance the robustness of their models.
For instance, Sibiano and Agasisti (2013) utilized a bootstrapped DEA to evaluate the efficiency of educational spending. This approach allowed them to generate statistically robust efficiency scores by accounting for random noise. Subsequently, they used a Tobit regression model to analyze the impact of contextual variables on these efficiency scores. Agasisti et al. (2016) employs bootstrap DEA to evaluate the cost efficiency of Italian municipalities, providing robust efficiency measures. The Second-Stage Truncated Regression analyzes the influence of environmental factors on efficiency scores, offering insights into how external variables impact performance. Then, a Jackknife Procedure is utilized to detect outliers in the dataset, ensuring that the efficiency estimates are robust and reliable. Additionally, the Malmquist Productivity Index measures productivity changes over time, considering both efficiency changes and technical progress, allowing for a comprehensive understanding of productivity dynamics. Cuccia et al. (2016) uses a two stage DEA approach where in the first stage, a bootstrapped DEA was used to calculate the technical efficiency scores of tourism destinations and then, in the second, the determinants of these were examined using semi-parametric regression. lo Storto (2016) uses DEAs with both CRS and VRS models and then runs a truncated regression analysis, with bootstrapped DEA scores as dependent variables, to study the relationship between context factors and indicators measuring the quality of public services. Finally, also Luca and Modrego (2021) assesses municipalities technical efficiency using DEA, particularly a Robust - DEA (R-DEA), with bootstrapping accounting for stochastic phenomena.

Parametric Approaches

The second family of techniques is the one represented by **parametric approaches.** Differently from DEA and FDH these techniques derive the efficiency frontier using a specific functional form based on econometric techniques (Narbón-Perpiñá & De Witte, 2018a). The most common technique in the parametric scenario is Stochastic Frontier Approach (SFA)(Aigner et al., 1977; Meeusen & Van den Broeck, 1977) which differently from non-parametric approaches not only identify of technical inefficiency but also the impact of the measurement error in the deviation

from the best practice frontier (Narbón-Perpiñá & De Witte, 2018a). Also environmental/contextual variables can be easily treated with SFA (Narbón-Perpiñá & De Witte, 2018a). Frenda et al. (2021) uses both DEA and SFA to leverage the strengths of each methodology while mitigating their individual limitations. Fusco and Allegrini (2020) extends SFA to account for spatial autocorrelation among residuals, separating the inefficiency component into inefficiency due to neighboring effects, specific inefficiency of the municipality, and a random error term. A Spatial Lag Model is then used to incorporate the influence of neighboring municipalities' efficiency into the analysis. Agasisti and Porcelli (2023) use a SFA to evaluate the efficiency of Italian municipalities. This method allows for the estimation of a cost function that incorporates both random noise, inefficiency components and control variables within it. Vidoli et al. (2023) employs SFA to estimate cost efficiency by considering spatial spillover effects and the endogeneity between output and costs, utilizing a panel model to capture the impact of neighboring municipalities on cost efficiency. Additionally, the Endogenous Frontier Approach models the U-shaped relationship between population size and cost efficiency, accounting for local supply and demand factors as well as latent variables that affect municipal performances. This combined methodology provides a comprehensive understanding of how population size and inter-municipal interdependence influence the cost efficiency of social service delivery.

A. Non-parametric & semiparametric approacches
A.1 DEA
Piacentino & Vassallo 2011, Suzuki et al. 2011, lo Storto 2016b, D'Inverno 2018, Agovino et al. 2018, Romano & Molinos-Senante 2020, lo Storto 2020, Lombardi et al. 2021, Ferraro et al. 2023, Rella et al. 2024
A.2 Bootstrapped DEA
Sibiano & Agasisti 2013, Agasisti et al. 2015, lo Storto 2016a, Cuccia et al. 2016, Luca & Modrego 2021
B. Parametric Approaches
SFA
Fusco & Allegrini 2020, Frenda et al. 2021, Vidoli et al. 2023, Agasisti & Porcelli 2023
C. Others
Padovano & Ricciuti 2009, Santolini 2020, Romano et al. 2021, Perugini 2024.

Table 2.2: Methodologies of Italian studies on local government efficiency

2.1.3. Input/Output variables

In addition to the different methodologies available, it is also important to address the issue of the selection of inputs and outputs. Indeed, in order to calculate the efficiency performance of a DMU, it is necessary to select measures that exhaustively represent the resources used to deliver public services and those that comprehensively represent the impact of their implementation. Since data availability is frequently an issue, the studies present high heterogeneity and various configurations of such variables, highly depending on the access to databases.

Input variables

For what concerns inputs, they could be classified in **financial** and **non-financial**.

Regarding the former, most of the Italian studies utilize the total expenditure as input metric. Luca and Modrego (2021) uses municipal expenditure retrieved from Opencivitas database. Particularly, it covers current expenditure, that is, spending on personnel, purchase of goods and services , passive interests incurred in the purchase/maintenance of fixed capital investments, current transfers, and depreciation. lo Storto (2016) retrieves data from OpenBilanci data bank including annual ex-

penditures relative to the provision of a number of basic services by municipalities: welfare services, territory and environment management, transports and roads, public education, culture, recreational activities, and sports and local (municipal) police. Similarly to lo Storto (2016) but excluding environmental management expenditure, D'Inverno et al. (2018) uses municipal balance sheets current expenditure, retrieved from Ministero degli Interni, covering various functions: general administration, social services, educational services, road maintenance and local mobility, and local police. In Agasisti and Porcelli (2023) data are collected from surveys conducted by SOSE S.P.A. (Società per gli Studi di Settore), an entity involved in economic and fiscal research, validated by the Technical Commission of the Ministry of Economy and Finance. The research regards five municipal functions: General Administration, Social Services, Educational Services, Road Maintenance & Local Mobility and Local Police excluding as in D'Inverno et al. (2018) Environmental & Waste management. Given this perimeter of analysis, the input variables included: total expenditure on administrative functions, expenditure on social assistance programs, expenditure on school-related activities, meals, and transportation, expenditure on maintaining public roads and local transport services and expenditure on public safety and police services. Ferraro et al. (2023) uses total annual costs per capita for managing urban hygiene services, including operating costs of unsorted waste, costs of managing separated waste collection, and common costs. Agasisti et al. (2016) input data includes General Administration Expenditures, which cover the costs associated with general administrative functions; Municipal and Administrative Police Expenditures, reflecting the costs related to local policing services; Waste Collection Expenditures, which encompass the costs of waste management services; and Road Network and Street Lighting Expenditures, which pertain to the costs of maintaining roads and street lighting. In its study on social services provision lo Storto (2020) uses costs associated with providing social services such as welfare, education, sport, and culture. In Rella et al. (2024) the input is the current expenditures of universities, including administration, personnel, and other services costs. The study by Frenda et al. (2021) uses health expenditure per inhabitant, municipality expenditure for social services per inhabitant, and expenditure for pensions per inhabitant.

Other than the total expenditure measure, some papers also use labor and capital costs. Fusco and Allegrini (2020) uses the total cost of waste management services,

derived from the final balance sheets of municipal governments, and the price of labor and capital, sourced from the private waste sector. Vidoli et al. (2023) uses several variables, including historical expenditure per capita, which represents the financial resources spent on social services, capital prices reflecting local costs associated with infrastructure and facilities, and the management type indicating the degree of cooperation between municipalities in service provision. Additionally, papers on Environmental and Waste management utilize the cost of waste among their inputs. Romano and Molinos-Senante (2020) includes the total cost of unsorted waste, total cost of recyclables, and other costs. Romano et al. (2021) includes the total cost of managing unsorted waste per capita, which encompasses expenses related to the collection, transport, disposal of unsorted waste, and other associated costs. Furthermore, it includes the total municipal costs of managing recycled waste per capita, covering the collection, transport, treatment, and recycling of sorted waste. Total assets of waste service providers, representing the financial value of the assets owned by these providers, is considered as well. Lombardi et al. (2021) uses the total cost per inhabitant, total cost per kilogram of waste collected, and total amount of waste collected (undesirable factor).

Finally, Santolini (2020) uses the speed of payments, the ratio of total current expenditure paid to total current expenditure committed within the financial year (retrieved from local public finance data from the Ministry of the Interior) as a dependent variable for its parametric model. Somehow this strategy emulates the DEA score found in other studies.

Regarding the second category of **non-financial inputs**, the variables used are highly related to the research question and very diverse. Piacentino and Vassallo (2011) uses the number of workers (Labour), private and augmented by public capital (Capital) and years of schooling and returns to education (Human Capital). Cuccia et al. (2016), in their study on tourism uses total accommodation capacity (hotels and other establishments) and tourist arrivals (in hotels and other establishments). Lo Storto (2016) uses non-discretionary inputs such as total population and land area. Sibiano and Agasisti (2013) uses the teacher-student ratio as the input variable, serving as a proxy for the resources invested in education. This ratio reflects the allocation of teaching resources across different regions. Suzuki et al. (2011) in their study on tourism use as input Data: Historical-Cultural Capital measured by

the number of museums, monuments, and archaeological sites standardized for the population; Human Capital measured by tourist school graduates divided by the working-age population; Labor Units as labor units employed in the tourism sector divided by the total regional labor force; and Length of Beaches as the total length of beaches per km^2 used as a fixed input.

Output variables

Shifting the focus on **output** variables there is definitely more heterogeneity since some studies aggregate various services (Global studies), while others evaluate a set of specific local services (Particular studies). Piacentino and Vassallo (2011) uses economic value-added by Italian regions as output. Luca and Modrego (2021) uses indicators measuring the level of goods and services delivered by each municipality across 12 key policy areas . lo Storto (2016) includes demographical and morphological variables such as the total resident population and municipality geographical area (territory surface). D'Inverno et al. (2018) uses a specific target population for each service: total population for general administration and social services, population aged 3-13 for educational services, population plus tourist presence for local police services and as exception for road maintenance and local mobility the length of roads has been used. In Agasisti and Porcelli (2023), various proxies were employed to represent the demand for different municipal services. Population size was used to gauge the demand for administrative services, while the number of individuals receiving assistance with social problems served as a proxy for social services. The demand for educational services was estimated through the number of students eligible for school meals, transportation, and extracurricular activities. Road maintenance and local mobility were represented by the length of roads and the combined total of the resident population and tourist presence. Finally, a composite indicator, reflecting the number of sanctions, complaints, and activities undertaken by local police, was used to assess the demand for local policing services. Cuccia et al. (2016) research about tourism used data about total nights stayed in hotels and other establishments. Still on tourism, Suzuki et al. (2011) uses Domestic Bed-Nights as the number of bed-nights by domestic tourists relative to the population, and International Bed-Nights as the number of bed-nights by international tourists relative to the population. Romano and Molinos-Senante (2020) comprises the amount of unsorted waste , considered as an undesirable output, and the amount of recyclable waste, considered as a desirable output. Romano et al. (2021) uses sorted munic-

ipal solid waste per capita, indicating the amount of recycled waste per capita as a desirable output, and unsorted municipal solid waste per capita, indicating the amount of unsorted waste per capita as an undesirable output. lLo Storto (2016) uses desirable outputs like depuration service coverage, differentiated waste collection, photovoltaic power, urban green space, public transportation demand, and Euro IV and V cars, and undesirable outputs including household water and energy consumption, non-differentiated waste, air pollution, and polluting cars. Lombardi et al. (2021) includes separate waste collected per inhabitant and total separate waste collected. In Fusco and Allegrini (2020) the output is represented by the tons of undifferentiated and differentiated waste collected, reflecting the total amount of waste handled by each municipality. Ferraro et al. (2023) uses kilograms of separated waste and unsorted waste per inhabitant. Agasisti et al. (2016) includes population size as a proxy for administrative service demand; municipal and administrative is represented by the distance covered yearly by police cars; waste collection is indicated by the quantity of waste collected; and road network and street lighting is measured by the kilometers of municipal roads.

In lo Storto (2020), the beneficiary outputs are measured by the number of individuals benefiting from these services, specifically focusing on unemployed persons, youth aged 0-19 years, and the elderly over 65 years. Additionally, infrastructure intermediate outputs are considered, which reflect the development level of social, educational, and sport/culture infrastructure, measured relative to the national average. Vidoli et al. (2023) uses a comprehensive measure of the range and intensity of social services provided, encompassing services for families, minors, disabled individuals, and seniors. Frenda et al. (2021) uses global spending on social protection, which includes total expenditure on health, pensions, and social welfare services. These variables are utilized to evaluate the efficiency of social protection expenditures across Italian regions. Sibiano and Agasisti (2013) uses the PISA 2009 mathematics scores, which represent the educational performance of students and serve as a measure of the effectiveness of the educational system in each region. Finally, in Rella et al. (2024) the output variables are the number of publications and patents, representing the universities' research activities and innovation.
A synthesized classification of input and output variables is provided in Appendix A.

2.1.4. Environmental/Contextual factors

In addition to the variables used as inputs/outputs to calculate efficiency scores, others are used to control for some **environmental/contextual factors** and see what happens to efficiency performances when this varies. Narbón-Perpiñá and De Witte (2018b) proposes a classification of these variables in six main categories:

1. Social and demographic
2. Economic
3. Geographical or natural
4. Political
5. Financial
6. Institutional or managerial

In many cases the effects of these variables on efficiency are ambiguous; this might be related to the data available for the study.

Regarding **social and demographic** variables, Luca and Modrego (2021) and Agasisti et al. (2016) finds that population density has a positive but small correlation with municipal efficiency, indicating that denser areas might experience some economies of scale in service provision, but this effect is limited, indeed lo Storto (2016), Agasisti and Porcelli (2023) and D'Inverno et al. (2018) shows that population density did not show a statistically significant relationship with municipal efficiency. Romano and Molinos-Senante (2020) finds that population density positively affects eco-efficiency. Lombardi et al. (2021) finds that urban waste management efficiency is higher in more densely populated towns. Then, larger population size municipalities tend to be more efficient, supporting the idea of economies of scale (D'Inverno et al., 2018; Fusco & Allegrini, 2020; Suzuki et al., 2011; lo Storto, 2020). On the other hand,Agasisti and Porcelli (2023) and Vidoli et al. (2023) identifies a U-shaped relationship between population size and efficiency, with medium-sized municipalities (around 10,000 inhabitants) being the most efficient with both very small and very large municipalities showing significant inefficiencies compared to medium-sized municipalities (respectively due to higher per capita costs and limited administrative capacity lead to inefficiencies and increased complexity, congestion,

and bureaucratic inefficiencies offset the benefits of larger size, leading to higher per capita costs and lower efficiency). Also, Santolini (2020) finds that larger populations can benefit from economies of scale but also face congestion effects. Perugini (2024) argues that the positive impact of government efficiency on income growth diminishes as municipal population size increases. For what concerns waste management, Romano and Molinos-Senante (2020) and Romano et al. (2021) finds that larger populations are more eco-efficient but also that municipalities with smaller areas are better. Furthermore, lo Storto (2020) finds that larger areas are related to higher efficiency in delivering social services . Higher levels of education among the population are associated with slightly higher municipal efficiency. Educated populations may demand better governance and are more likely to engage in civic activities that promote efficient administration (Luca & Modrego, 2021) .The presence of organized crime, measured by the local mafia index in Luca and Modrego (2021), negatively impacts municipal efficiency. lo Storto (2016) argues that a higher number of micro-crimes per inhabitant is associated with higher efficiency scores. Furthermore, Cuccia et al. (2016) argues that higher levels of petty crime negatively impact the technical efficiency of tourism destinations. Also, higher vehicle density as well as a higher number of car accidents is associated with lower efficiency (Agasisti & Porcelli, 2023). A higher percentage of young residents (age distribution) correlates with higher efficiency and, in a specular way, a higher percentage of elderly residents correlates with lower efficiency (Agasisti & Porcelli, 2023; Agasisti et al., 2016), being true also for eco-efficiency measures (Romano & Molinos-Senante, 2020). Lombardi et al. (2021), though, finds that urban waste management efficiency is higher in higher elderly population towns but the proportion of elderly residents influences the demand for social services and related costs (Vidoli et al., 2023) .Romano and Molinos-Senante (2020) controlled for Gender Ratio not finding any significant result. Higher numbers of incoming commuters correlate with lower efficiency because transient populations increase service demands and costs, reducing efficiency (Agasisti & Porcelli, 2023). Higher property tax rates are associated with higher efficiency (Agasisti & Porcelli, 2023). A Higher percentage of foreign residents generally had a positive impact on cost efficiency in delivering social services (Agasisti & Porcelli, 2023). Sibiano and Agasisti (2013) finds that a higher proportion of disabled students has a significant negative impact on public education spending efficiency.

Continuing on **economic determinants**, higher unemployment rates generally correlate with lower municipal efficiency, as economic hardship can strain municipal resources and increase the demand for social services (Luca & Modrego, 2021). Also, Perugini (2024) found that unemployment has a negative and significant impact on income growth. There is a negative relationship between value added per inhabitant and efficiency score for municipalities (lo Storto, 2016; D'Inverno et al., 2018) also Romano and Molinos-Senante (2020) controlled for income per capita not finding any significant relationship but Romano et al. (2021) finds that greater income per capita might positively affect eco-efficiency performance. Higher income levels are associated with better performance, suggesting that wealthier municipalities can allocate more resources effectively to social services (lo Storto, 2016). Sibiano and Agasisti (2013) finds that regions with higher GDP per capita tend to have higher efficiency scores in educational spending. Municipalities with high levels of tourism tend to be less efficient, possibly due to the additional costs and seasonal fluctuations in service demand (D'Inverno et al., 2018) and this is true also for their eco-efficiency performance (Romano & Molinos-Senante, 2020; Romano et al., 2021). Higher numbers of workers in tourism correlate with lower efficiency (Agasisti & Porcelli, 2023) as well as higher economic deprivation (Agasisti & Porcelli, 2023). Also, municipalities with higher deprivation levels had greater social service needs and costs, highlighting the role of socio-economic conditions in influencing municipal performance (Vidoli et al., 2023) . In lo Storto (2016) the development of social infrastructure did not show a significant relationship with municipal efficiency, higher education infrastructure development shows a positive correlation but cultural and sport infrastructure show a negative one. Higher infrastructure investments correlate with higher efficiency (Agasisti & Porcelli, 2023; Agasisti et al., 2016) also Cuccia et al. (2016) find that well-developed transportation infrastructure positively influences the technical efficiency of tourism destinations.

On **geographical or natural** determinants, altitude does not affect efficiency (Luca & Modrego, 2021). Mountainous municipalities are less efficient, likely due to higher costs and logistical challenges in service provision (D'Inverno et al., 2018; Agasisti & Porcelli, 2023). Municipalities in earthquake-prone areas exhibit lower efficiency (Agasisti & Porcelli, 2023; Agasisti et al., 2016) while coastal zones municipalities do not seem to be less efficient (Agasisti & Porcelli, 2023). Geographical location is

an important factor to consider, Perugini (2024) finds that government efficiency is more pronounced in southern municipalities compared to those in the North-Centre and that efficiency improvements have a larger positive impact in more peripheral areas compared to urban poles. Lombardi et al. (2021) and Fusco and Allegrini (2020) also observed higher efficiency in Northern and Central towns compared to Southern and Island towns when it comes to waste management services. On the other hand, lo Storto (2020) and Vidoli et al. (2023) find that social services efficiency in central, southern, and island municipalities perform better than those in the North, potentially due to different socio-economic and administrative conditions. Cuccia et al. (2016) control for kilometers of beaches and the presence of protected natural areas, finding that they both positively affect the tourism related technical efficiency, Suzuki et al. (2011) finds the same controlling for coastal areas. Also, the presence of UNESCO World Heritage Sites, both in absolute terms and weighted by years of inscription, negatively impacts the technical efficiency of tourism destinations (Cuccia et al., 2016).

With regards to **political** determinants, election cycles, controlled by Luca and Modrego (2021), but also by Agasisti and Porcelli (2023), do not drive efficiency changes significantly but Santolini (2020) finds that municipalities increase their expenses compared to budgeted ones during election years to signal better performance to voters. Municipal administrations in their second term are more efficient, possibly because they do not face re-election pressures and can focus on optimizing expenditures (D'Inverno et al., 2018; Agasisti & Porcelli, 2023). Political orientation (Right/Left wing) does not significantly affect efficiency (Agasisti & Porcelli, 2023) but Agasisti et al. (2016) finds that center-left coalition in Lombardy shows greater efficiency. Agasisti and Porcelli (2023) also controlled for the gender of the mayor without finding any significant evidence. At a regional level Padovano and Ricciuti (2009) finds that higher political competition leads to higher regional per capita income, indicating improved economic performance but also reduces total regional spending, indicating more efficient resource use.

Moving to **financial** determinants, Lombardi et al. (2021) finds a negative correlation between efficiency and the average waste tariff. Higher tariffs are associated with lower efficiency, indicating that higher costs do not necessarily translate into

better performance.

Finally, considering **institutional and managerial** determinants, municipalities in regions with better governance practices (i.e. Emilia-Romagna) tend to be more efficient (Luca & Modrego, 2021) . Higher percentages of differentiated waste collection correlate with higher efficiency (Agasisti & Porcelli, 2023) but also municipalities with more waste management plants are more efficient (Agasisti & Porcelli, 2023; Fusco & Allegrini, 2020) also having greater distances from landfill sites might implicate cost inefficiencies (Fusco & Allegrini, 2020). Direct provision of school meals is associated with higher efficiency (Agasisti & Porcelli, 2023). Lombardi et al. (2021) controls for the waste collection method (service delivery method) finding that door-to-door collection methods are associated with higher efficiency scores compared to street-bin systems. This method improves the quality and quantity of recyclable waste collected and fosters better waste management practices among residents. Also Romano et al. (2021) control for waste service providers ownership not finding any significant difference between public or private companies. Agasisti et al. (2016) finds there is a negative impact in outsourcing activities to external companies. In conclusion, Rella et al. (2024) controls for the digitalization level of municipalities using the Smart Technologies Index which they computed through a questionnaire. A synthesized classification of contextual variables can be found in Appendix A.

2.2. Quality of Life and local government efficiency performance

The second topic which will be discussed in this literature review is the theme of Quality of Life and how it is linked with local government performance. This is fundamental to this study for two main reasons: first, it helps understand what are the most common variables/indicators used to measure and assess QoL (2.2.1). Then, it defines the state of the art of the research question guiding the study (2.2.2).

2.2.1. How do you measure Quality of Life

Quality of Life is a multi-faceted concept that is difficult to measure as it includes various aspects of well-being related to economic, environmental, and social dimensions of life (Bigerna & Polinori, 2014). The main approach to assess QoL in a place or region is to synthesize these elements into a comprehensive QoL score or index, allowing different areas and aspects to be compared on a common scale. Several studies have tried to tackle this challenge in an empirical way. Many of these researches employ DEA as in the efficiency case for its ability to handle multiple inputs and outputs without requiring a pre-specified functional form. In these studies, the input and output variables are carefully chosen to represent both the negative and positive factors influencing QoL in municipalities.
Inputs typically encompass variables that reflect challenges or costs, such as pollution, noise, limited green spaces, commuting time, and personal insecurity. These variables are termed "unfavorable factors" because reducing them is expected to lead to improvements in QoL. Conversely, outputs are indicators of the benefits or achievements within a municipality, including the availability and quality of healthcare and education, socio-economic conditions, and housing quality. These are referred to as "positive factors," as higher levels or better conditions in these areas are indicative of a higher QoL for residents.

The research approaches can be categorized into two orientations: input-oriented studies, which aim to minimize unfavorable factors, and output-oriented studies, which focus on maximizing favorable ones. Each orientation offers a distinct perspective on how to enhance the overall Quality of Life within a given municipality.

Royuela et al. (2003) incorporates a wide range of indicators to assess QoL in

Barcelona municipalities, grouping them into three main components: Individual Opportunities for Progress, Index of Social Equilibrium , and Community Conditions of Life. These components collectively consider factors such as wealth, education, health, social services, and community infrastructure. Murias et al. (2006) utilizes DEA to craft an Economic Wellbeing Index for Spanish provinces which incorporates a range of variables to measure economic prosperity. The input variables, which the provinces aim to minimize, include the Gini index (indicating income inequality), the percentage of the population with minimum incomes (reflecting economic deprivation), and the unemployment rate (indicating economic insecurity). The output variables instead, which the provinces aim to maximize, include gross disposable income per capita, average size of dwellings (as a proxy for real consumption capacity), the stock of total net capital per capita, the stock of human capital (measured by the percentage of the population with tertiary education), and the percentage of long-term or indefinite employment contracts, representing job security.
Jurado and Perez-Mayo (2012) employs a multidimensional approach to construct a well-being index for Spanish Autonomous Communities, using DEA. Input variables include factors that potentially reduce well-being, such as economic security risks (e.g., risk of illness, poverty rate over 65, unemployment rate) and measures of equity like the Gini index and poverty index . The output variables instead represent desirable outcomes, including adjusted consumption (private and public), life expectancy, real wealth (physical capital, human capital, R&D expenditure), and environmental protection efforts.
Hashimoto et al. (2009) analyzes shifts in Quality of Life across Japan's 47 prefectures over the period from 1975 to 2002 using DEA and the Malmquist index to measure changes over time in QoL. DEA Inputs are negative social indicators and outputs are positive social indicators. Particularly, suicide rates and hospital beds per capita (health), crime rates and traffic accidents (safety), bankruptcy rates and per capita income (economy), water quality and sewage coverage (Environment).
Following this approach, González-Consuegra and Verdú (2011) investigate the QoL in Spanish municipalities by constructing a comparison frontier from the best municipalities observed, using DEA and Value Efficiency Analysis (VEA). They use input indicators that represent drawbacks or negative aspects of living in a municipality (e.g., unemployment rate, pollution, crime, poor transportation) and as output indicators that represent advantages or positive aspects (e.g., health facilities, education levels, cultural facilities, socio-economic conditions). Also, they control for environ-

mental factors such as population density, growth, aging, socio-economic conditions, purchasing power, health facilities, education levels, cultural and leisure facilities, environmental quality, security, and transport conditions. They find that education is identified as the variable requiring the largest improvement in low-performing municipalities, followed by health and culture facilities, pollution, and crime. Higher population density, growth, and aging are positively related to QoL.
Likewise, González et al. (2018) developed a composite indicator of QoL for Spanish municipalities by employing DEA with weight constraints to enhance robustness and consistency while Martín and Mendoza (2013) focus on measuring QoL in Canary Island municipalities, considering both positive and negative factors again using DEA as statistical tool. González et al. (2018) use as main variables sixteen indicators covering eight dimensions of QoL: material living conditions, health, education, environment, economic and physical safety, governance and political voice, social interaction, and personal activities. On the other hand, Martín and Mendoza (2013) use as inputs unfavorable factors , including commuting time, lack of parks, bad communications, pollution, external noise, lack of cleanliness, delinquency and vandalism, and unemployment rate. As outputs positive factors , including health facilities, social care facilities, cultural and sports facilities, education facilities, average education level, post-compulsory education, university studies, socio-economic condition, average area per occupant, physical conditions of dwellings, and the weight of the tertiary sector.

2.2.2. The relationship between local government efficiency and QoL

The literature cited above limited their effort in creating QoL scores exploiting DEA to properly compare different areas under different aspects. Few other studies, though, try to see if there is any kind of trade-off between local government efficiency in managing its resources and effectiveness in delivering value to citizens and to improve their Quality of Life.
Bigerna and Polinori (2014) found there is a significant relationship between the efficiency of local governments and the QoL experienced by citizens in Italian Municipalities. An efficient resource management by local governments correlates with higher QoL standards. Although they use data from Legambiente, which uses mainly environment related variables excluding other important factors in QoL. Particularly,

they explore this using a two stage model where in the I stage a DEA uses as inputs the total costs including all expenses listed in municipal budgets for the provision of public services related to QoL. As outputs both desirable and undesirable factors: wastewater treatment, separate waste collection, green areas, pedestrian areas, air quality monitoring stations, elderly population, daycare centers, waste production, NO2 concentration in water, water waste, air pollutants, mortality crime and building abuses. In the second stage then they search for any eventual correlation with environmental variables: electricity consumption, water consumption, fiscal autonomy, total fiscal revenue, population density, average altitude , unemployment rate , education level , political alignment with the region , government coalition fragmentation and mayor's second term. Also, lo Storto (2016) indirectly evaluates the cost efficiency of major Italian municipalities and investigates whether there is an association between efficiency and the quality of public services provided, which can be linked to the Quality of Life of residents, controlling in the II stage of his study for some variables proxying QoL measures (e.g. indices of social infrastructure development, public education infrastructure development, cultural and sport infrastructure development). He finds that there exists a trade-off between technical efficiency and the quality of some public services such as public transportation, cultural facilities. Higher efficiency is associated with lower quality in these services, which can negatively impact QoL. lo Storto (2020), somehow study the relationship between QoL and efficiency, finding that in the delivering of social services in Italy, efficiency and effectiveness are preconditions for each other rather than being in conflict. Higher performance can be achieved without sacrificing either component. Differently, DDoumpos et al. (2020) not only created for French municipalities a multidimensional QoL composite indicator but also further explored the relationship between QoL performance and the financial strength of municipalities. Particularly, financial aspects, such as the municipalities revenues, grants received by the central government as well as taxes were found to be strongly related to the QoL performance for French municipalities. In conclusion, Cárcaba et al. (2022) finds that in Spain municipalities government efficiency is positively and significantly associated with subjective well-being (SWB). Citizens in well-managed municipalities report higher levels of happiness. A comprehensive catalog of papers on Quality of Life and local government efficiency is available in Appendix A.

2.3. Main literature trends & gaps

This literature review tried to highlight the main trends and ways to compute local government efficiency and what are the main possibilities to measure citizens Quality of Life through a synthetic indicator.

For what concerns the first, there are several studies which analyze efficiency of a particular local government services but they do not show a specific trend in the ways they compute them. This is reasonable considering the variability of type of services local government provide in their mix. In the other hand, global perspective studies follow some kind of trend. The majority of them utilize DEA as main econometric tool to compute scores (few papers utilize bootstrapped DEA). Also in the most common input utilized is total expenses, either cumulated or divided by category. This is different for the output used which ranged for simple, Area and Population like in llo Storto (2016), till very specific service related specifics like in Luca and Modrego (2021), Vidoli et al. (2023) and AAgasisti and Porcelli (2023). Apart from the methodological issues, variable used and controlled for, scholars found that generally Northern-Central local governments tend to be more efficient than Southern one even if there are some exceptions (like lo Storto (2016) which finds the opposite). Also, they did not find any precise trend on scale effects. Indeed, almost all the studies find there are economies of scale in small municipalities but these usually become congestion effects when the size of the local government increases to much.

For what concern Quality of Life assessment, all the paper examined tried to create a synthetic indicator in order to grasp many aspect of Quality of Life. Just few studies deepened the study on the relationship between local government efficiency and citizens Quality of Life. Bigerna and Polinori (2014) found a positive correlation between efficient resource management by local governments and higher QoL, their study though utilize variable related to environmental and waste management services. Furthermore, lo Storto (2016) highlighted a potential trade-off between technical efficiency and the quality of certain public services, such as public transportation and cultural activities, suggesting that while efficiency increases, the quality of these services may decrease, negatively affecting QoL. DDoumpos et al. (2020) added that financial strength, including revenues and government grants,

significantly influences QoL, particularly in French municipalities. Furthermore, Cárcaba et al. (2022) demonstrated that government efficiency is positively associated with subjective well-being, as citizens in well-managed municipalities tend to report higher happiness levels. These studies indicate a complex interplay between efficiency and QoL, influenced by both financial and service quality considerations.

2.3.1. Innovative steps

The previous section (2.1, 2.2) showed that not only there exists significant literature on the theme of local government efficiency measurement, in Italy and abroad, but also that the field of research in the last twenty years have deeply investigated empirical methods to assess Quality of Life across different areas and dimensions. Despite this though, several gaps remain in the literature especially when it comes to the relationship between local government efficiency and citizens Quality of Life. This paper tries to identify these gaps and proposes a few innovative steps to deepen the understanding of how local government performance is related to QoL in the Italian local government context. These insights might then be used to support a effective policy-making that enhances both governmental efficiency and citizen well-being. Particularly, it provides a **three-fold contribution to the literature**.

First it provides **a comprehensive literature review** on Italian studies on local government technical efficiency. Particularly, papers have been analyzed following the Narbón-Perpiñá and De Witte (2018a) adn Narbón-Perpiñá and De Witte (2018b) guidelines additionally focusing not only on global perspective papers tackling more than one services but also on particular services, comprehending Environmental & Waste Management, Education, Social Services, Public transportation and Culture, Sport & Leisure.

From a **data management** viewpoint, it uses new variables to measure Quality of Life, and relates it to local government efficiency, trying to represent it in a much more comprehensive way. Indeed, it tackles not only dimensions related to Environmental & Waste Management services like in Bigerna and Polinori (2014) or in llo Storto (2020) with Social services ones but also to other QoL dimensions: Wealth and consumption, Business and work, Environment and Waste management

services, Demographics, society, and health, Justice and security and Culture and leisure. As of today, there is no Italian paper connecting local government efficiency with such an amount of indicators reflecting different QoL measures. Moreover, it builds up on the literature in the way it aggregates financial data from local government balance sheets, aggregating municipalities expenses at the provincial level. Additionally, this study assesses whether using only the capital city's municipality as a proxy, as suggested by Bigerna and Polinori (2014), provides a reasonable approximation.

Finally, it introduces an **innovative methodology** based on three stages. First, it exploit a bootstrapped DEA to compute technical efficiency scores in a basic way, following lo lo Storto (2016), and then in much more complex one following the variable utilization of Agasisti and Porcelli (2023). Then, in the second stage, QoL is assessed through two separate bootstrapped DEAs, one considering the totality of QOL aspects cited above and one only considering variables where local governments have a direct impact on. Finally, in the last stage linear regression models are used to study the correlation between these scores and see what factors might affect the relationship between local government efficiency and citizens QoL. In the following chapters the methodology, framework and results of this steps will be discussed.

3 | Methodology

Following the comprehensive review of the literature discussed in the preceding pages, the next three chapters aim to deeply describe the methodology adopted and the conceptual framework developed for this paper and how these fill the literature gaps described in the previous subsection.

In order to facilitate an accurate interpretation of both the conceptual framework and the results, it is essential to gain a comprehensive understanding of the methodology employed to calculate efficiency and Quality of Life scores. This necessitates an examination of the mathematical models that have been utilized, a process which will be addressed in these sub-chapters.

3.1. Data Envelopment Analysis

As largely discussed in the literature review, one of the most used methods is the Data Envelopment Analysis (DEA), which is highly effective for evaluating the cost efficiency of local governments and assessing the Quality of Life of their populations for several reasons.

DEA is a technique used to measure the efficiency of various entities, such as companies, schools, hospitals, etc. and can help to assess who is producing or obtaining the most possible from its resources.
Given a population of Decision-Making Unit (DMU), the DEA method calculates an efficiency score for each of them by comparing the use of resources (inputs) with the outcomes achieved (outputs). A DMU is considered efficient if, given the resources at its disposal, it achieves the best possible results relative to other units. Through the model implementation, a "efficiency frontier" is constructed, representing an optimal

combination of inputs and outputs. DMUs located on this frontier can be defined efficient, while those below the frontier have the potential to improve their efficiency.

3.1.1. DEA General Model

Delving into the theoretical model synthetically explained Anderson (2003) a key assumption underlying Data Envelopment Analysis (DEA) is convexity. Specifically, we assume that if a particular DMU, denoted as Producer A, can generate $Y(A)$ units of output using $X(A)$ inputs, then other producers, when operating efficiently, should also be able to achieve the same level of output with the same input configuration. Similarly, if Producer B can produce $Y(B)$ units of output with $X(B)$ inputs, it is expected that other producers should be capable of replicating this production process under efficient conditions.
The principle of convexity further suggests that we can construct a composite or virtual producer by taking a weighted combination of Producers A and B (as well as potentially other producers). This composite producer would have composite inputs and composite outputs derived from the weighted mix. Importantly, this virtual producer does not represent a real entity but rather a hypothetical construct used to model the efficiency frontier in DEA.
The analysis focuses in finding the "best" virtual producer for each real producer. If the virtual producer is better than the original producer by either making more outputs with the same inputs or making the same outputs with less inputs then the original producer is **inefficient**.
The procedure of finding the best virtual producer can be formulated as a linear program.
Given n DMU to study, DEA comprehends a set of n linear programming (LP) problems to solve.

Standard formulation

$$\begin{aligned} \min_{\theta,\lambda} \quad & \theta, \\ \text{s.t.} \quad & Y\lambda \geq Y_0, \\ & X\lambda \leq \theta X_0, \\ & \lambda \geq 0. \end{aligned} \tag{3.1}$$

Where:

- λ vector describes the components of other producers used to construct the virtual producer.
- θ are the efficiency scores.
- The matrices X and Y describe the virtual inputs and outputs, respectively.
- The vectors X_0 and Y_0 are the input and output vectors for the DMU currently being examined.

Another important factor to consider when dealing with DEA its oriented which could be input or output based.

3.1.2. Input vs Output-oriented models

It is important to highlight that second constraint in the linear model 3.1 above computes how much less input the virtual DMU would need to produce that output if it was efficient. For this reason, this type of model it is called input-oriented.

E.g. Taking in consideration two students that have to study several pages (output) in given time (input): Alice and Bob with θ score equals to 1 and 0.83 respectively. This means that Alice is on the efficiency frontier and can be considered efficient. On the other hand, Bob is not: to be considered efficient he should be able to achieve the same amount of output with the 83% of the inputs he used.

If, referring to the example above, we would like to compute how much Bob should have produced with the given input, different equations would be required: an output

oriented model.

$$\begin{aligned} \max_{\phi,\lambda} \quad & \phi, \\ \text{s.t.} \quad & Y\lambda \geq \phi Y_0, \\ & X\lambda \leq X_0, \\ & \lambda \geq 0. \end{aligned} \tag{3.2}$$

If the assumption of **constant return to scale** (CRS) is in place, it is true that $\theta = 1/\phi$

The model that better suits a research only depends on the problem design and whether a DMU aims to reduce input while achieving the same level of output or emphasizes producing more output given the same level of input. Depending on the linear program formulation, an output-oriented efficiency will be 1.0 or higher: scores greater than 1.0 indicate inefficiency. For instance, an output-oriented score of 1.5 (or 150%) indicates that a DMU should be able to increase output by 50% while consuming the same input. (Technically, it means that a DMU should be able to produce at least 50% more of each output while using no more of any input than is currently being used.)

3.1.3. Return to scale

Returns to scale refers to increasing or decreasing efficiency based on size.

A constant returns to scale (CRS, also known as CCR after Charnes, Cooper, Rhodes in Charnes et al. (1978)) means that the DMU are able to linearly scale the inputs and outputs without increasing or decreasing efficiency, but this assumption does not always match the reality, which includes other types of return to scale:

- **Incresing Returns to Scale IRS:** which means that efficiency is always positively impacted by the increasing of inputs and outputs.
- **Decreasing Returns to Scale DRS:** which means that efficiency is always negatively impacted by the increasing of inputs and outputs.
- **Variable Returns to Scale VRS:** combines the two extreme cases cited above

In term of mathematical formulation, the VRS model which is in literature often cited as the BCC model (after Banker, Charnes, and Cooper in Banker et al. (1984)) can be obtained by adding a constraint that impose the sum of the λ variables be equal to 1.

$$\vec{1} \cdot \lambda = 1$$

3.1.4. Strengths and limitations

DEA's ability to analyze multiple inputs and outputs simultaneously makes it ideal for assessing complex entities like local governments, where various resources and services must be considered. Furthermore, DEA not only measures efficiency but also identifies the "best practice" units, providing benchmarks for under-performing DMUs and information about how much is the distance from the best case scenario within the population.

Nevertheless, the same characteristics that make DEA a powerful tool can also create problems: DEA is good at estimating "relative" efficiency of a DMU, but it converges very slowly to "true" efficiency. In other words, it can tell you how well you are doing compared to your peers but not compared to a "theoretical maximum." Moreover, since DEA is an extreme point technique, results are extremely influenced by the used sample and noise (even symmetrical noise with zero mean) such as measurement error can cause several problems.

Input-Oriented	**Output-Oriented**
$\begin{aligned} \min_{\theta,\lambda} \quad & \theta, \\ \text{s.t.} \quad & Y\lambda \geq Y_0, \\ & X\lambda \leq \theta X_0, \\ & \lambda \geq 0. \end{aligned}$	$\begin{aligned} \max_{\phi,\lambda} \quad & \phi, \\ \text{s.t.} \quad & Y\lambda \geq \phi Y_0, \\ & X\lambda \leq X_0, \\ & \lambda \geq 0. \end{aligned}$
Output fixed, provides information about input usage efficiency	Input fixed, provides information about output production efficiency

Table 3.1: DEA model comparison

3.1.5. Bootstrapped DEA

Regarding DEA, one significant problem to consider is the sensitivity of efficiency scores to the specific sample data used. Given that DEA efficiency scores are calculated relative to an estimated production frontier based on finite samples, these scores can vary significantly depending on the sample, leading to potential instability and lack of robustness in the results.

Bootstrap methods provide a statistical framework to address the inherent sampling variability in DEA. The bootstrap is a resampling technique that allows to estimate the distribution of an estimator by repeatedly resampling with replacement from the original data. In the context of DEA, applying bootstrap techniques helps in generating confidence intervals for efficiency scores, correcting biases, and performing hypothesis testing with greater statistical rigor.

In practice, it involves three main steps:

- **Resampling**: Generate multiple bootstrap samples by resampling with replacement from the original dataset of DMUs.
- **Re-computation**: For each bootstrap sample, recalculate the DEA efficiency scores using the same DEA model.
- **Analysis**: Analyze the distribution of these bootstrapped efficiency scores to estimate confidence intervals, correct biases, and conduct hypothesis tests.

This process allows us to approximate the sampling distribution of DEA efficiency scores and to make inferences about the true efficiency of DMUs with greater confidence. The bootstrap approach thus enhances the reliability of DEA by accounting for the uncertainty inherent in finite sample data, offering a more nuanced understanding of efficiency and performance.

3.2. Linear regression

3.2.1. Mathematical overview

A linear regression is a statistical model that estimates the linear relationship between a dependent variable and one ore more independent variables also known as regressors. A linear regression can be either simple or multiple depending if it in-

cludes respectively one or more regressors, considering the latter case it is possible to formulate the following equation:

$$y_i = \beta_0 + \beta_1 x_{i1} + \cdots + \beta_p x_{ip} + \varepsilon_i, \quad i = 1, \ldots, n,$$

These n equations can be also summarized as follows:

$$\mathbf{y} = \mathbf{X}\boldsymbol{\beta} + \boldsymbol{\varepsilon}$$

where:

- $\mathbf{y}$ $(n \times 1)$ is the vector of the observed values y_i, representing the dependent or target variable. The choice of y_i is typically based on the assumption that its values are influenced or caused by the independent variables.
- $\mathbf{X}$ $(n \times (p+1))$, known as the design matrix, contains the row vectors $\mathbf{x}_i^T$, where each row includes the independent variables (or regressors) for each observation. The first column of $\mathbf{X}$ is often filled with ones to account for the intercept term β_0.
- $\boldsymbol{\beta}$ $((p+1) \times 1)$, is the parameter vector of regression coefficients, where β_0 represents the intercept term. If no intercept is included in the model, this vector becomes $p \times 1$ dimensional.
- $\boldsymbol{\varepsilon}$ $(n \times 1)$ is the error (or residual) vector, representing the difference between the observed values $\mathbf{y}$ and the predicted values from the model. These residuals capture the unexplained variance in the model.

3.2.2. Applications and interpretation

Linear regressions have many practical applications, primarily related to prediction, forecasting, or understanding the relationships between dependent and independent variables. For each independent variable, a p-value is obtained through a t-test, which tests the null hypothesis that the corresponding β-coefficient is zero. A small p-value suggests that the predictor is statistically significant.

The R^2 and adjusted R^2 measure how much of the variance in the dependent variable is explained by the model, with adjusted R^2 accounting for the number of predictors.

The p-value from the F-test evaluates whether the model explains significantly more variance than a model with no predictors.

The values of the β-coefficients indicate the direction and magnitude of the relationship between each independent variable and the target variable y. A positive β-coefficient suggests a direct relationship, while a negative β suggests an inverse relationship. The magnitude of β reflects the strength of this influence.

3.3. The t-test

The t-test is a statistical tool used to determine whether a significant difference between the means of one or two groups is present. In addition to its general applications, as mentioned above, the t-test is also integral in the context of linear regression for assessing the significance of each regressor. Below, a brief introduction of both general forms and specific role in a linear model is reported.

One-sample t-test

The one-sample t-test, used to test if $\bar{x}$, which is the mean of a sample, is significantly different from a hypothesized population mean μ_0. The t-statistic is calculated as follows:

$$t = \frac{\bar{x} - \mu_0}{\frac{s}{\sqrt{n}}},$$

where:

- $\bar{x}$ is the sample mean,
- μ_0 is the population mean under the null hypothesis,
- s is the sample standard deviation, and
- n is the sample size.

The t-statistic follows a t-distribution with $n - 1$ degrees of freedom, and a corresponding p-value is obtained to assess whether the difference from μ_0 is statistically significant, as with a low p-value it is possible to reject the null hypothesis, therefore suggesting that the sample mean is significantly different from the population mean.

Two-sample t-test

The two-sample t-test, as noted, compares the means of two independent groups. The t-statistic for this test is computed as:

$$t = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}},$$

where:

- $\bar{x}_1$ and $\bar{x}_2$ are the sample means of the two groups,
- s_1^2 and s_2^2 are the sample variances,
- n_1 and n_2 are the sample sizes.

The degrees of freedom are $n_1 + n_2 - 2$, and the resulting p-value, coherently with the previous case, determines whether the difference between the group means is statistically significant.

Paired t-test

The paired t-test is used when two samples are related or paired, as in pre- and post-treatment measurements on the same subjects. In this case, we test whether the mean difference between the paired observations is significantly different from zero. The t-statistic is given by:

$$t = \frac{\bar{d}}{\frac{s_d}{\sqrt{n}}},$$

where:

- $\bar{d}$ is the mean of the differences between paired observations,
- s_d is the standard deviation of the differences, and
- n is the number of paired observations.

This test follows a t-distribution with $n - 1$ degrees of freedom. A low p-value suggests that the mean difference is significant, providing evidence that there is a systematic difference between the two sets of paired measurements.

T-test in a linear model

In the context of linear regression, the t-test is applied to assess whether each regression coefficient β_j is significantly different from zero, which would indicate that the corresponding independent variable x_j has a statistically significant effect on the dependent variable y.

The t-statistic for each coefficient is computed as:

$$t_j = \frac{\hat{\beta}_j}{\mathrm{SE}(\hat{\beta}_j)},$$

where:

- $\hat{\beta}_j$ is the estimated value of the regression coefficient,
- $\mathrm{SE}(\hat{\beta}_j)$ is the standard error of $\hat{\beta}_j$.

This t-statistic follows a t-distribution with $n - (p + 1)$ degrees of freedom, where n is the number of observations and $p + 1$ is the number of estimated parameters, including the intercept. A small p-value (typically less than 0.05) suggests that the variable x_j is a significant predictor of y.

In summary, while the t-test is widely used in many contexts, its role in linear regression is crucial for identifying which independent variables contribute significantly to the model.

4 | Data usage and overview

To properly employ the statistical tools presented above is fundamental to build an exhaustive and well constructed research framework. Before delving into the detailed structure of the model, it is essential to specify the granularity of analysis, the type of data selected, and some assumptions made during the framework design.

4.1. Data description and sources

As comprehensively discussed above, this thesis wants to study the interaction and possible correlation between the efficiency of local governments in Italy and the Quality of Life experienced by their citizens. Given the nature of this research, is clear that data of different type and thus from different sources were needed to cover both sides of the study.
Particularly, they can be divided in three main clusters:

1. **Financial data** about expenditures of the DMUs of our study, taking in consideration the cash flow statement to assess the actual utilization of resources over the period. These data have been downloaded from OpenBilanci.it[1] which gathers data about cash inflows and outflows about every Italian municipality from the *Direzione Centrale della Finanza Locale* of *Ministero dell'Interno*. All the financial data are divided by nature of the transaction, highlighting the scope of the expenditures.

2. **Socio-economic data** about population, density, services, territorial extension etc of the DMUs. These data have been downloaded from opencivitas.it[2], platform that provides information about local governments promoted by Ministero dell'Economia e delle Finanze, and ISTAT. This dataset includes

[1] https://openbilanci.it/pages/faq#chi%20siete
[2] https://www.opencivitas.it/it/dataset/2021-comuni-servizi-totali-indicatori-e-determinanti

information about standard expenditure, indicators, level of services provided, historical expenditure and services determinants for each municipality (e.g. number of schools, numbers of childcare ...). The Opencivitas dataset has been integrated a few more variables from ISTAT needed to achieve a complete coverage of analysis. (Green areas, average private cost of labour, illuminated streets and infrastructure for sport activities)

3. **Quality of Life data:** simple and synthetic indicators that could be used as a partial estimator to assess the quality of the life within the DMUs area. This data have been obtained from the annual Il Sole 24 Ore ranking[3] about QoL in Italian provinces. It includes 90 indicators gathered from many institutions that together cover many fields that can impact citizens QoL, providing thus a comprehensive representation of the subject. These 90 variables cover the main aspect of citizens life and are clustered in 6 comprehensive categories[4] which contain 15 variables each.

	Financial Data	**Socio-economic data**	**QoL data**
About	Cashflows	Services and expenditures	Quality of Life
Source	Openbilanci	Opencivitas et al.	Il Sole 24 Ore
Granularity	Municipality	Municipality	Province
Availability	Until 2020	2019 & 2021	Every year
Coverage	Total	Non autonomous regions	Total

Table 4.1: Dataset overview

4.2. Merging datasets and Manipulation

Merging data from different sources into a full, compact database is fundamental in order to have a clear and clean analysis. A common problem witnessed by researchers when approaching studies like this one is the difference in data time availability, granularity, and spatial coverage when gathering them from different sources. As clearly reported in Table 4.1, the three datasets used had several differences in these three characteristics.

[3]https://lab24.ilsole24ore.com/qualita-della-vita/

[4]Wealth and consumption (Ricchezza e consumi), Business and work (Affari e lavoro), Justice and security (Giustizia e sicurezza), Demographics and society (Demografia e società), Environment and services (Ambiente e servizi), and Culture and leisure (Cultura e tempo libero).

With regard to the financial data set, the source provided data regarding the cash flow of each Italian local government for each year up to and including 2023. However, the JSON files related to each Italian municipality could only be downloaded in bulk up to 2020. Moving to the socio-economic data instead, numbers were available for every municipality excluding the ones in autonomous regions (currently Trentino-Alto Adige, Valle d'Aosta, Friuli Venezia Giulia, Sicilia and Sardegna) which due to their special status follow different regulations. Data about the total of the function were available on the Opencivitas website only for two years: 2019 and 2021, while the single variable integrated were available for many years. Lastly, the Il Sole 24 Ore ranking covers every Italian province and it is published and available for every year since 1990 but data download is available on the GitHub repository only from 2020.

Given these three datasets, the three dimensions had to be merged:

- **The spatial coverage** kept in the model comprehended values for all the municipalities belonging to non autonomous regions, cleaning the data from local governments located in special status territories from all the datasets. This was done not only to merge the data with the Opencivitas dataset (data from special status regions were available online independently as well) but also to make sure to have a DMUs operating in comparable contexts in our sample from a fiscal and financial point of view.

- **The year** selected was the 2019, as data from 2020 and 2021 and deeply influenced by Covid-19 pandemic and restrictions (particularly the ones about Quality of Life). Furthermore, any year after 2020 would have caused problems as the manual download of the cashflow statements of each municipality from OpenBilanci is highly time consuming. Data from Il Sole 24 Ore have been copied manually from the website.

- **The granularity** of the analysis posed a significant challenge in the research design, requiring the formulation of several key assumptions. As referenced in the literature review, Bigerna and Polinori (2014) addressed this issue by using data from the provincial capital municipality as a proxy for all other municipalities within the province.

  However, as shown in Figure 1.1, individual municipalities are responsible for

a variety of expenditure items that directly impact residents' Quality of Life. Thus, relying solely on financial data from the provincial capital may introduce bias, as it neither provides a complete evaluation of all municipalities nor constitutes a representative sample of the entire population (Figure 4.2).
Additionally, when assessing the capacity of local governments, including those in smaller jurisdictions, to enhance the well-being of their citizens, it is essential to consider the low urbanization rates present in many provinces. Consequently, the provincial capital often represents only a small fraction of the total population, as shown in Figure 4.1.

To better understand the potential bias introduced by this approach, the final chapter of this thesis includes an additional analysis comparing the results of models that incorporate data from all municipalities within a province against those that rely solely on the provincial capital.

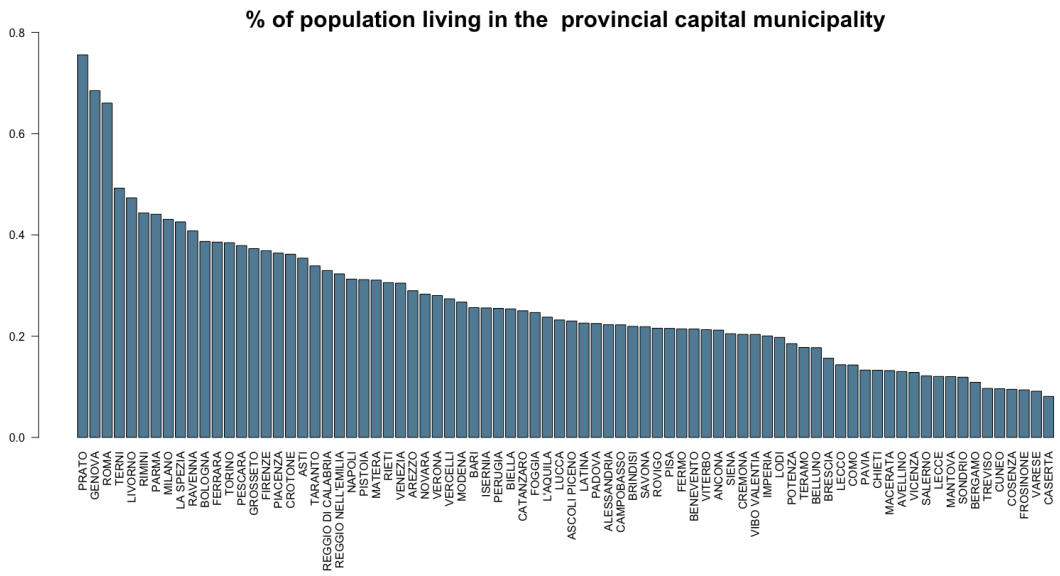


Figure 4.1: % of province population living in the provincial capital municipality

To address this limitation, and given the available Quality of Life data, this research adopts the reasonable assumption that the QoL values reported by Il Sole 24 Ore for each province can be considered uniform across all municipalities within that province.
Assuming so, the integration of the additional data, including the financial ones, have been performed: municipalities were aggregated at the provincial level using either a summation or a mean function, depending respectively if

the values were displayed in absolute or in per capita terms, including in this way expenses from every single municipality.

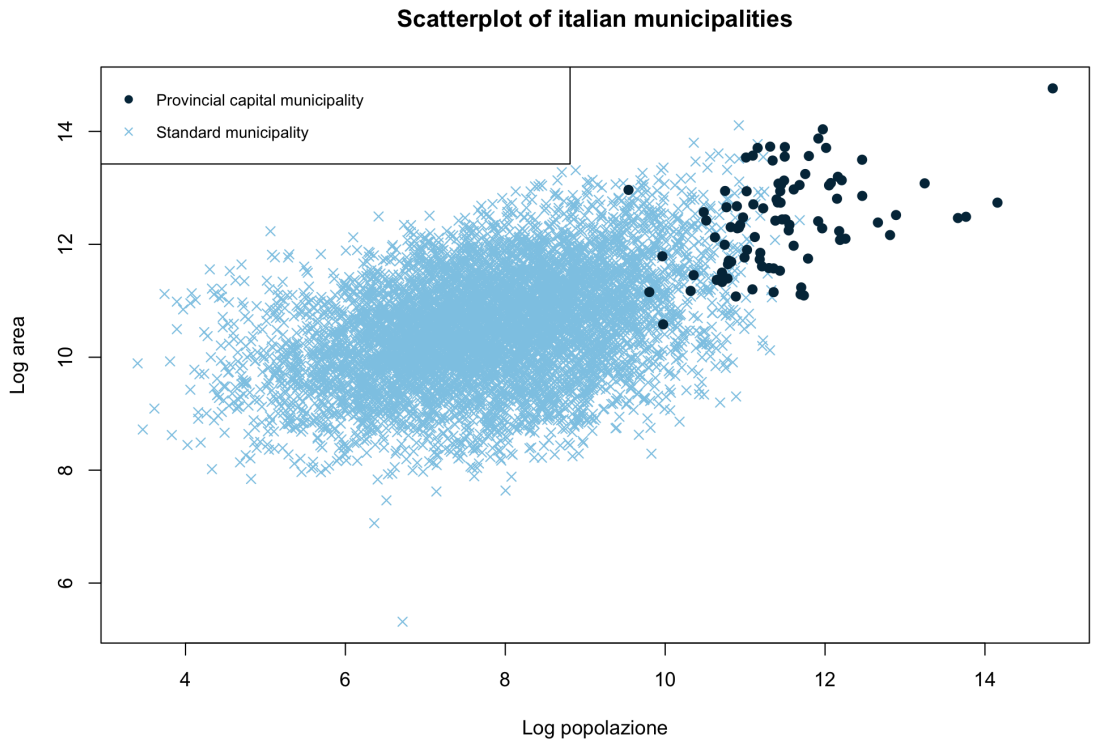


Figure 4.2: Scatterplot of Italian capital and standard municipalities

4.2.1. Data manipulation

Once defined the level of granularity, the coverage and the period on analysis of our research, some data manipulation activity becomes necessary to maintain the needed level of coherence and consistency to conduct the study.

The values of the variables have been normalized according to the methodology implemented by Il Sole 24 Ore in their QoL ranking research, extending this methods to all the variables utilized as input and output of our DEA models.

The data normalization was done using Min-Max scaling, transforming all values to a range of 0 to 1000. In this process, the minimum value of each variable is mapped to 0, the maximum to 1000, and the intermediate values are rescaled proportionally between these two limits according to a linear transformation.

For variables where lower values indicate better performance (i.e., "less is better" indicators, such as air pollution, bankruptcy etc.), an inverse scaling was applied. This adjustment ensures that, even for these variables, a score of 1000 is assigned to the best-performing province.

$$\text{Positive indicators: } X_{\text{new}} = \frac{X - X_{\text{min}}}{X_{\text{max}} - X_{\text{min}}} \cdot 1000$$

$$\text{Negative indicators: } X_{\text{new}} = \frac{X_{\text{max}} - X}{X_{\text{max}} - X_{\text{min}}} \cdot 1000$$

The only variables that have not been normalized are the ones regarding the average private salaries within the single provinces and the onces about the expenses of the local governments, which have instead only been divided by the total population of the provinces to obtain a per capita indicator as all the previous one.

4.3. Data selection and management

DEA models witness problems in reduction of discriminatory power when the number of inputs and outputs increases, leading to an higher number of DMUs placed on the efficiency frontier. (Charles et al., 2019) For this reason, an accurate selection and reduction of the dimensions to include in the models was required to manage effectively all the variables present in our datasets that accounted for more than 200 units, each of them representing a single different indicator.

4.3.1. Variable distinction and clustering

Before delving into the selection of the variables to be used in the study, a step back to the research question is necessary. To assess the presence of a relationship between the efficiency of local governments and the Quality of Life of the citizens within them, it is essential to clearly define both of these concepts and the variables that could describe them.

To ensure the avoidance of any bias in studying the potential relationship between these two aspects, the available variables were clustered into two macro groups: those related to municipal efficiency and those related to Quality of Life.

Regarding local government efficiency, variables on which municipalities have direct impact and control were considered, making them directly and easily related to the municipality's expenditure items.
For instance, to assess the efficiency of the municipality's actions on transport services and citizens' right to mobility, variables such as the public transport offer (in km covered per citizen), the amount of roads per capita, and the number of streetlights in the area were considered. While these variables fall in the first cluster, the number of passengers using the services can not be included in it: even though the municipality can influence citizens' behavior by providing better services, it can not have direct control over how many people will use the transport system.

Continuing with the example above, the use or non-use of public transport services, as reductions in theft or robberies and the average education level of the population, are not variables directly controlled by the municipality. However, they represent the 'success' achieved through efforts related to variables that are under municipal

control, therefore providing a measure of the local government's effectiveness. These latter variables, in contrast to metrics like the number of police officers on the streets or the number of school buildings, have a direct and significant impact on the Quality of Life of the population, thus falling into the cluster of variables that can be used to measure the Quality of Life achieved.

4.3.2. Variable selection and reduction

As mentioned above, in DEA models, especially when the data points are limited to the number of Italian provinces in ordinary statute provinces, it is crucial to keep the number of inputs and outputs of the model low in order to maintain the discriminating power of this statistical tool.

After distinguishing which variables were related to Quality of Life and which to the efficiency of local governments, it was necessary to identify sub-clusters for aggregating the input and output variables of the DEA models, which will be described in the following chapter.

With regard to municipal efficiency, the expenditure items obtained from OpenBilanci were used as a starting point for defining the sub-clusters. Of the 24 total cost items present in municipal budgets, those related to activities for which municipalities have primary accountability were selected, as previously discussed in the institutional background. Overall, nine expenditure items were retained: general institutional services and management (Servizi istituzioni generali e di gestione), public order and safety (Ordine pubblico e sicurezza), education and the right to study (Istruzione e diritto allo studio), protection and promotion of cultural assets and activities (Tutela e valorizzazione dei beni e delle attività culturali), youth policies, sports and leisure (Politiche giovanili, sport e tempo libero), transport and the right to mobility (Trasporti e diritto alla mobilità), land use and public housing (Assetto del territorio ed edilizia abitativa), social rights, social policies and family (Diritti sociali, politiche sociali e famiglia), and sustainable development of the territory and environment (Sviluppo sostenibile del territorio e dell'ambiente).

Given these variables, six main clusters were developed: security; education; sports, culture and leisure; transport and urban planning; social rights and environment. An extra cluster is included aside to take in consideration the **general institutional**

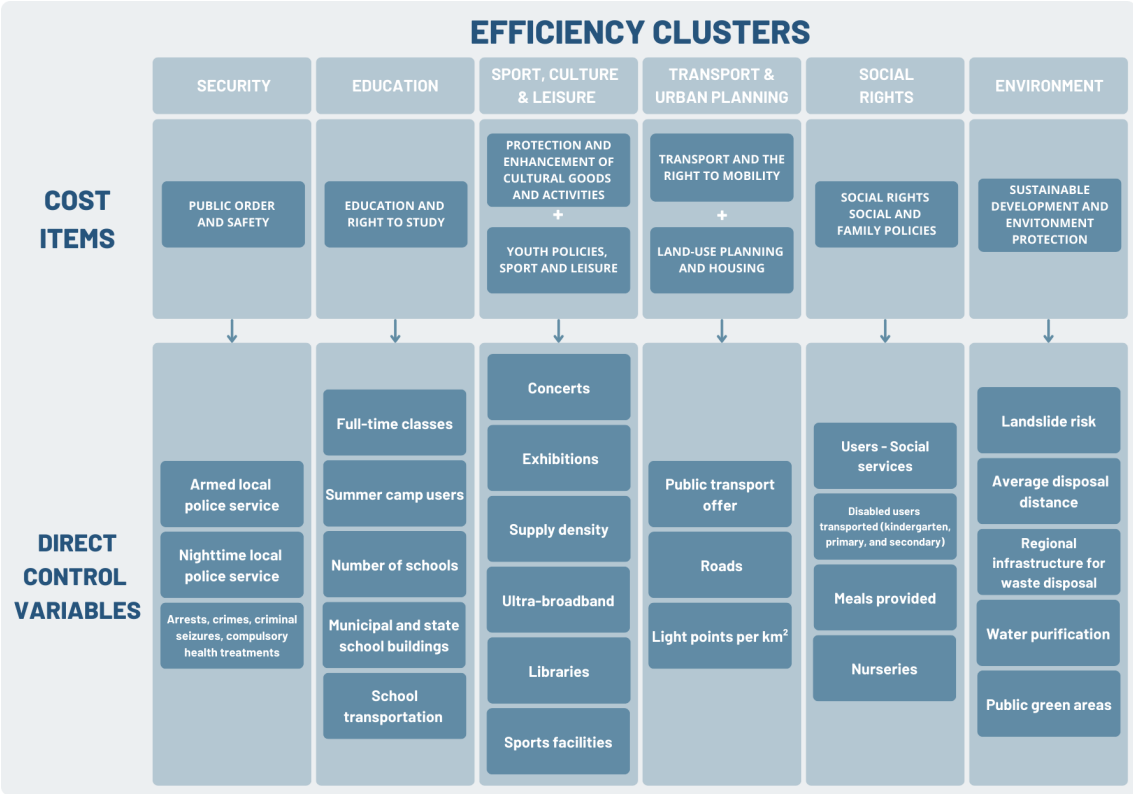


Figure 4.3: Clusterization of the technical efficiency variables

and management services, which represents the costs sustained to maintain the local government operations themselves.

Once these sub-clusters were defined, the work of placing the variables defined as having a direct impact and control by the municipality within them had been carried out, using mainly sources from Opencivitas and some additional variables integrated from Il Sole 24 Ore and the ISTAT website. The final results is illustrated in Figure4.3.

Afterward, it was necessary to create a sub-clustering of the variables previously considered related to the effectiveness of municipalities, which, for this reason, are tied to Quality of Life. Although it would have been possible to use the same categorization as for the efficiency variables, Quality of Life encompasses a broader spectrum beyond the areas where municipalities have direct accountability, such as economy, health, and justice. For this reason, the clustering of Quality of Life (QoL) variables was based on the categorization proposed by Il Sole 24 Ore, as presented

in the rankings published by Il Sole 24 Ore, from which the data were sourced. This categorization includes six sub-clusters: Wealth and consumption (Ricchezza e consumi), Business and work (Affari e lavoro), Justice and security (Giustizia e sicurezza), Demographics and society (Demografia e società), Environment and services (Ambiente e servizi), and Culture and leisure (Cultura e tempo libero). The variables that were included within these categories were cherry picked by the Il Sole 24 Ore dataset, to select the right ones several steps has been followed:

1. Removal of all the variable of the dataset that have been categorized in the fist main cluster and thus have been already considered as proxies to assess the efficiency of local governments. In our previous clusterization, these were the public transportation offer (offerta del trasporto pubblico), number of concerts (Concerti), exhibitions and expositions (Mostre ed esposizioni) and libraries (Biblioteche), avaialability of Ultra wide band (Banda ultra larga) and density of cultural offer (Densità dell'offerta culturale).

2. Hand selection of all the variables that have been previously utilized by other papers cited in the literature review and are clearly resumed in Table A.4.

3. Annexation of variables that can be directly influenced by each of the 6 sub-clusters defined for efficiency of local governments and that were not included yet, as for instance the number of public transportation users (Passeggeri del trasporti pubblico).

4. A final check on the ones that were still excluded from the sub-clusterization.

At the conclusion of the of this process (Figure4.4), these were the selected variables: Residential market absorption (Assorbimento mercato residenziale), Debt - Average monthly payment (Debiti - Rata media mensile), Bank deposits (Depositi bancari), Old-age pension amounts (Importo pensioni di vecchiaia), Average total income (Reddito medio complessivo), Household spending (Spesa delle famiglie) and Value added per inhabitant (Valore aggiunto per abitante) for **Wealth and Consumption**, Gender employment gap (Gap occupazionale di genere), Bankrupt companies (Imprese in fallimento), Registered companies (Imprese registrate), Foreign companies (Imprese straniere), Innovative startups (Start up innovative), Unemployment rate (Tasso di disoccupazione), Youth unemployment rate (Tasso di disoccupazione giovanile), Inactivity rate (Tasso di inattività) and Youth entrepreneurship trend (Trend imprenditorialità giovanile) for **Business and work**, Extortions (Estor-

sioni), Car thefts (Furti di autovetture), Home burglaries (Furti in abitazione),Fires (Incendi), Road accidents (Incidenti stradali), Crime index (Indice di criminalità), Litigation index (Indice di litigiosità), Robberies (Rapine), Drug-related crimes (Reati legati agli stupefacenti), Money laundering and employment (Riciclaggio e impiego di denaro), Fraud and computer scams ("Truffe e frodi informatiche") and Sexual violence (Violenze sessuali) for **Justice and Security**, Hospital emigration (Emigrazione ospedaliera),ICityRank (ICityRank), Climate index (Indice del clima), General practitioners (Medici di medicina generale), Public transport passengers (Passeggeri del trasporto pubblico), Pediatricians (Pediatri), Air quality - PM10,(Qualità dell'aria - Pm10) and Separate waste collection (Raccolta differenziata) for **Environment and Services**, Acquisitions of citizenship (Acquisizioni di cittadinanza), Elderly dependency ratio (Indice di dipendenza degli anziani), Average years of schooling (Numero medio di anni di studio), Life expectancy at birth (Speranza vita alla nascita), Mortality rate (Tasso di mortalità), Birth rate ("Tasso di natalità") and Life expectancy trend (Trend speranza di vita) for **Demographic and Society**, Sports index (Indice di sportività), Sports and Children index (Indice Sport e Bambini), Sports and Nature index (Indice Sport e Natura), Bookstores (Librerie), Gyms (Palestre), Restaurants and bars (Ristoranti e bar) and Cinemas (Sale cinematografiche) for **Culture and Leisure**.

The use of two distinct categorizations, one for efficiency and another for Quality of Life, is more precise for this kind of study, as the two sets of variables are meant to represent two different concepts. Additionally, this approach helps reduce potential bias that might have influenced the research had the categories been directly overlapping.

To actually move to a reduction of the number of variables, several mathematical tools were available. To keep the highest amount of variance possible on all dimensions, a principal component analysis has been taken in consideration, but this procedure experienced many issues as the number of required dimensions to achieve a good percentage of variance explained was variable and often too high to keep the number of variable low. Furthermore, often the new dimensions were not easily explainable and it was hard to clearly define a meaning for each of them. To solve the problem, the best solution is to change the statistical method, going for a simple average value that can effectively work as a good proxy of the score of the province

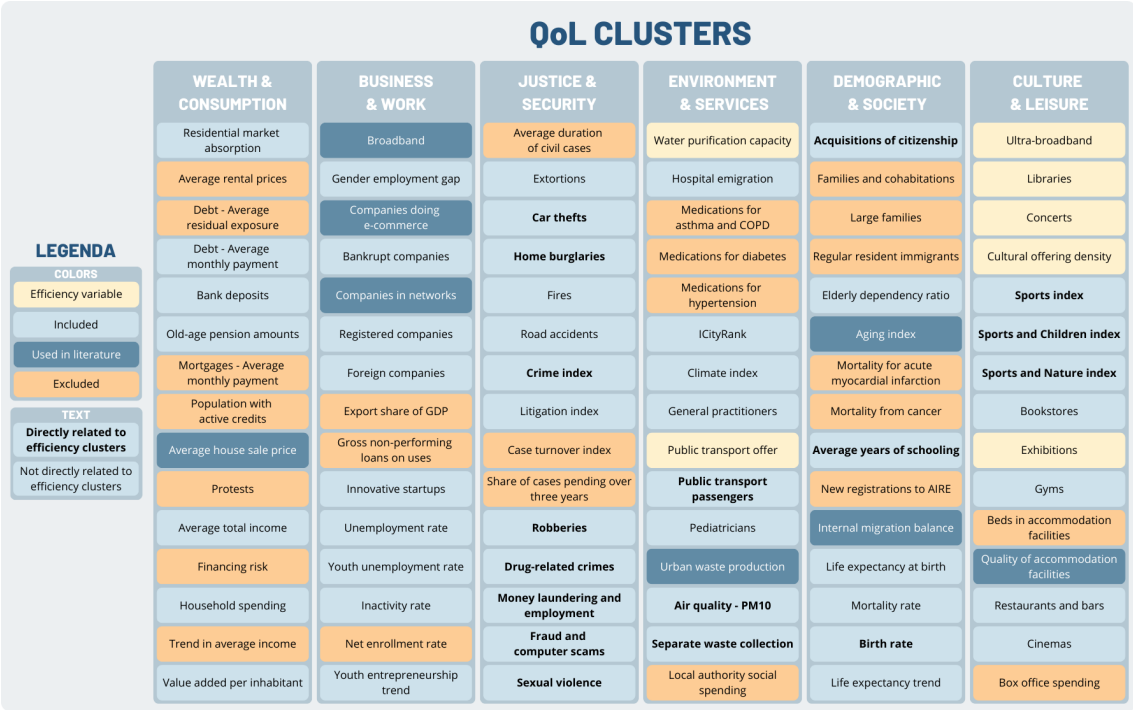


Figure 4.4: Clusterization and selection of the QoL variables

in each sub-cluster, under the assumption that each variable accounts for the same relevance and thus the same importance of all the others within its category.

4.3.3. Data exploration

Some exploration of the distribution of the available data is required to avoid any kind of bias on the results that could be determined by outlier or incomplete and not precise information. Particularly, a deep control on the distribution of the expenses on the different cost items have been conducted: a first explorative analysis identified some outliers in the selected expenses of our model. Firstly, Milano sustained really high costs for transport and the right to mobility, which can be explained by the particularly extended and developed subway and bus network. This highers costs matches an as well higher level of the services provided to the citizens in the mobility field and for this reason removing this data point is not needed, as to a higher expense a better service is related. On the contrary, Figure4.5 shows that a misleading outlier is present in the general institutional services and management cost item: L'Aquila has an surprisingly high value in that expense, even higher than most of the total

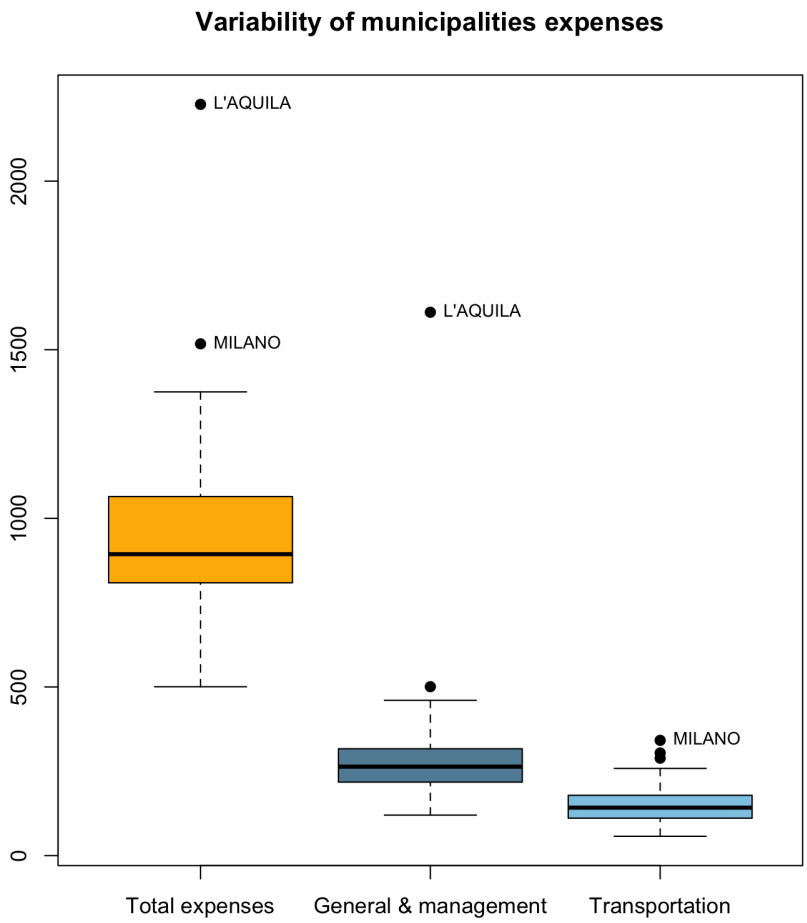


Figure 4.5: Expenses outliers

expenses of the other provinces. This outlier, probably mainly due to the expenses related to the earthquake that the area witnessed in 2009, could actually reduce the effectiveness of DEA models to correctly compute the scores, as the efficiency frontier and the score formulation is made through bench-marking and so influenced by all the DMUs present in the dataset.

Moving on with our analysis, an explorative geographical plot of the map of Italy was performed to spot other data or trends to be fixed. The map clearly shows a strong differences in expenses between the northern and southern territories, for this reason data about the average cost of private labour has been taken in consideration to understand if this differences was to just related to actual higher spending or if

it was determined by different costs of the same products or services along the peninsula. The dataset about the cost of labour in 2019, sourced by Istat, shown a similar trend of the exploration plot, explaining that the reason is likely to be the latter. To fix this bias, an average cost of labour value has been computed through a mean function and a corrective factor has been calculated through the division of the cost of labour in the single province and the average Italian value.

$$\text{Corrective factor}_i = \frac{\text{Cost of labour}_i}{\text{Average Italian cost of labour}}$$

given i = Alessandria, Ancona, ...,Viterbo.

Once computed the corrective factor, each expenses item has been multiplied by the corresponding value for each province, correcting in this way the cost values for the cost of labour (results shown in Figure4.6). This new value for the expenses has been defined as "adjusted expenses" and its use will be crucial to improve the correctness of the following models as this research focuses on computing and assessing the pure technical efficiency scores of the local government.

The correctness of this adjustment has to be contextualized in the calculation of the pure technical efficiency, that broadly differs from the global efficiency.

The technical efficiency indeed refers to a firm's or a decision-making unit's (DMU) ability to obtain the maximum possible output from a given set of inputs. It measures whether a firm is producing as much as it can given its resources and focuses on internal processes and resource utilization without considering external or environmental factors like market conditions. On the other hand, global efficiency extends the concept of efficiency by incorporating not just technical efficiency, but also external or allocation aspects such as cost efficiency, scale efficiency, and the optimal allocation of resources in relation to market prices and economic conditions.

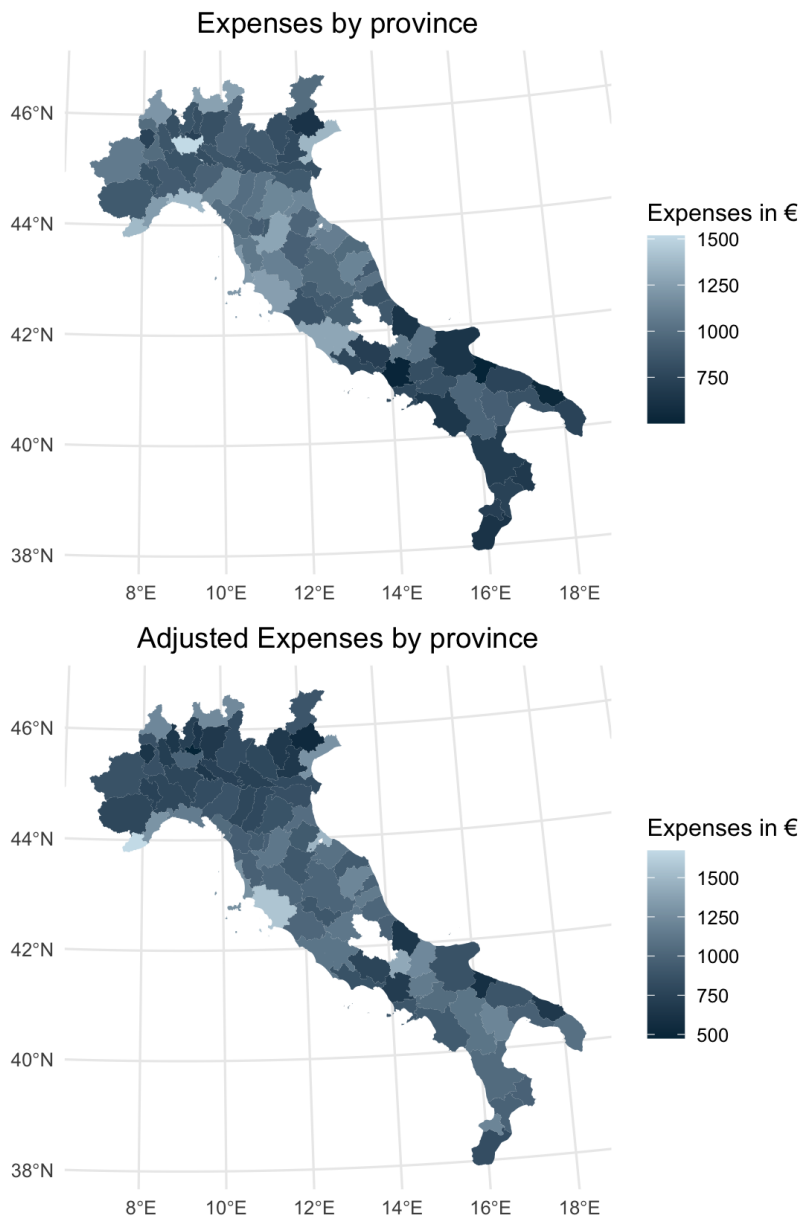


Figure 4.6: Real expenses vs adjusted expenses maps

5 | Conceptual Framework - Main model

5.1. Framework design - Efficiency

Moving on to the description of the framework, for what concerns efficiency, two different analysis have been developed. The first one followed the simplest way to compute technical efficiency scores, inspired by the papers previously reported in the literature review (e.g. lo Storto (2016)). The second instead includes a model that provides a innovative and original contribution to this research topic and that leverage on the variable distinction and clusterization cited above.

5.1.1. Model 1: Purely technical efficiency

The first part follows the approach proposed by lo Storto 2016a and calculates efficiency scores using cost items as inputs. In the present research, the input is composed by a single comprehensive cost item representing the aggregation of the nominal absolute values of all the current expenses. For the outputs, two demographic indicators have been utilized: the population and the administrative area of the entire province. The result of this initial analysis provides what can be defined as technical efficiency: an input-oriented DEA that aims to minimize the expenditure of Decision-Making Units (DMUs) to achieve a given output. In this case, it indicates how efficient the municipalities in each province are in serving a certain population within their respective territories, excluding from the calculation any indices related to the quality or the amount of services provided by the local government.

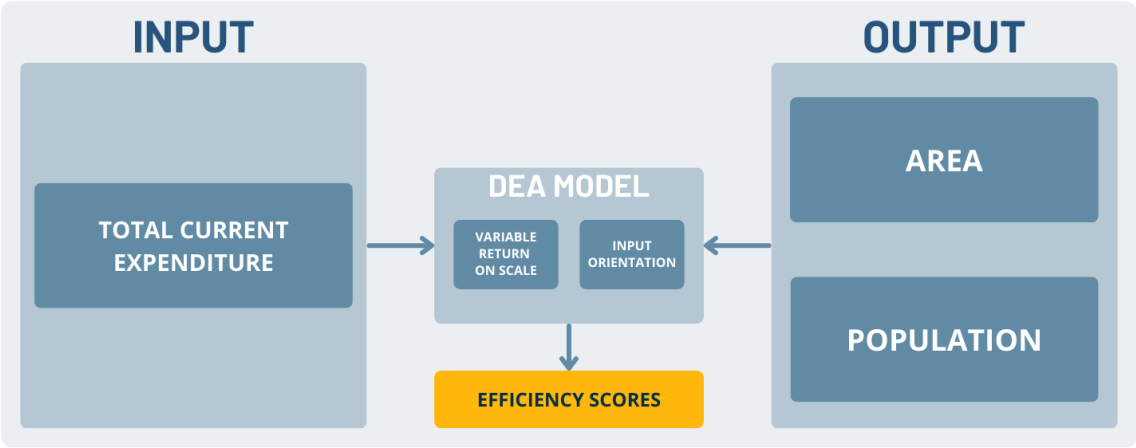


Figure 5.1: DEA model for pure technical efficiency

5.1.2. Model 2: Original efficiency model

The new framework proposed by this paper to evaluate the efficiency of local governments uses a DEA model which follows the direct correlation between expenses items and the direct control variables defined in the chapter above and clearly represented by Figure 4.3.

The input variable in this analysis aggregates the "adjusted" expenditure items defined in Figure 4.3, comprising the sum of the per capita values of the nine key costs outlined in the previous chapter: general institutional services and management (Servizi istituzioni generali e di gestione), public order and safety (Ordine pubblico e sicurezza), education and the right to study (Istruzione e diritto allo studio), cultural asset protection and promotion (Tutela e valorizzazione dei beni e delle attività culturali), youth policies, sports and leisure (Politiche giovanili, sport e tempo libero), transport and mobility rights (Trasporti e diritto alla mobilità), land use and public housing (Assetto del territorio ed edilizia abitativa), social rights and family policies (Diritti sociali, politiche sociali e famiglia), and sustainable territorial and environmental development (Sviluppo sostenibile del territorio e dell'ambiente).

This approach marks a shift from the previous - simpler - model, aiming to refine technical efficiency measurements by including only those expenditures directly related to the services under evaluation. Costs are reported in per capita values due to consistency reasons, as the population will not be included into the outputs

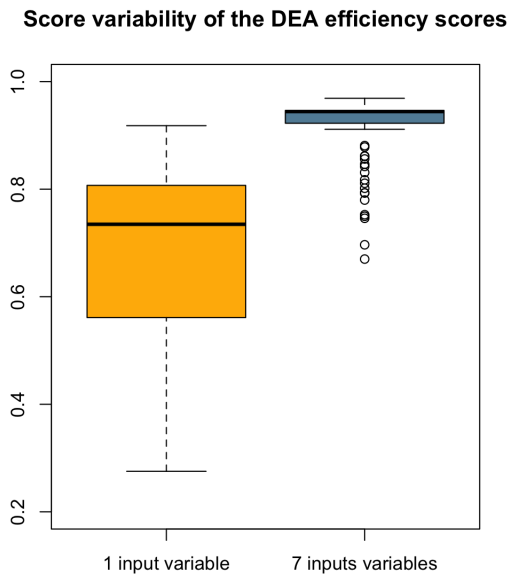


Figure 5.2: Variability changes with disaggregated input

anymore.

The inclusion of all the different expenditure in one aggregated item of cost instead of the 7 different expenses clusters defined was needed to reduce the number of variable given in input to the model: this aggregation led to increase the variability of the efficiency scores of the DEA, as it can be easily seen in the Figure 5.2. In the second box, representing the scores variability from the model without aggregated expenses, it is clear how the increasing the number of input lead to higher and less distinct values for the provinces, losing variability in the results.

As outputs, the 6 sub-clusters containing variables from Opencivitas, Il Sole 24 Ore and other external sources have been utilized, each of them synthesized in a single item through aggregation of the variables included, performed through the use of a simple mean function as previously described in the previous section.

The bootstrapped DEA has been performed using the input orientation formula and assuming variable return to scale, as the the objective is to keep the costs down given a certain level of service provided and there are not prove available to state that there is a defined different return to scale in place.

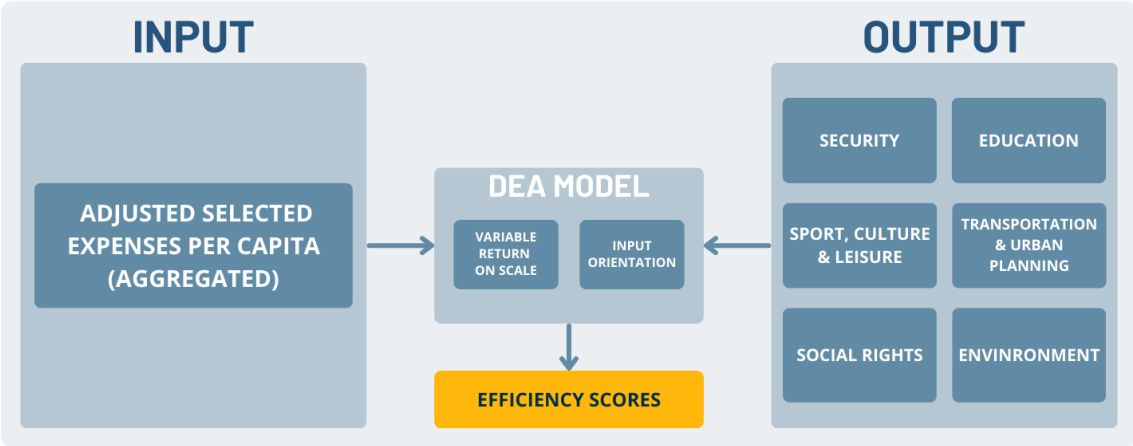


Figure 5.3: Innovative DEA model for efficiency

The scores deriving from this DEA model provides us a synthetic indicator of efficiency of the municipalities within each province as it considers the expenses of the local governments (as inputs) and the actual output obtained by them in variables in which they have both direct accountability and control. Moreover, the adjustment of expenses based on the average cost of private labour allows to fairly compare different area of Italy where prices are subject to relevant differences. In the following results section the difference of the model with and without adjustment will be better displayed and discussed.

5.2. Framework design - Quality of Life

5.2.1. QoL - Global model

Concerning the model to assess the Quality of Life of Italian provinces, a global comprehensive model have been developed.

From a detailed study of the papers cited in the literature, it emerges that research using DEA as a non-parametric model to measure QoL scores has often employed an approach that divides variables into desirable and undesirable categories. Variables that represent aspects contributing positively to citizens' Quality of Life are used as outputs, while those representing negative contributions are placed as inputs in the DEA model. This technique, as explained in the methodology Chapter [3],

rewards DMUs that, given a low number of inputs (undesirable variables), achieve the highest level of outputs (desirable variables). This approach is also adopted in the model used in the present thesis.

Given the data processing explained in the *Data Usage and Overview* section (Chapter [4]), all variables in our dataset are structured with the "more is better" logic, meaning they are all considered desirable factors and, therefore, treated as outputs in the model. These variables were grouped as previously described and subsequently aggregated through averages into six clusters: Wealth and Consumption, Business and Work, Justice and Security, Demographics and Society, Environment and Services, Culture and Leisure.

In contrast, since there are no undesirable factors, the model's inputs consist of a vector containing a unitary value for each province. This approach simplifies the input structure while allowing us to focus entirely on maximizing outputs related to the Quality of Life.

The DEA model used here is output-oriented, as it seeks to maximize outputs for a fixed input (in this case, 1 for all provinces). As in efficiency models, there were no conditions to assume that returns to scale differed from variable returns to scale (VRS).

The scores obtained from this model serve as a proxy for the Quality of Life in Italian provinces and can thus be linked to their effectiveness, as there are no inputs to be minimized. The use of this model allows to generate scores ranging between 0 and 1, facilitating a more effective comparison with the technical efficiency scores previously computed.

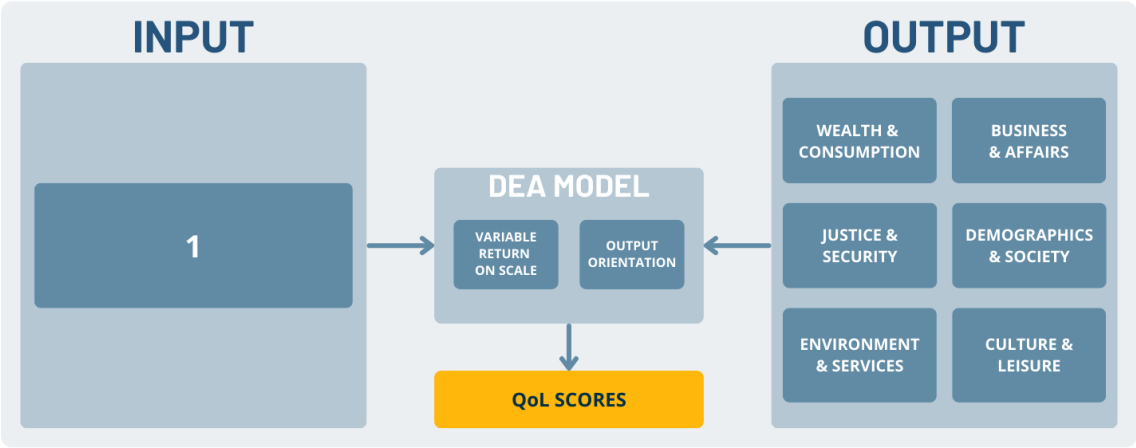


Figure 5.4: Quality of Life DEA model

5.2.2. QoL - Direct model

After calculating the Quality of Life (QoL) scores based on the six dimensions provided by Il Sole 24 Ore, a final nested DEA model focusing on Quality of Life was developed. To better evaluate the direct impact of local government operations on citizens' lives, the QoL scores were recalculated, excluding from the outputs all variables that were not directly related to the efficiency clusters used in the technical efficiency Model 2. The output variables retained in the model are those highlighted in bold in Figure 4.4.

Since no direct variables were present in the first two clusters, Wealth & Consumption and Business & Affairs, this model only includes the remaining four clusters. Their values have been adjusted due to the reduction of variables within each cluster.

When analyzing the results of this nested model, it is crucial to recognize that the QoL scores obtained cannot be considered a complete proxy for the overall Quality of Life of citizens in the respective areas. This is because the model focuses on only a limited subset of QoL dimensions, rather than capturing the full scope of the concept.

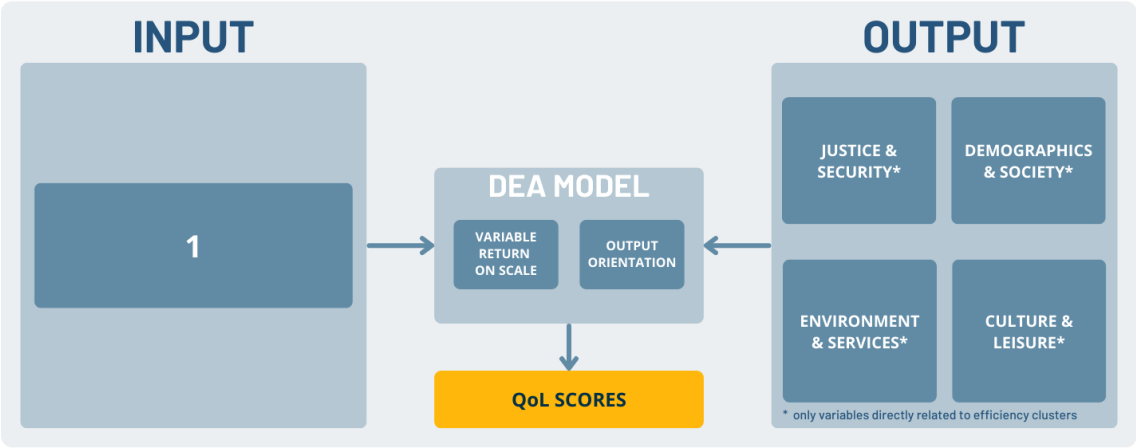


Figure 5.5: Quality of Life DEA direct model

5.3. Linear models design

After obtaining the technical efficiency and Quality of Life (QoL) scores, several regression models were implemented to investigate the statistical significance of the relationship between regressors and target variables. For each set of scores from the DEA models, various linear models were tested, including expenditure items and contextual variables as regressors, with particular attention to the external factors outlined in Chapter 1.1.

Additionally, similar models were developed to explore the relationship between the different sets of scores, primarily using efficiency scores as regressors to predict QoL scores as the target variable. In these models, additional control variables such as the Gini coefficient, altitude variation, and population density were included to assess if their values affect or change this relationship.

Only the most insightful and statistically significant models for the research objectives are presented in the following results section, Chapter 6.

6 | Results

This chapter aims to present the results obtained from all the steps involved in the main model, as described in Chapter 5.

First, the efficiency scores derived from the two technical efficiency models will be presented, analyzed, and compared. Next, the results from the DEA model evaluating the Quality of Life will be illustrated, followed by a comparison with the subsequent efficiency scores. Finally, linear models outcomes will be shown in order to assess the relationship between technical efficiency and QoL and also potential contextual factors affecting it. The totality of the scores are cataloged and shown in Appendix B.

6.1. Technical Efficiency results

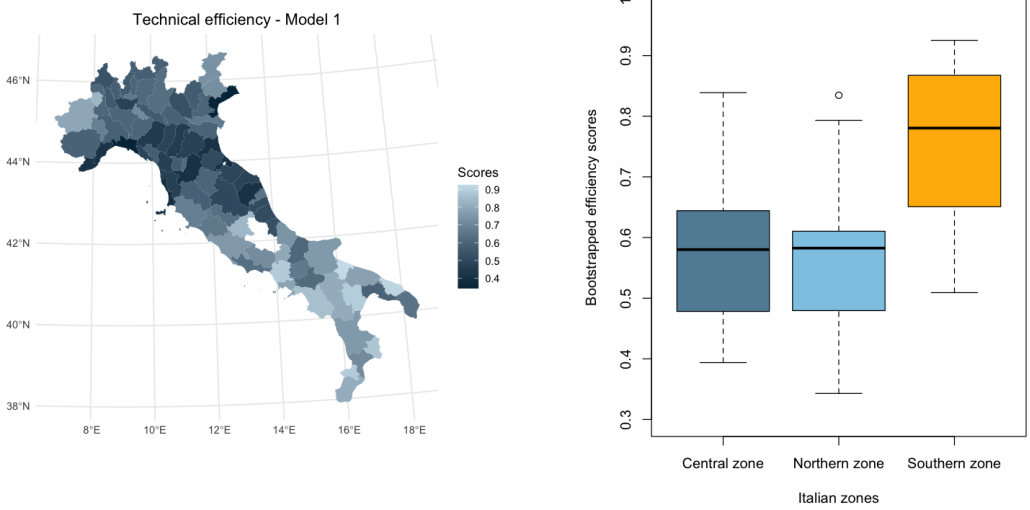
6.1.1. Model 1

Among all the provinces, the one that obtained the highest score is Barletta Andrai Trani whose result reaches the 92.55% of efficiency , followed by Brindisi, Matera and Caserta. As these provinces suggest, the southern zone registered remarkably better scores compared to the central and norther zone of Italy, as clearly illustrated by the box-plot in Figure 6.1b and the lighter color shades on the map in Figure 6.1a.

In terms of numbers, the average value of the scores is 61.83% allover the peninsula, moving within the range that goes from the best, around 93%, to the worst, which is obtained by the province of Venezia, around 34.29%. The average values of the three zones are 56.42%, 57.40% and 75.46% for the north, the center and the south respectively.

# rank	Province	Boostrapped score	Normal score
1	Barletta Andria Trani	92.55%	100%
2	Brindisi	91.13%	96.98%
3	Matera	89.18%	100%
4	Caserta	88.80%	100%
5	Vibo Valentia	88.76%	99.09%
...	...	...	...
81	Imperia	40.68%	37.37%
82	Rimini	40.30%	36.96%
83	Livorno	39.39%	41.72%
84	Genova	34.32%	42.65%
85	Venezia	34.29%	43.07%

Table 6.1: Technical efficiency scores - Model 1



(a) Geographical distribution - DEA technical efficiency scores - Model 1

(b) Technical effiiency scores by Zone - Model 1.

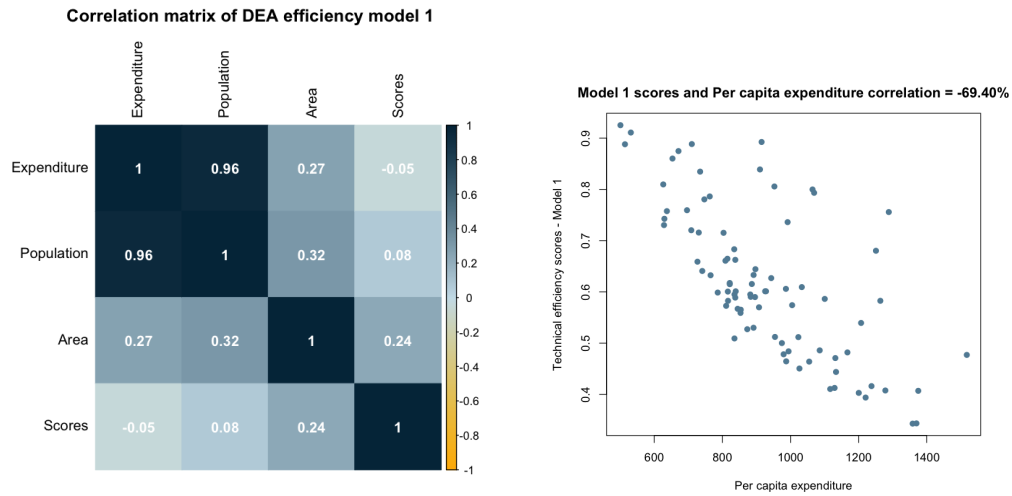
Figure 6.1: Geographical analysis of technical efficiency Model 1 results

Correlation analysis

To assess the validity and robustness of the scores obtained, a correlation analysis was conducted. A high correlation was found between the population size and the expenditure values used as input variables, while the other variables appear to be

generally uncorrelated, as illustrated in Figure 6.2a. This relationship reflects the allocation of government expenditure, which is based on the number of taxpayers in a given area, and is therefore closely tied to the overall population size.

At first sight, the scores produced by the model do not appear to be significantly correlated with any of the input or output variables. However, a more detailed analysis that takes into account per capita expenditure reveals a strong correlation between the scores and local government expenditure per resident. As shown in Figure 6.2b, the negative correlation between these two variables is approximately -70%. This result suggests a limitation in the model's accuracy and completeness, as it largely determines each province's score based on per capita expenditure even if this data does not belong to the model, without adequately considering the outputs or services which local governments delivered using these funds. This correlation therefore explains why the model highly advantages the provinces of the southern part of Italy which, as it is possible to see at Figure 4.6, registered the less amount of money per capita.



(a) Correlation matrix - DEA technical efficiency - Model 1

(b) Per capita expenditure and Model 1 Efficiency scores correlation - Scatterplot.

Figure 6.2: Correlation analysis of technical efficiency Model 1 results

6.1.2. Model 2

Regarding the Second Model, described in Chapter 5, the efficiency scores obtained seemed significantly different from the first. The Northern and Central part of Italy

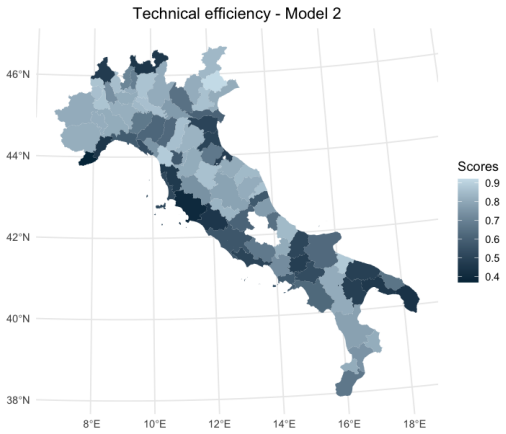
# rank	Province	Score adjusted	Score
1	Treviso	92.22%	93.20%
2	Lucca	88.61%	85.15%
3	Barletta Andria Trani	88.30%	86.71%
4	Bergamo	86.93%	90.99%
5	Vercelli	86.89%	78.01%
...	...	...	...
81	Viterbo	44.98%	60.79%
82	Sondrio	44.77%	50.57%
83	Lecce	43.45%	71.67%
84	Grosseto	39.37%	51.41%
85	Imperia	36.89%	52.41%

Table 6.2: Technical efficiency scores - Model 2

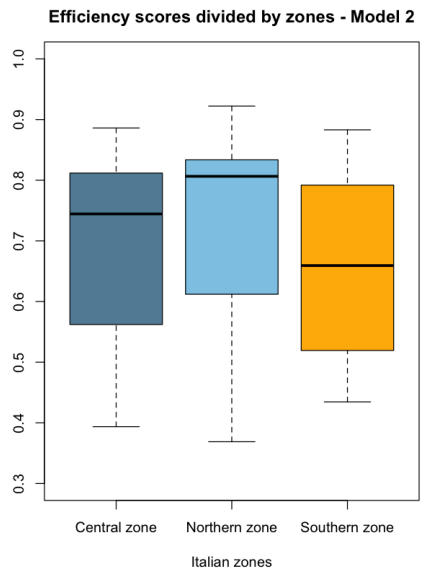
gained some efficiency points compared to the previous model and there is definitely much less distinction between the three main geographical zones. Particularly, in the Northern regions, the average increase in efficiency scores is around 16%, while in the Center it is approximately 11%, and in the South, there is an average decrease of 10%. A paired t-test was conducted on the scaled values of the scores to assess variation, considering that the scores are calculated through benchmarking, and therefore absolute values can be misleading. The p-value of the t-test for the Northern and Southern regions is below 1% ($p < 0.01$), indicating a statistically significant difference in these areas, while for the Center, we cannot reject the null hypothesis.

As showed in Figure 6.4 then, since expenses were adjusted by the cost of labor of the Province under analysis, it is easy to see how this adjustment additionally changed the results favoring the Northern and Central areas compared to the Southern ones.

The average score now is 69.27%, from a minimum of 26.89% for the Province of Imperia until 92.22% of the Province of Treviso which stands in the podium followed by Lucca, Barletta Andria Trani, Bergamo and Vercelli.



(a) Geographical distribution - DEA technical efficiency scores - Model 2



(b) Technical effiiency scores by Zone - Model 2

Figure 6.3: Geographical analysis of technical efficiency Model 2 results

Correlation analysis

The correlations between input and output variables are generally lower in Model 2 than in Model 1 (Figure 6.5). This is a positive outcome, as variables that are uncorrelated in DEA models typically enhance discrimination power and reduce the risk of bias. The only correlation exceeding an absolute value of 0.5 is between Adjusted Expenses and Score, at approximately -0.54, which may be attributed to the imbalance between the number of input and output variables.

When recalculating this correlation with nominal per capita expenditure, the absolute value of the correlation between the scores and nominal expenditure drops to 26%, significantly lower than in Model 1. This decrease indicates a weaker relationship between these two indicators, suggesting that the final technical efficiency scores are less influenced by purely financial metrics and instead incorporate a broader range of factors that can impact performance.

Moving forward with the analysis of these results and the investigation of what they could be correlated with, some scale-effects have been researched. Calculating the correlation between the efficiency score computed and the population size of the

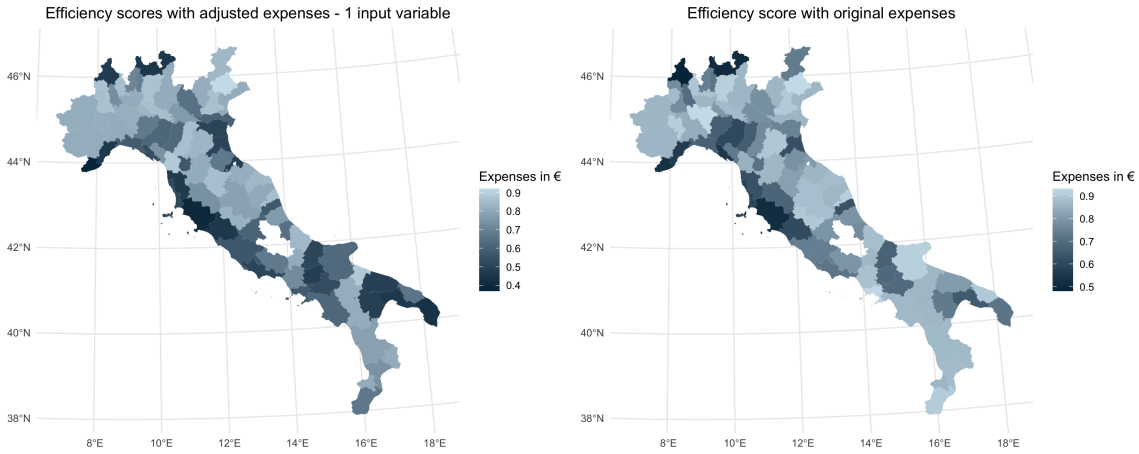
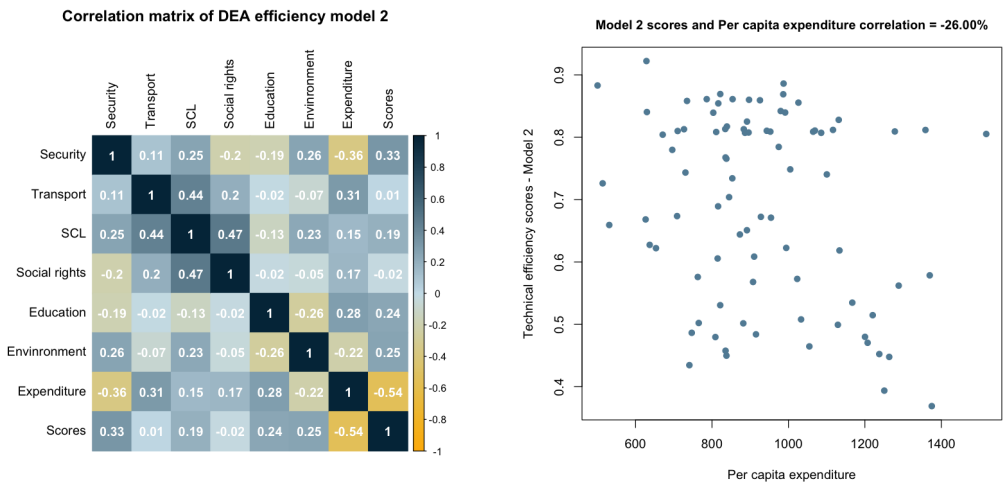


Figure 6.4: Efficiency scores compared: with and without cost adjustments

single provinces, the results indicates a 0.04 correlation value, not providing any proof to support that these effects are in place.



(a) Correlation matrix - DEA technical efficiency - Model 1

(b) Per capita expenditure and Model 2 Efficiency scores correlation - Scatterplot.

Figure 6.5: Correlation analysis of technical efficiency Model 2 results

Furthermore, control for population (with a logarithmic scale) have been conducted for both the two efficiency Scores. Figure 6.6 shows that, for both Model 1 and Model 2, there are not significant trends in scores when both population and average population per municipalities increases or decreases. Also, t-test for this relationship

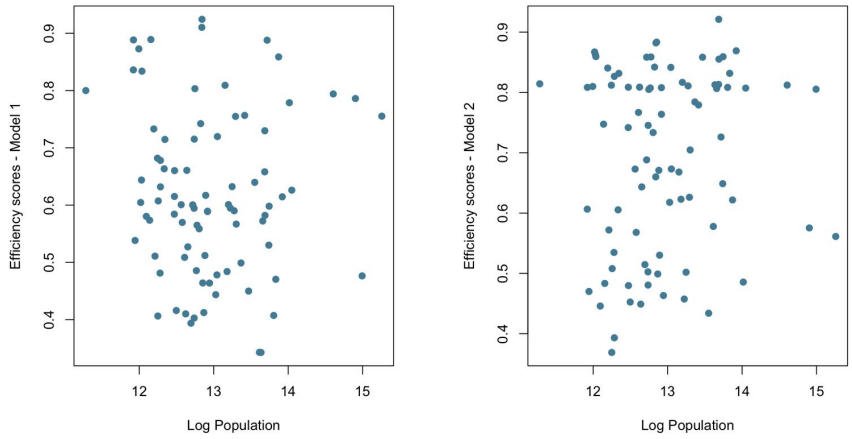


Figure 6.6: Absence of scale effects

were not significant showing in all cases values higher than 20%.

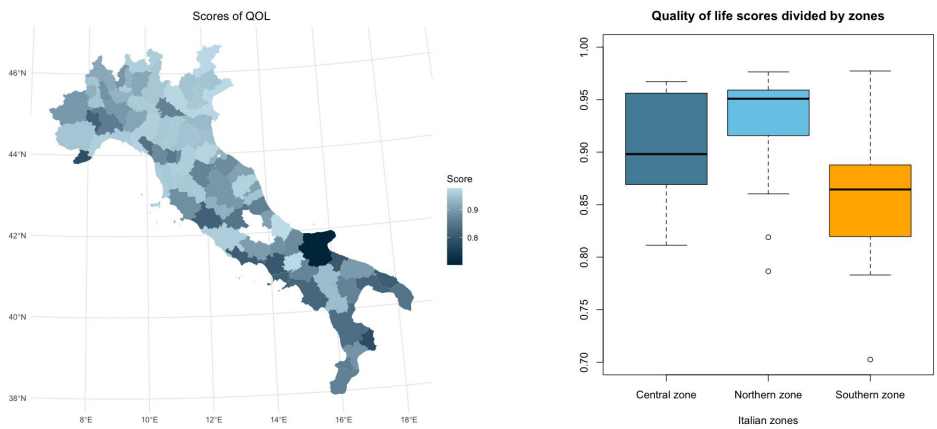
6.2. Quality of Life results

6.2.1. QoL - Global model

After the efficiency results presentation, Quality of Life scores from the global model need to be illustrated. The designed model, as illustrated in the subsection 6.2.1, generates Quality of Life scores from an output oriented configuration, yielding in scores value greater or equal than 1. From now on though, the reciprocal of these scores will be utilized. In this way scores will be distributed from 0 (worst Quality of Life) to 1 (best Quality of Life) and will be easier to compare them with technical efficiency scores of the previous models. The five best and worst QoL scores are shown in the table 6.3. The average value of the reversed QoL scores is 90.39% with a range from 70.25% (Foggia) till 97.73% (Chieti). Particularly, as can be seen in Figure 6.7b scores in Northern regions, with an average score of 93.23 %, are significanlty higher than those in the Central (Two sample t-test p-value = 1.4%), average score of 90 %, and in the Southern regions (Two sample t-test p-value = 0.001%) with average score of 85.77%.

# rank	Province	Reversed score	Score
1	Chieti	97.73%	1.023
2	Venezia	97.64%	1.024
3	Benevento	97.55%	1.025
4	Belluno	97.36%	1.027
5	Verona	97.20%	1.028
...	...	...	...
81	Barletta Andria Trani	80.23%	1.246
82	Caserta	80.10%	1.248
83	Imperia	78.65%	1.271
84	Crotone	78.30%	1.277
85	Foggia	70.25%	1.423

Table 6.3: Quaity of life scores - Global Model



(a) Geographical distribution - DEA QoL - Global Model

(b) QoL scores by Zone - Global Model

Figure 6.7: Geographical analysis of QoL Global Model results

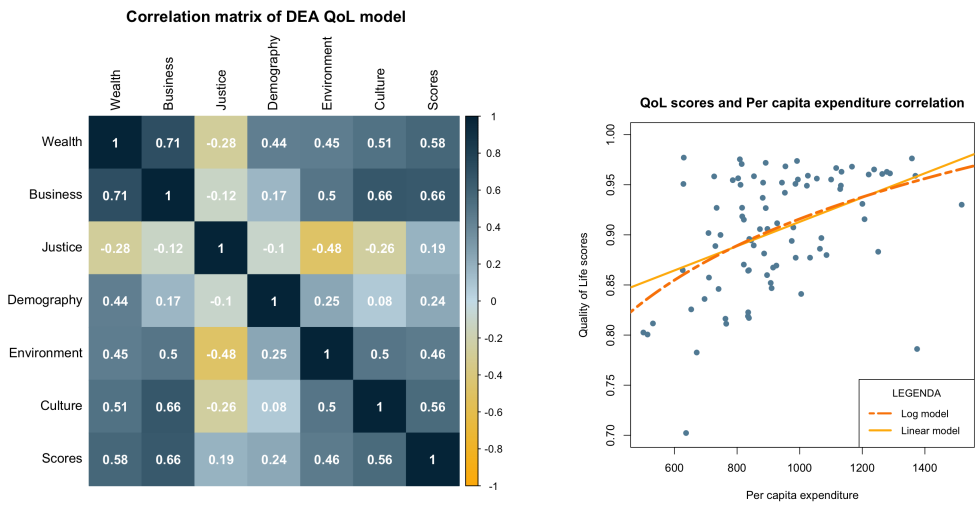
Correlation analysis

Applying the same approach used for the technical efficiency scores, some significant correlations were found between the QoL efficiency scores and the six main output variables of the model. The strongest correlation observed was between the "Affari" variable and the efficiency scores, with a correlation coefficient of 0.66.

Furthermore, since the first efficiency model indicated that lower expenditures were associated with higher technical efficiency scores, the relationship between per capita

expenditure and QoL scores was analyzed using a linear regression model. The results show a positive and significant coefficient for expenditure, equal to 1.212e-04 (p-value = 3.06e-05), although the Adjusted R-squared value of 0.1801 suggests limited explanatory power for the model.

Advancing this analysis, applying a log transformation to the expenditure values improved the correlation, reaching approximately 47%, and led to a reduction in the p-value to around 6.95e-06. This indicates an increased significance of the variable within the model.



(a) Correlation matrix - DEA QoL - Global Model

(b) Per capita expenditure and Global QoL scores correlation - Scatterplot

Figure 6.8: Correlation analysis of QoL Global Model results

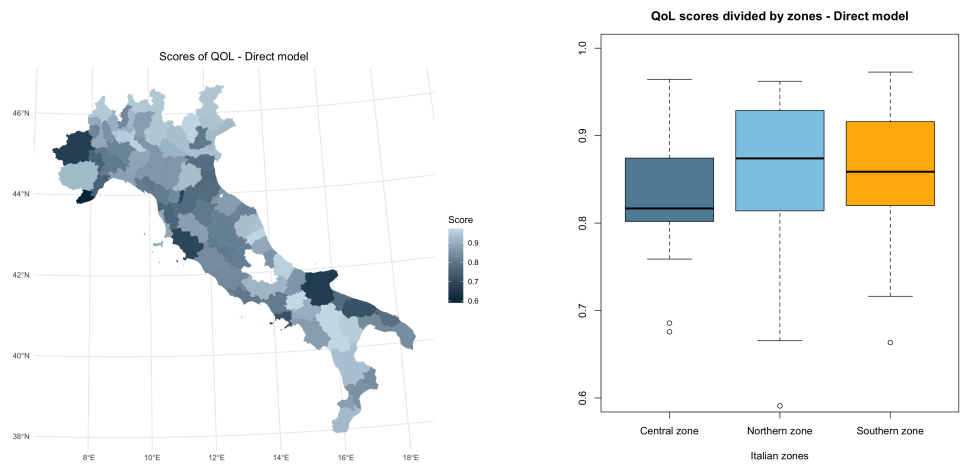
6.2.2. QoL - Direct model

Concluding with the presentation of the results concerning the direct DEA model, it shows significant differences in the scores of individual provinces and, consequently, their positions in the ranking, as highlighted in Table 6.4.

# rank	Province	Reversed score	Δ ranking
1	Benevento	97.27%	+ 02
2	Potenza	96.81%	+ 31
3	Ascoli Piceno	96.45%	+ 28
4	Vicenza	96.22%	+ 25
5	Lodi	96.10%	+ 15
...	...	...	...
81	Grosseto	68.56%	- 25
82	Prato	67.57%	- 25
83	Torino	66.56%	- 34
84	Foggia	66.35%	+ 01
85	Imperia	59.10%	- 02

Table 6.4: Quality of Life scores - Direct Model

Moving on to a geographical analysis, the color gradients on the map in Figure 6.9a and the median values displayed in the box-plots in Figure 6.9b clearly indicate an increase in the scores of provinces located in the southern region of the peninsula.



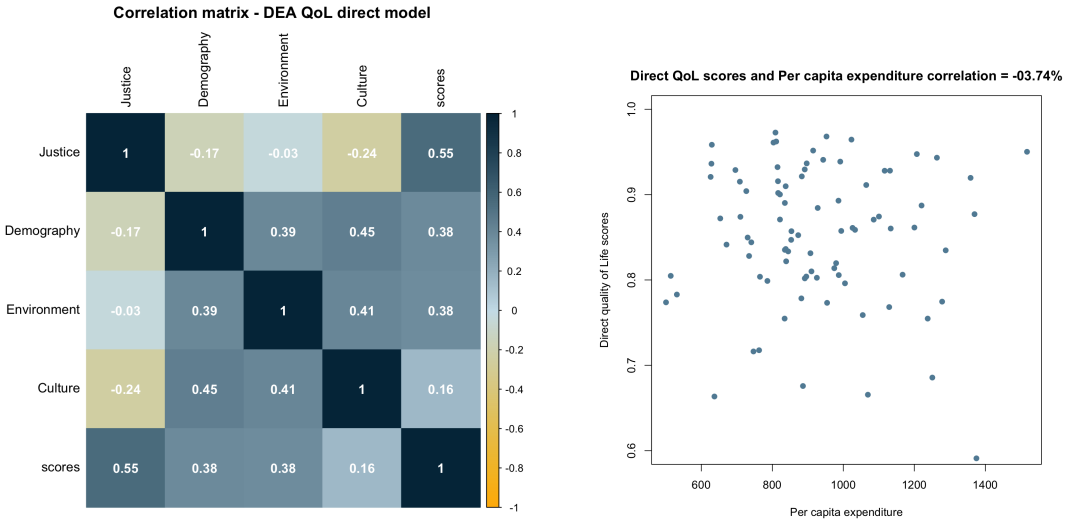
(a) Geographical distribution - DEA QoL - Direct Model

(b) QoL scores by Zone - Direct Model

Figure 6.9: Geographical analysis of QoL Direct Model results

Correlation analysis

To conclude, the same analysis performed on the previous models was conducted to identify potential strong correlations between the scores and the output variables included in the model. The analysis revealed the strongest correlation with the Justice and Security dimension. As for the scatter-plot, the correlation with the per capita expenditure values of the provinces reached its lowest point, dropping to -3.74%.



(a) Correlation matrix - DEA QoL - Direct Model

(b) Per capita expenditure and Direct QoL scores correlation - Scatterplot

Figure 6.10: Correlation analysis of QoL Direct Model results

6.3. Comparison & further analysis

Continuing our investigations aimed at addressing the research question, we conducted several analyses to examine potential relationships between the technical efficiency results obtained from the DEA Models and the Quality of Life scores recently presented. To achieve this, an initial linear model was developed, which tried to study the relationship between efficiency scores generated in the Model 1 (literature model 6.1) and QoL scores 6.3. The model can summarized:

$$QoL_i = \beta_0 + \beta_1 \cdot \text{technical_efficiency1}_i + \varepsilon_i, \quad i = 1, \ldots, n \tag{6.1}$$

This model shows a significant and negative correlation between efficiency scores and QoL ones, with an adjusted R-squared of 0.2095. This result, illustrated in Figure6.11, confirms what could have been anticipated from the analysis of the DEA models on technical efficiency and Quality of Life, which were, respectively, negatively and positively correlated with per capita expenditure (figures 6.2b & 6.8b).

Summary 6.1 linear model		
	Estimate Std.	**Pr(>|t|)**
Intercept	1.02131	**<2e-16 *****
Efficiency scores	-0.19066	**6.33e-06 *****
Signif. codes:	*0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1*	
Adjusted R-squared: 0.2095		

Table 6.5: 6.1 linear model summary

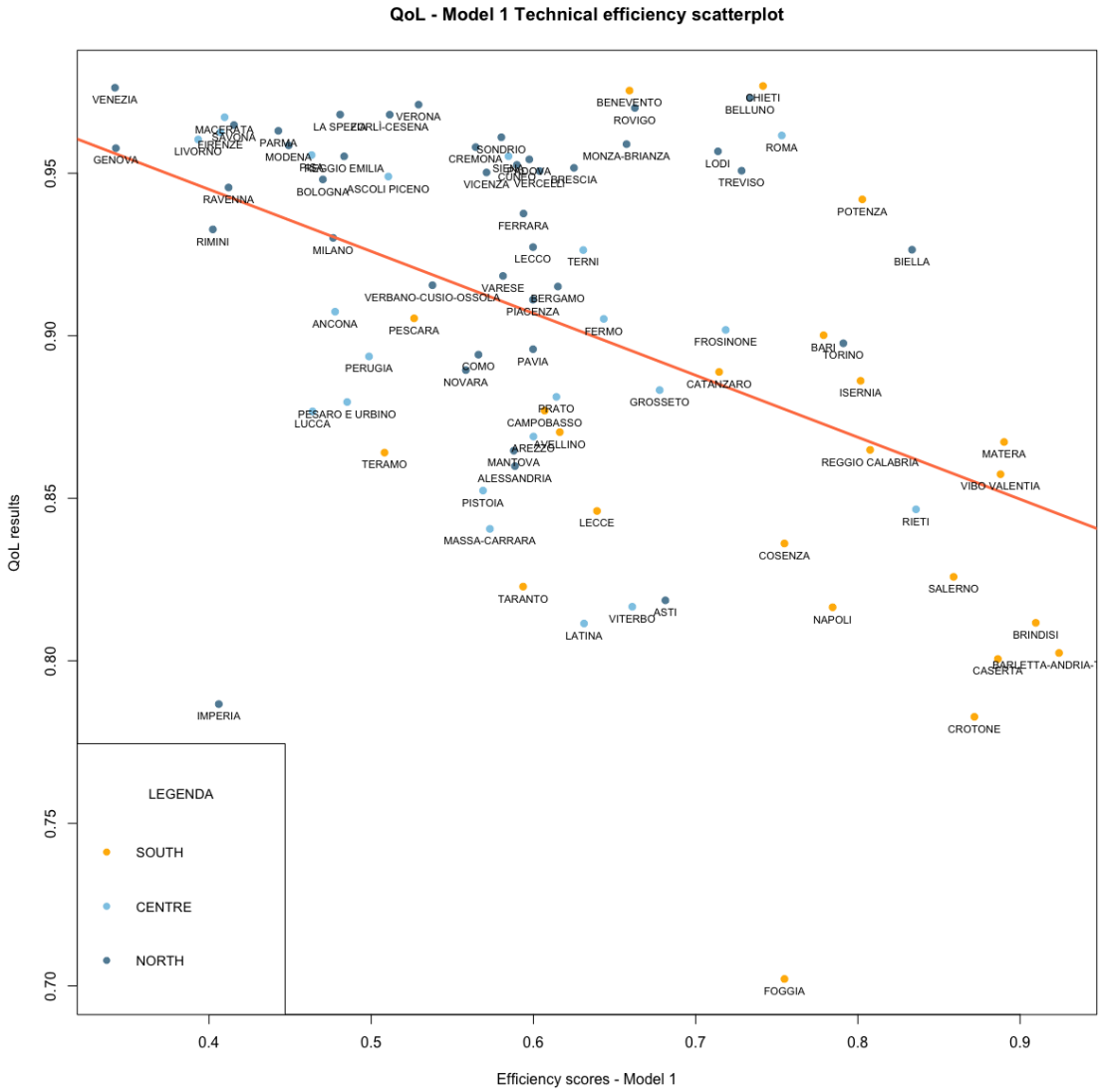


Figure 6.11: Relationship between Model 1 technical efficiency scores and Quality of Life scores

Continuing to the second analysis, the relationship between technical efficiency Model 2 and QoL scores has been analyzed through the same methodology implemented for the Model 1, the linear model is therefore represented by the following formulation:

$$QoL_i = \beta_0 + \beta_1 \cdot \text{technical_efficiency2}_i + \varepsilon_i, \quad i = 1, \ldots, n \tag{6.2}$$

As expected, the results obtained by this linear model clearly differ from the previous one, highlighting once again the differences between the two approaches to esteem the technical efficiency:

Summary 6.2 linear model		
	Estimate Std.	**Pr(>|t|)**
Intercept	0.86881	**<2e-16 *****
Efficiency scores	0.05030	0.237
Signif. codes:	*0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1*	
Adjusted R-squared: 0.00496		

Table 6.6: 6.2 linear model summary

The summary shows that the relationship between technical efficiency scores and QoL ones is positive but not significant. Also, the adjusted R-squared of the model is very low, indicating that the model has almost no explanatory power and fails in capturing the variance of the data.

Building on our analysis, a deeper investigation into the results, including our efficiency model, was conducted. The previously developed model was expanded by introducing a three-level factor variable representing the three macro-regions of Italy: South, Center, and North:

$$QoL_i = \beta_0 + \beta_1 \cdot \text{efficiency}_i + \beta_2 \cdot \text{Zone}_i + \varepsilon_i, \quad i = 1, \ldots, n \tag{6.3}$$

The summary obtained from the linear model described by equation 6.3 shows that the relationship between technical efficiency scores and QoL ones is still positive but not significant. On the contrary, the zone has not only a significant impact on QoL but also definitely increases the explanatory power of the model, rising the adjusted R-squared to (**0.2605**).

Summary 6.3 linear model		
	Estimate Std.	**Pr(>|t|)**
Intercept	0.88776	**<2e-16 *****
Efficiency scores	0.01806	0.62569
Zona Nord	0.03146	**0.02119 ***
Zona Sud	-0.04216	**0.00627 ****
Signif. codes:	*0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1*	
Adjusted R-squared: 0.2605		

Table 6.7: 6.3 linear model summary

Since the linear model has not shown any significant results, further analysis to better understand this relationships had been conducted. The two sets values, Model 2 efficiency scores and Global Quality of Life scores, have been scaled and both divided in two subsets: those values which were equal or above 0, therefore above the average value of the scores, have been labeled as "high", while the other as "low". From the results, a matrix have been developed, which contained four main clusters:

- Cluster 1: High QoL with high technical efficiency
- Cluster 2: High QoL with low technical efficiency
- Cluster 3: Low QoL with high technical efficiency
- Cluster 4: Low QoL with low technical efficiency

As can be seen in figures 6.12 and 6.13, the distribution of the clusters along the peninsula is mainly due to the QoL scores whose higher values are mainly positioned in the northern part of Italy.

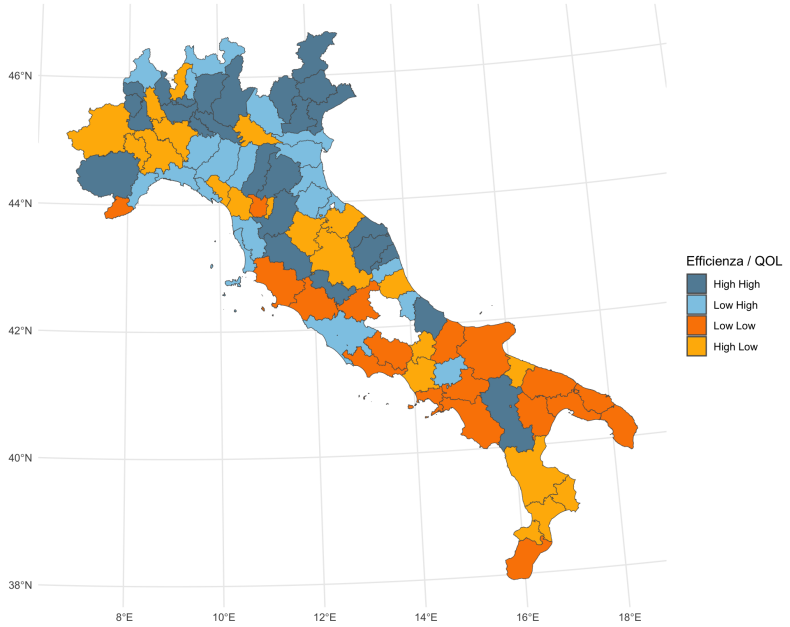


Figure 6.12: Geographical distribution of the four main of scenarios

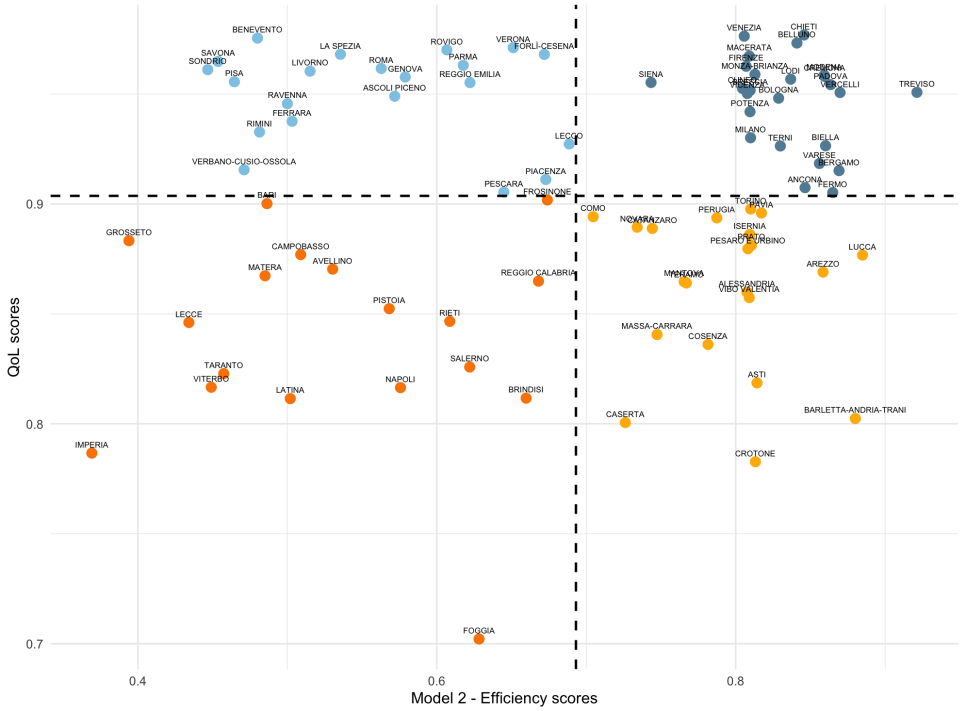


Figure 6.13: Scatterplot highlighting the four main scenarios

Delving in a deeper investigation of the geographical distribution of the clusters, a bar-chart for each Italian zone has been reported, as illustrated in Figure 6.14: while the central part of Italy is similar to the whole sample, the south and the north show marked differences in the distribution, depicting lower and higher values of QoL respectively.

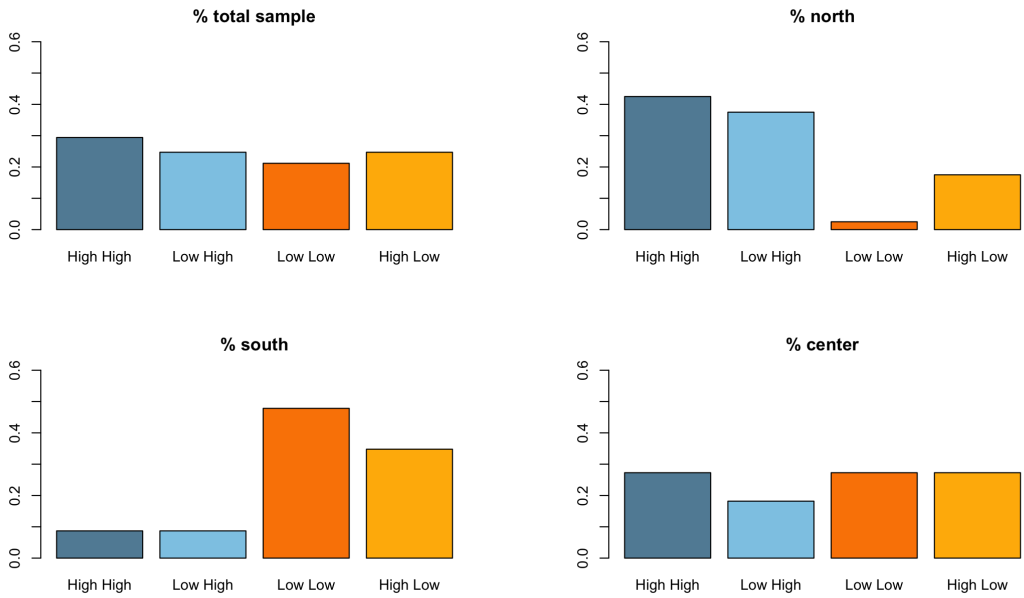


Figure 6.14: Cluster distribution by zone

Moving on with the analysis, the same approach has been implemented for the type of province as well, separating the once with a metropolitan city in it to the others. Results (Figure 6.15) show how metropolitan cities seems to be more likely in a coherent situation (High-High or Low-Low), recording the same result in both dimensions.

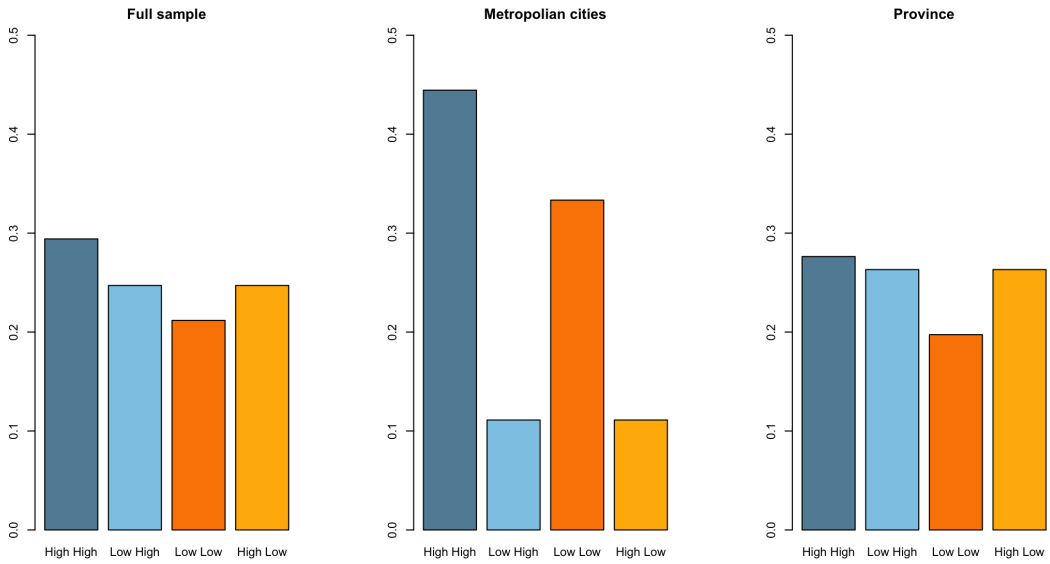


Figure 6.15: Cluster distribution by type of province

With regards to the direct QoL DEA model, a linear model similar to the 6.2 model has been replicated to study the same relationship but using the direct Quality of Life scores as target variable, as represented in equation 6.4.

$$\text{QoL_direct}_i = \beta_0 + \beta_1 \cdot \text{technical_efficiency2}_i + \varepsilon_i, \quad i = 1, \ldots, n \tag{6.4}$$

As table 6.8 shows, this variation of the linear model reports a positive significant correlation between QoL and technical efficiency: even if the model fail in capturing most of the variance of data, the t-test computed on the efficiency score regressor records a p-value below 5% ($\approx 3.04\%$). A visual representation of the model implemented is illustrated in Figure6.16.

Summary 6.4 linear model		
	Estimate Std.	**Pr(>|t|)**
Intercept	0.76465	**<2e-16 *****
Efficiency scores	0.12595	**0.0304 ***
Signif. codes:	*0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1*	
Adjusted R-squared: 0.04384		

Table 6.8: 6.4 linear model summary

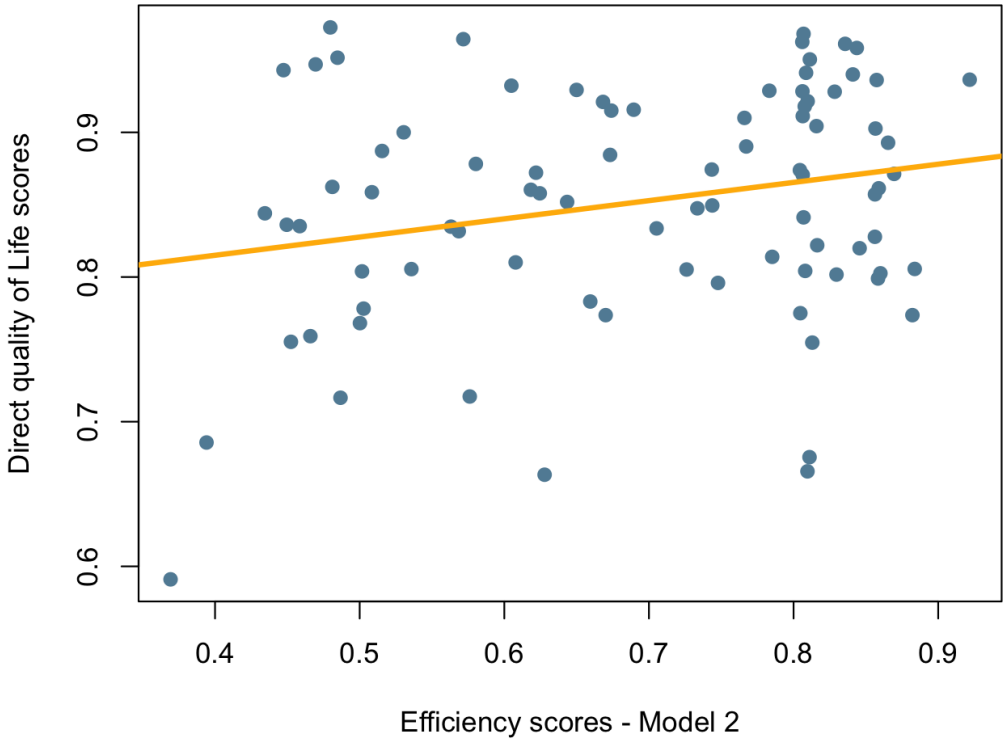


Figure 6.16: Model 2 efficiency - Direct QOL scores relationship

Moving on to one last analysis, to better evaluate how well the direct QoL DEA model captures a portion of the overall concept of Quality of Life, a final linear regression analysis was conducted. In this model, the global QoL scores serve as the target variable, while the direct QoL scores are included as regressors to represent the

scope of action for local governments. Additionally, GDP is used as a proxy for the economic factor, which is the primary distinction between the two QoL models, as both the *Wealth and Consumption* and *Business and Work* clusters are not included in the direct QoL model as they do not have any variable directly linked to the local government operate.

An interaction term between the two regressors, direct QoL scores and GDP, was included in the model to account for potential variability in the impact of direct Quality of Life scores depending on the level of economic development.

This interaction allows to explore whether the relationship between local government-related Quality of Life and overall Quality of Life is moderated by the economic conditions of the area.

$$\text{QoL}_i = \beta_0 + \beta_1 \cdot \text{QoL_direct}_i + \beta_2 \cdot \text{GDP_pc}_i + \beta_3 \cdot \text{QoL_direct}_i \cdot \text{GDP_pc}_i + \varepsilon_i \tag{6.5}$$

$$i = 1, \ldots, n$$

As shown in Table 6.9, the summary of the linear model reports high statistical significance for all the regressors, including the interaction term between them.

Summary 6.5 linear model		
	Estimate Std.	**Pr(>|t|)**
Intercept	-2.406e+00	<**4.26e-12** ***
QoL direct	1.454e+00	<**5.48e-06** ***
GDP per capita	8.657e-05	<**1.10e-12** ***
QoL direct:GDP per capita	-3.847e-05	**0.000466** ***
Signif. codes:	*0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1*	
Adjusted R-squared: 0.5739		

Table 6.9: 6.5 linear model summary

In contrast with the other models computed above, the linear model 6.5 records significantly better results in capturing the variance of the data as well, as its Ad-

justed R-squared value reaches 57.39%. This means that the model developed in this case shows significantly better performance in describing the relationship between local government efficiency, economic factors, and overall Quality of Life, providing a more accurate and comprehensive representation of the factors influencing Quality of Life across different regions.

7 | Discussion

After presenting the results, it is essential to extrapolate from them key insights and knowledge. This study highlights several critical points that warrant discussion and are expected to contribute valuable findings to the existing literature on local government efficiency and the measurement of Quality of Life. These points will hopefully deepen the understanding of these areas and offer a meaningful contribution to the ongoing research in the field.

7.1. The limited role of technical efficiency

From a technical efficiency perspective, the scores obtained in the two models presented, Model 1 and Model 2, showed significantly different results. This outcome aligns with the literature, which lacks clearly defined trends for Italy.
Model 1 found that municipalities in Southern provinces generally demonstrated higher efficiency than their Northern counterparts. These results are fully consistent with those presented by lo Storto (2016), whose model served as the primary literature source for Model 1 developed in this research. While the findings regarding regional disparities align with the literature, our study did not find significant evidence for economies or dis-economies of scale, in contrast to lo Storto (2016) and several other studies (Agasisti & Porcelli, 2023; Agasisti et al., 2016; Perugini, 2024; D'Inverno et al., 2018). This discrepancy could be attributed to the level of aggregation used in the analysis. Aggregating expenditures at the provincial level may have smoothed out spending fluctuations occurring at the municipal level, potentially obscuring improvements in local government efficiency as population size increases.

The second model implemented to compute technical efficiency, that differently from Model 1 has been built on the variables utilization proposed by Agasisti and Por-

celli (2023) but utilizing DEA instead of SFA to compute scores, showed different results. No particular effect of scale was found and there were only small difference between provinces in the North, Center and South. Northern provinces perfomed better compared to the one in the South (as in Agasisti and Porcelli (2023)).
As demonstrated in both Model 1 and Model 2, there are multiple approaches to calculate technical efficiency scores, and the results vary significantly depending on the method, the data used, and the complexity of the model. Additionally, the relationship between the two efficiency scores and citizens' Quality of Life differs markedly. The first score, based on the method presented by lo Storto (2016), shows a negative and significant relationship with QoL. In contrast, the more complex model proposed in this paper, Model 2, reveals a more ambiguous relationship, with limited significance. This difference underscores that the impact of technical efficiency on Quality of Life is highly dependent on how the research defines these measures and, consequently, the model that is constructed. **While technical efficiency could be used as a reasonable proxy, it remains difficult to determine whether it provides a comprehensive estimate that captures all inefficiencies in local government operations.** Hence, it becomes challenging to assess the extent to which these kind of measure alone affect municipalities' ability to deliver value to citizens. To better assess the capacity of local governments to create value to communities and citizens, a variety of additional metrics from a New Public Management perspective should be considered. These metrics not only evaluate how efficiently governments use resources, but also whether they provide meaningful value to citizens. **Resource allocation efficiency**, in order to align public sector resources with social needs, optimizing welfare in a budget-constrained environment (Pollitt & Bouckaert, 2011) and **managerial/operational efficiency** to ensure public sector agility and reducing waste across processes (Osborne & Gaebler, 1993), are just a few of the metrics NPM suggest to better understand the relationship between local government efficiency and citizens' Quality of Life.

7.2. The importance of local governments in less economically prosperous communities

The QoL results revealed other interesting points of discussion, particularly regarding the increasing gap between the two main scores computed: Global and Di-

rect. When examining the Global QoL score, there is a clear distinction between provinces in the North and the South. Northern areas tend to have higher QoL scores compared to their southern counterparts. However, this difference disappears when looking at the Direct QoL scores, which exclude strictly economic variables and therefore do not capture all aspects of well-being experienced by citizens. This highlights the significant role economic factors play in influencing citizens' QoL, as evidenced by the strong correlation between the Global QoL scores and GDP per capita (Table 6.9). Moreover, per capita expenditure also has a positive impact on QoL. Indeed, as shown in Figure 6.8b, the positive relationship (both logarithmic and linear) indicates that in areas with higher per capita spending, the Quality of Life is also higher.

Also, the linear model 6.5 computed provides valuable insights into this topic. Both Direct QoL scores and GDP per capita contribute positively to the Global Quality of Life value. This is intuitive, as GDP per capita is highly correlated with Global QoL scores, and the Direct QoL scores are a component of the Global ones. However, the interaction between the two reveals a negative coefficient, indicating that as the GDP per capita of a province increases, the influence of Direct QoL scores on overall Quality of Life diminishes. This suggests that in regions with higher GDP, the contribution of local government performance, represented by Direct QoL scores, becomes less significant in determining the overall Quality of Life value. Complementarily, this shows **the crucial difference in the local government related QoL impact to the overall QoL in different economic conditions**. Indeed, the less economically prosperous a region is the more local government related services are important and impacting in the model, suggesting that the role of the public sector increases. This is in accordance with Perugini (2024) which finds that local government efficiency is particularly crucial in the southern and less populated areas of Italy, where they can significantly affect economic growth. But also with, Bigerna and Polinori (2014) which argues that efficient local governance can have a greater impact on QoL (concerning mainly Environment and waste collection variables), especially in areas with fewer resources or in less developed regions. Hence, it is essential to understand the actual leeway local governments have and how much of the QoL is influenced solely by higher levels of government performances or by different kind of reasons (e.g. private sector performances).

7.3. The role of local governments in shaping citizens QoL

In order to overcome the limited power of technical efficiency, to completely grasp the delivery performances of local government and to analyze the relationship they have with QoL, this study tried to better understand the relationship between QoL scores and technical efficiency ones. Results revealed interesting insights on this.

Starting from the relationship between Model 1 and Global QoL scores (Figure 6.11), the strong negative correlation between these two indicators complicates the interpretation of the data.

Unlike QoL, which appears to increase with higher spending, the technical efficiency computed using the first methodology shows a marked inverse relationship (approximately -70%, as illustrated in Figure 6.2b). This trend may suggest that the scores are likely to be **overly influenced by per capita expenditure alone, regardless of the quantity of services each DMU delivers within that budget.**

Thus, M1, like all models that employ the methodology used by lo Storto (2016), not only seems to fails in capturing the complexities of public service provision and its effects on citizens' lives, but may also be inadequate for assessing technical efficiency in local governments. Since higher expenditure is often associated with improvements in well-being, in line with the findings presented in the papers written by Perugini (2024) and Doumpos et al. (2020), the model's simplicity may lead to classifying as highly efficient those DMUs that excessively reduce spending instead of those actually improving their perfomances providing better services spending a few more money. **This limitation highlights the need for a more nuanced approach that considers additional factors to accurately evaluate local government performance.**
The more the complexity and completeness of variables used to compute technical efficiency increases, as in Model 2, the less defined the correlation becomes, and this effect disappears. In fact, looking at the relationship between QoL global scores and Model 2 efficiency scores the **relationship** becomes positive but not significant and could be interpreted as **ambiguous** but certainly more interesting to study. Not always when technical efficiency increases QoL behaves similarly and vice versa. This

happens, but only in certain areas and groups of provinces as showed in Figure 6.12 were clusters on the different types of relationships between efficiency and QoL have been created. Somehow the initial research question now changes, regarding more what is that defines the collocation of each province in one these groups. **Why do certain local governments experience technical efficiency but at the same time they have low QoL? Or Why certain communities experience high QoL levels despite technical inefficiencies of their local government?**
Some insightful viewpoints could be grasped by looking and the third relationship studied (Linear Model 3 6.4, between Model 2 and direct QoL scores and by the characteristics of each province. The significant positive relationship between Model 2 technical efficiency scores and QoL direct impact scores (in accordance with Bigerna and Polinori (2014) and Cárcaba et al. (2022) findings), even if it does not prove causality, it indicates that when technical efficiency increases also QoL standards in categories who are directly influenced by municipalities operations rise, indicating that **the ambiguous relation between Global QoL scores and technical efficiency is likely to be derived by factors that local government cannot control which enable certain provinces to experience a boost, or fall, in their QoL.** For instance, private sector related factors (e.g. the wealth of the population, according to the positive GDP impact on QoL seen in the previous section), healthcare matters or other services whose responsibility is of higher governmental level, like the region or the State itself. Particularly, the most interesting ones are the one which in Figure 6.12 are defined by high technical efficiency and low QoL (Yellow) and the ones presenting the complementary situation with high QoL despite technically inefficient municipalities (Light Blue).
Regarding the first category, many yellow provinces, especially in the Calabria region, increase their QoL scores when only direct variables are considered (on average, they increase their ranking by 10 positions circa). This could indicate that provinces in this quadrant are highly affected in a negative way by conditions that do not concern municipalities. Indeed, scarce economic opportunities and private sector underdevelopment might be reasons why these territories do not experience high QoL, even if they have good technical efficiency scores. On the other hand, light blue territories might experience a significant decline in their QoL scores when variables related to factors outside municipal control are considered (on average, they decrease their ranking by 18 positions circa), indicating that the role of this government level is less impactful in determining citizens' well-being. These areas

experience some sort of crowding-out effect by other state levels (e.g., regions) or by the private sector itself. This is particularly true for the Emilia-Romagna region, which is well known for its flourishing private sector and regional institutional best practices (Luca & Modrego, 2021). Switching to the last two clusters: in the bottom left corner, there are provinces that not only have low technical efficiency but also experience low QoL (without any significant change even in direct QoL). These areas should better leverage the power of local government to engage and encourage other actors, such as the private sector. In the top right corner are provinces mainly located in the North of Italy, in regions like Veneto and Lombardy, as well as provinces like Bologna and Florence. This highlight another very interesting factor related to the characteristics of the province itself: the presence of a metropolitan city (Figure 6.15). This factor greatly contributes to the placement of the province in either the High-High or Low-Low cluster. This may be due to the higher institutional and decision-making power, and therefore impact, that metropolitan cities have on their area, emphasizing the importance of well-managed local government in such provinces.

7.4. Managerial and Policy implications

This discussion open the doors for few managerial and policy implications. Particularly, tailor made suggestions will be proposed for each cluster showed in Figure 7.1. It is intuitive that after what have been said above, the ideal condition would be to exist in the top right corner of the Matrix in what has been called the *Deserved Succes* quadrant. So, what could municipalities in the other three quadrants do to be like them?

Municipalities in the bottom right corner, which has been denoted *Useless Virtue*, even if they experience good technical efficiency, fail to have a high QoL mainly due to reason which not directly concerns municipalities but other issues as stated in section 7.3. Municipalities could re-orient their investments and expenses towards programs which might support or have indirect side effects on areas which are others' responsibilities, such as economic development and competitiveness or healthcare support. This approach would not only foster private sector growth and resilience but also help bridge gaps between different levels of government, such as

regional and municipal authorities, addressing citizens' needs more directly. For instance, municipalities can play a role in supporting local small and medium enterprises (SMEs) facilitating growth and encourage international expansion. An example is Milan's Milano Internazionale program, which economically fosters the participation in international fairs, foreign promotion, and specialized consulting services aimed at internationalization (Comune di Milano, 2021). In addition, municipalities can fund the construction and management of local markets to attract customers and foster business activities, as well as organize themed fairs that enhance visibility for local businesses. Investing in technological infrastructure, like broadband expansion, is another key area; cities like Turin and Bologna have improved broadband access in urban and rural areas to reduce the digital divide and support businesses dependent on reliable, high-speed internet (Regione Piemonte, 2019). Also, in healthcare, although primarily a regional responsibility, municipalities can offer complementary support. For instance, municipalities played a critical role during the Covid-19 pandemic by converting public spaces, such as gyms and community centers, into vaccination hubs, thereby easing access to vaccines and assisting regional health authorities with logistics and service provision (Agenzia Italiana del Farmaco (AIFA), 2021). These initiatives showcase how municipalities can enhance healthcare access and local economic development by working alongside regional and private entities. Clearly, a significant improvement in QoL will always be closely linked to higher budget allocations from higher levels of government: while municipalities can provide supportive measures, substantial improvements must be driven by those who are directly accountable for the factors mentioned above.

Switching to the top left corner, in provinces known as *Lucky Stars*, the issue is that local governments have low technical efficiency, although Quality of Life (QoL) remains high. These municipalities benefit from a strong and healthy regional or private sector presence; however, they should improve efficiency at the local level to push QoL even higher. In particular, they should focus on topics such as procurement cost efficiency, digitalizing administrative processes, reorganizing governance and implementing efficiency frameworks like Lean Management which can help these municipalities reduce costs and improve service delivery. According to McKinsey & Company (2017) digital solutions and streamlined workflows allow public sectors to cut administrative expenses by up to 30% by minimizing redundancy and optimizing resource allocation. An Italian example is the municipality of Milan, which launched

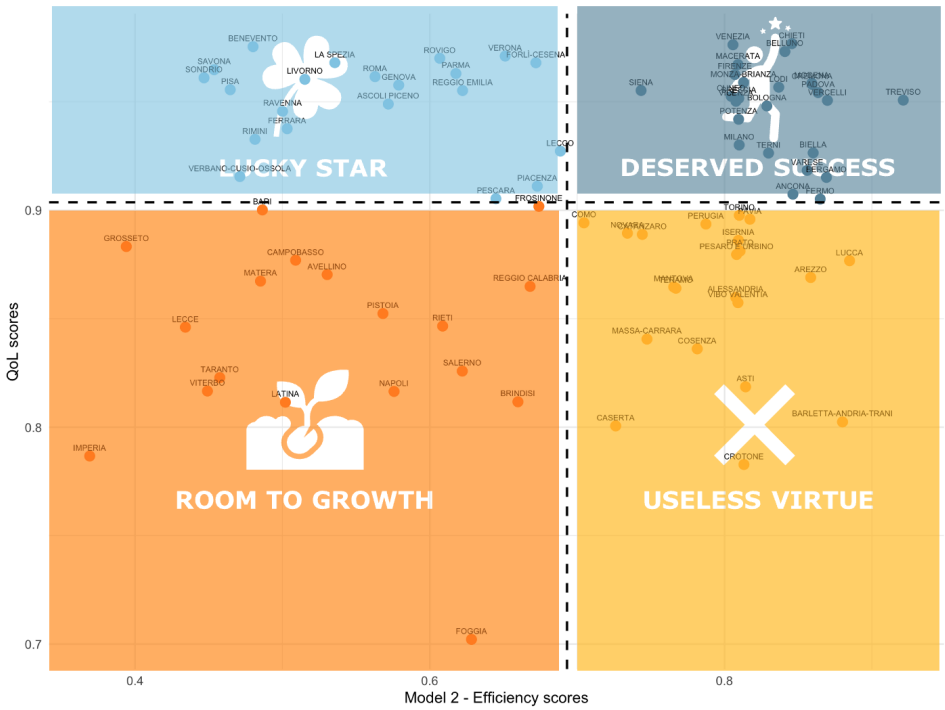


Figure 7.1: Efficiency - QoL Matrix

the Milan Digital Agenda to enhance e-government services. By moving services like permits, licensing, and tax payments online, Milan significantly reduced processing times and administrative costs, demonstrating how digitalization can boost productivity while maintaining high-quality services for citizens.

Lastly in the bottom left corner resides the so called *Room to Growth* Provinces. In this area municipalities should work in both the areas explained for quadrants above, *Useless Virtue* and *Lucky stars*. First they should try to structurally improve their efficiency performance investing and using tools explained above (procurement cost efficiency, digitalizing administrative processes, reorganizing governance and Lean Management) and then try to direct their operations to foster other areas of QoL as suggested for the *Useless virtue* province.

Since these areas are typically less economically prosperous than others, the role of the national government would probably be necessary too. Either by direct subsidizing or helping in structural investment to increase efficiency, the State could also direct information towards mayor and public servants in order to better inform on national and/or EU funding opportunities.

These were the major findings and proposals which have been extrapolated from this study's result. They should be used as a starting, and not an ending point, to encourage discussion on such a delicate topic like the relationship between citizens QoL and local government efficiency.

8 | Additional investigation

In addition to the primary research conducted in the preceding sections of this thesis, two supplementary analyses were undertaken. The first focused on calculating vertical technical efficiency scores across the six main areas of responsibility managed by municipalities. The second explored the validity of using the capital municipality as a representative proxy for the results of the entire province, as anticipated in Chapter 4.

8.1. Vertical DEAs

Taking inspiration from several papers reviewed in the literature that calculate efficiency results vertically by applying statistical models to specific sectors of local government action, such as education or environmental management, this research has conducted a series of vertical analyses using DEA. These analyses were performed on the six clusters defined in previous chapters, which represent the direct accountability of municipalities, building on the framework developed for this study.

Efficiency scores, which are shown in detail in Appendix B, have been computed using a framework similar to that of Model 2, thoroughly explained in Chapter 5, but with each area of services utilizing the specific variables shown in Figure 4.3. The cost item, included as an input, is therefore only associated with the cluster under analysis, and all variables previously aggregated within the cluster for the Model 2 analysis have now been used separately as independent output variables.

A quick look at the results of the different models, as illustrated in the maps in Figure 8.1, reveals that the distribution of top performance across sectors is not uniform for all the clusters analyzed. While the northern part of the country appears to record higher scores in security and environmental sectors, the highest scores for education and transportation are more concentrated in the southern regions. The distribution

of scores in Sport, Culture, and Free Time (SCF), as well as Social Rights, does not seem to follow a clear geographical pattern, appearing scattered across the entire country.

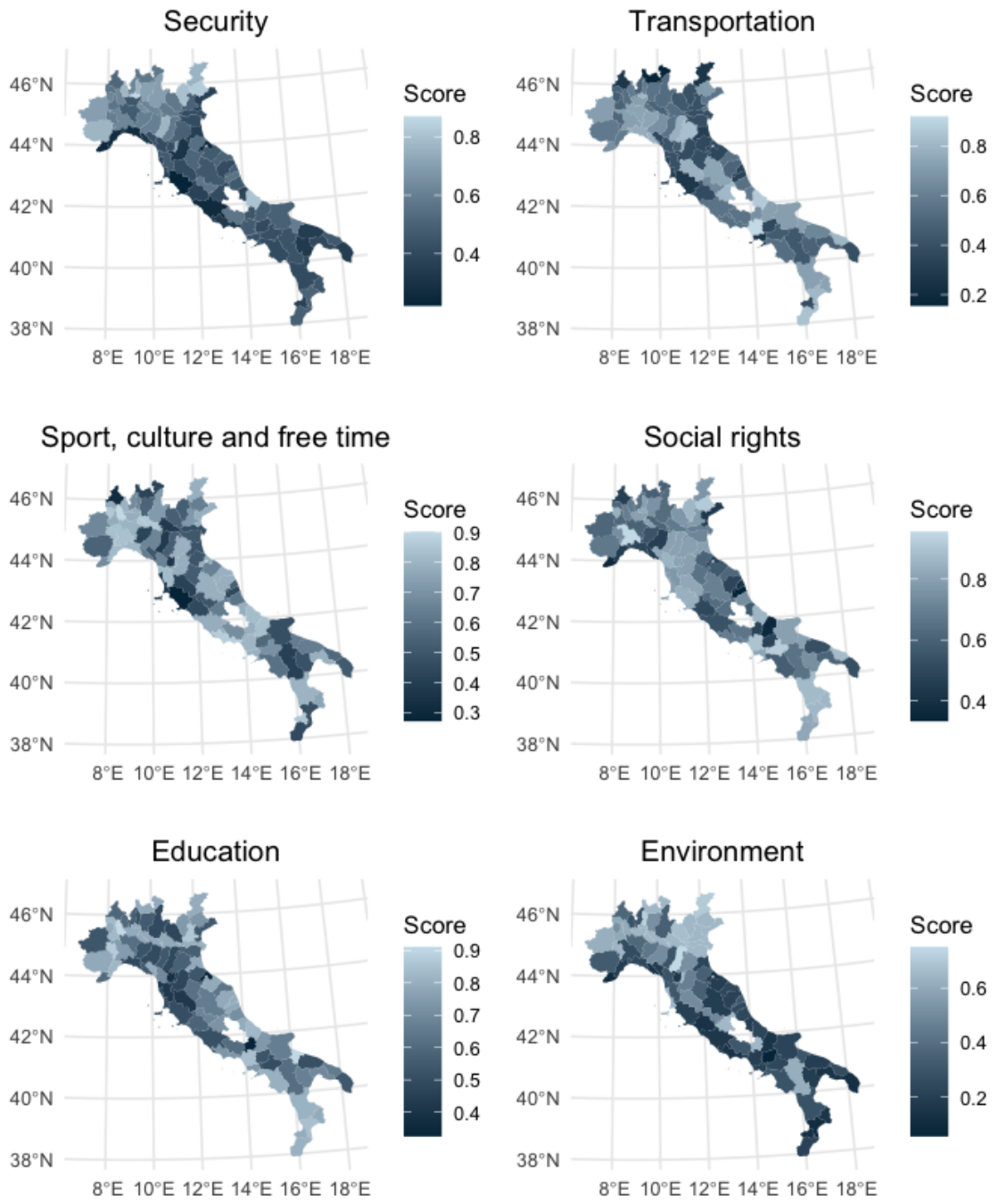


Figure 8.1: Vertical DEA model results

#	SEC		TRA		SCF		SR		EDU		ENV	
1	MB	0,87	CE	0,92	NO	0,90	AL	0,96	NO	0,91	MO	0,75
2	TV	0,83	CH	0,87	LT	0,87	AV	0,93	BT	0,91	LC	0,72
3	CH	0,81	RC	0,84	CR	0,86	TV	0,92	AT	0,87	BL	0,70
4	VI	0,80	BO	0,84	LO	0,85	CE	0,90	PD	0,86	VR	0,66
5	VA	0,77	CZ	0,81	BI	0,85	BR	0,88	CZ	0,84	VI	0,65
...	...		...		...		...		...		...	
81	GE	0,26	NA	0,28	RE	0,38	VE	0,44	SI	0,42	VV	0,13
82	RM	0,26	GR	0,27	LI	0,37	FM	0,41	PI	0,42	LE	0,12
83	RN	0,25	VB	0,27	PT	0,36	IM	0,36	PT	0,38	CZ	0,10
84	IM	0,25	BL	0,26	VB	0,31	CB	0,36	RN	0,34	IM	0,10
85	GR	0,22	SO	0,16	GR	0,27	AP	0,33	IS	0,32	BN	0,06

Table 8.1: Technical efficiency scores - Vertical DEA

Beyond the geographical analysis, additional insights emerge from calculating a correlation matrix for provincial scores across different categories. First, only positive correlations are observed, indicating that technical efficiency, when present, tends to support similar performance trends across various functional areas. However, the correlation values are generally low: in almost all cases, these fall below 20%, with the exceptions of security and environment and security and social rights, which show correlations of 49% and 31%, respectively. This suggests that synergies across different functional areas are limited, requiring each area to be optimized individually. Likely due to the distinct nature of each service area, the potential for leveraging synergies across sectors remains constrained.

While these sector-specific analyses likely provide a more precise measurement of municipal performance within a given sector, they cannot substitute the research conducted on the overall operation of local governments. Only a comprehensive analysis indeed can offer a synthetic proxy of how these public entities provide services to the population from a comprehensive point of view.

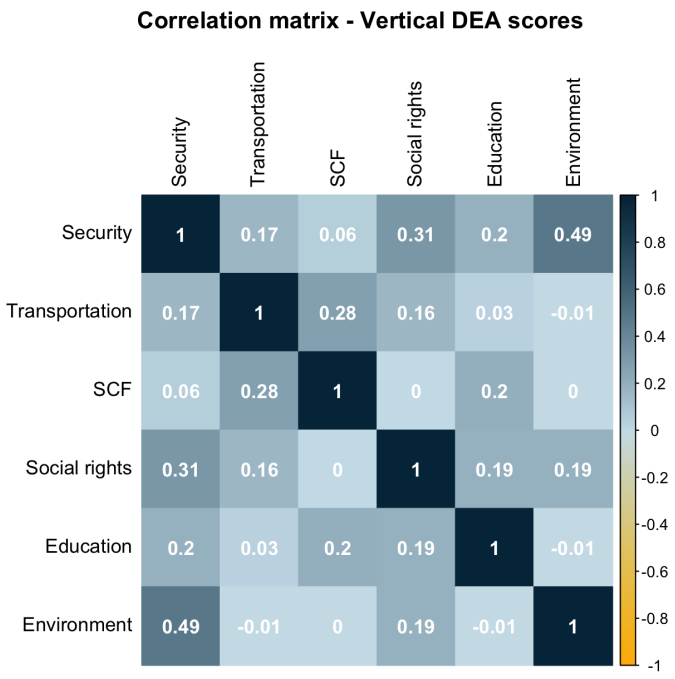


Figure 8.2: Correlation matrix - Vertical DEA model scores

8.2. Capital municipality approximation

This last section addresses a common problem in studies on local government performance: the lack of comprehensive data for all Italian municipalities, particularly due to the challenges of manually gathering data for over 6,500 municipalities across the country.

To address this issue, several studies, such as Bigerna and Polinori (2014), have proposed using the capital municipality of each province as a proxy for all the municipalities within that province. Given the data available for this research, the models discussed above were recomputed using this proxy approach to evaluate potential differences in outcomes. A first data cleaning procedure done to remove outliers has led to the removal of some provinces from the dataset, which will not be present in the charts due to this reason.

Among the most challenging datasets to collect are local government expenditure values, which serve as critical inputs for both technical efficiency models. Figure

8.3 demonstrates a positive correlation between the per capita public expenditure of the capital municipality and the total expenditure of all municipalities within the province. This finding suggests that the capital municipality's expenditure can be a reliable proxy for the entire province.

To investigate this relationship more deeply, a linear model was developed, with the total provincial expenditure as the dependent variable and the capital municipality's expenditure as the main regressor. The number of municipalities in the province was also included as a predictor. Results showed a good degree of variance capture (around 50%), with both predictors displaying significant statistical relevance. As expected, the results indicate that the influence of the capital municipality's expenditure on the total provincial expenditure decreases as the number of municipalities in the province grows, confirmed by the negative coefficient of the interaction term.

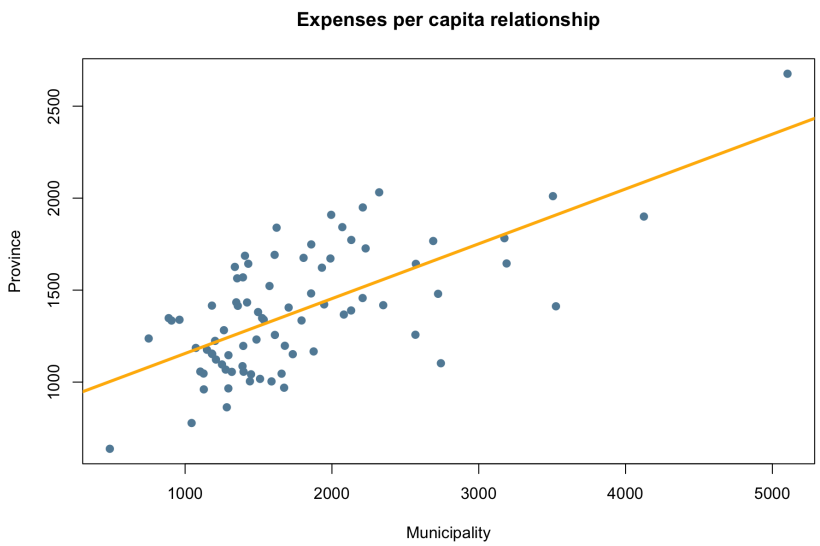


Figure 8.3: Scatterplot of per capita expenditure - Capital municipality vs. total provincial expenditure

Moving on to efficiency scores, both Model 1 and Model 2 were recomputed using the same framework outlined in Chapter 5. No new models were developed for Quality of Life (QoL), as the data used were already at the highest level of granularity available.

In the case of Model 1, Figure 8.4 illustrates noticeable variations in efficiency scores,

as shown by the changing color shades on the map. A geographical analysis based on macro-regions (North, Center, South) reveals consistent trends across models (as shown in Figure 8.5a). However, a paired t-test conducted on the normalized scores yields a p-value slightly above 1%, which is sufficient to reject the null hypothesis. This suggests that the two models (with and without the capital municipality proxy) produce significantly different results.

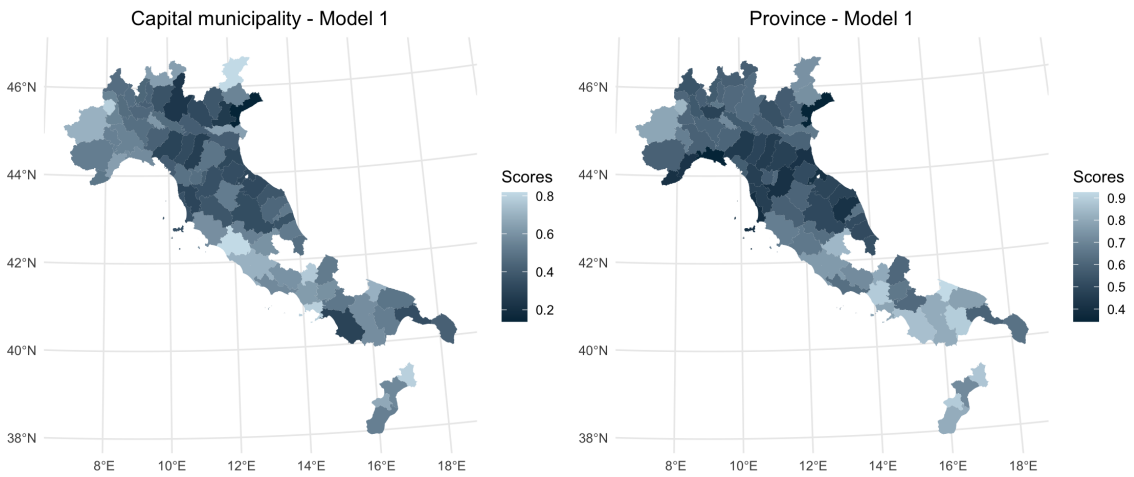
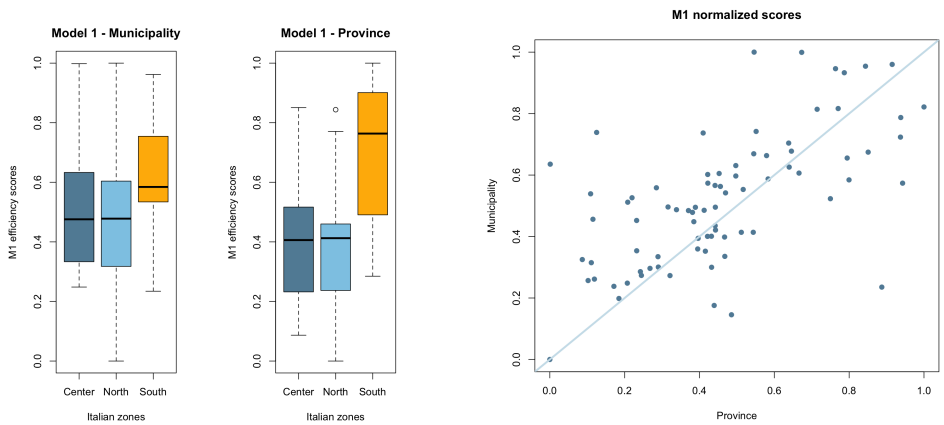


Figure 8.4: Model 1 efficiency scores: Map comparison



(a) Zone comparison - Model 1 (b) Model 1 differences - Scatterplot

Conversely, applying the same approach to Model 2 yielded different results. Despite the apparent similarity in map representation (Figure 8.5), a paired t-test conducted on the normalized scores produced a p-value around 30%, making it impossible

to reject the null hypothesis. On a geographical level, the three macro-regions maintained the same ranking, though with some differences in absolute values.

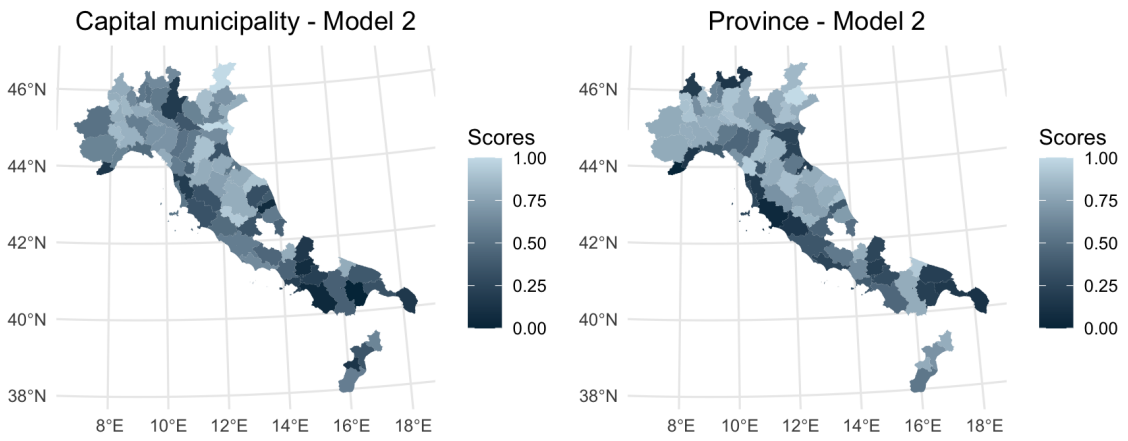
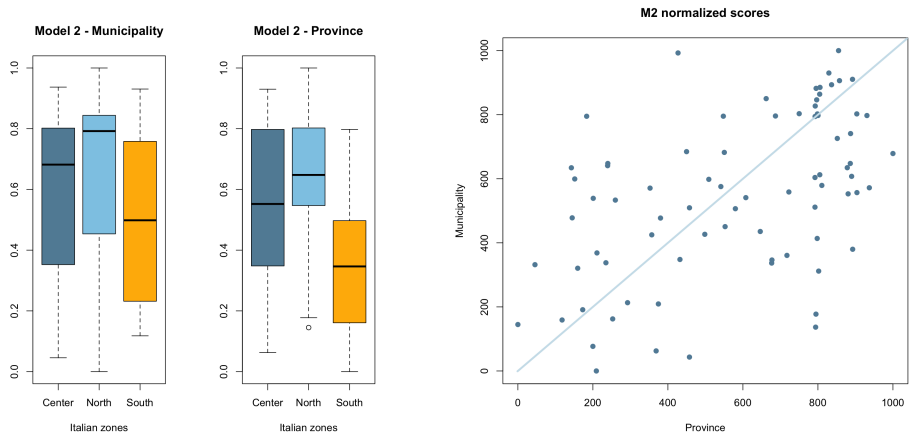


Figure 8.5: Model 2 efficiency scores: Map comparison



(a) Zone comparison - Model 2 (b) Model 2 differences - Scatterplot

In conclusion, using the capital municipality's data as a proxy for the entire province appears to be an effective approach when precision is not critical. However, the reliability of this approach varies depending on the selected model and the number of municipalities within each province. As observed, a higher number of municipalities tends to reduce the proxy model's accuracy in reflecting results based on higher data granularity.

9 | Conclusions

As this study approaches its conclusion, it is essential to gather and synthesize all the steps, methods and findings and connect them to the initial research questions: investigating the relationship between local government efficiency and on the contextual factors affecting it.

First, an exhaustive literature review (Chapter 2) on the topic of local government technical efficiency and QoL indicator computation was conducted. This review not only helped define the topics, methods, and variables needed to empirically address the research question, but it also provided a solid foundation on the state of the art in this field, highlighting a significant literature gap on this topic in Italy.
Then, after selecting the econometric and statistical tools used to compute QoL and efficiency indicators (Chapter 3), an accurate data selection and manipulation have been conducted (Chapter 4) to build a solid and innovative research framework (Chapter 5) enabling a consistent and comprehensive interpretation of results. Two efficiency scores and two QoL scores were computed. Specifically, Model 1 followed an approach proposed by lo Storto (2016), while Model 2 was more complex and innovative, building on the variable utilization similar to Agasisti and Porcelli (2023). On the other hand, QoL scores were computed maximizing desirable factors and minimizing undesirable ones. The first model comprehensively considered both economic and non-economic aspects, while the second model focused solely on QoL factors that Italian municipalities can directly influence.
Fortunately, the results (Chapter 6) on the relationships between these scores and other contextual variables yielded several interesting discussion points. First, the limited role of technical efficiency scores has been demonstrated. While these scores can serve as a useful proxy for assessing local government performance, the significant differences observed between the two model results, largely due to the varying levels of complexity on which they are based, highlight the importance and need to

double check the impact of this performances linking these scores with other indicators, such as effectiveness and value delivered to citizens. Then, QoL scores revealed an expected and pronounced divide in QoL between Northern and Southern Italian municipalities. Also, the results indicate that economic factors, such as GDP per capita, heavily influence QoL scores signaling the increased importance of the municipal role in regions where external economic factors are less favorable, as precise local government efforts can significantly contribute to citizens' well-being. Finally, the relationship between these scores has been analyzed, revealing an ambiguous link between local government efficiency and QoL. This suggests that a case-by-case approach is necessary to accurately interpret the findings. Specifically, four main clusters have been identified, each requiring tailored managerial and policy recommendations to enhance local government effectiveness and, consequently, improve QoL.
Lastly, in addition to the main analysis, the study explored two other themes: vertical technical efficiency scores and the use of capital municipality as a proxy for the entire province, as in Bigerna and Polinori (2014). Regarding the first, correlations between vertical efficiency scores show limited synergies between different public services, with mostly low positive correlations, highlighting low synergies in the mix of services local governments offers. Then, capital municipality's spending offers a viable proxy in cases where detailed data is lacking; the study finds that the reliability of this approach diminishes in provinces with a larger number of municipalities.

9.1. Limitations

Despite the numerous contributions this research has made to the literature, it is also accompanied by certain limitations.

A first group of limitations is related to the **data used**. The granularity of data varies across regions, with Quality of Life data only available at the provincial level, requiring aggregation that may not fully capture municipal-specific conditions. Although this approach provides reasonable estimates, particularly for social, demographic and service related variables, it could lead to inaccuracies in financial figures by not fully accounting for all provincial-level funds, potentially affecting the precision of spending analysis. Additionally, the inherent subjectivity of Quality of Life and the variable selection to represent local government services represent a poten-

tial issue. In this study QoL is defined primarily through Il Sole 24 Ore indicators and it might be reasonable to think that using alternative measures might yield different insights. Furthermore, Model 2's technical efficiency analysis is constrained to variables available on OpenCivitas and a select few others, limiting the scope for a more exhaustive assessment on all local governments related services. Finally, aggregating expenses across municipalities can mask the scale effects between smaller and larger municipalities, which may differ significantly in their financial dynamics.
A second group of limitations is related to the **time horizon** utilized. The focus on a single year not only restricts the study's ability to capture evolving trends but also obscures the long-term impacts of municipal investments, particularly when current expenses and long-term investments are not distinguished. Many structural projects yield benefits over an extended period rather than within a single fiscal year. When current expenses and long-term investments are combined, it becomes challenging to assess which expenditures are producing immediate operational efficiencies and which are setting the foundation for future QoL improvements. Without a multi-year perspective, it is impossible to observe the return on investments and how they translate into measurable changes in QoL or efficiency scores over time.
The **Clusters** made also need few comments which limit their interpretation. The distiction identified in this study should be interpreted with a degree of fuzziness, as values near the boundaries (i.e., average score values) may not clearly belong to one cluster or another (e.g. Torino, Pavia, Frosinone, Pescara, ecc...) . These borderline cases should be treated with caution and warrant a more in-depth investigation to understand the nuanced characteristics that may not be fully captured by strict cluster assignment.
A final limit of this research is then related to the **relationship** the study try to identify. Focusing on examining correlations rather than causation, as establishing causation would require a control and a under-treatment group, which were not feasible in this research design. Consequently, while the analysis reveals significant associations between technical efficiency and Quality of Life, it does not establish a direct cause-and-effect relationship. Without a randomized control, factors such as economic cycles, policy changes, and unique regional characteristics might also influence the observed results. This limitation means that the findings should be interpreted with caution, recognizing that other external or unmeasured variables could be contributing to the correlations identified.

9.2. Further research opportunities

While the findings have contributed valuable insights into the relationship between technical efficiency and QoL, they also highlight areas subjected to few limitations where additional investigation could enhance our understanding and offer more nuanced guidance for policymakers and public servants.

Starting from one of the limitation presented above, a first valuable extension of this study could be creating a **longitudinal analysis** involving data across multiple years to observe trends over time. This would allow for a more comprehensive view of how technical efficiency and QoL evolve and are influenced by long-term economic, policy, or social changes. A multi-year analysis could also be interesting to evaluate investments' social returns for citizenship and reveal the cumulative effects of municipal policies on QoL, helping clarify causation patterns that are harder to detect in a single-year analysis. Also, integrating qualitative measures such as **citizen satisfaction surveys** with QoL indicators could overcome the limitation on the data used. This would allow an integration between objective indicators of QoL (Il Sole 24 Ore data) and **citizens' subjective perceptions**, which may reveal additional dimensions of local government performance. For instance, a vertical regional analysis that comprehensively includes Quality of Life (QoL) data for all municipalities within a region could offer valuable insights into the relationship between QoL and their efficiency within a shared regional context.

Moreover, this research not only could be integrated over time but also vertically in each of the service municipalities are responsible for. In Chapter 8 a first calculation of vertical technical efficiency score has been computed but, since many of the services they provide are not highly subjected to synergies, analyzing efficiency within **specific service** domains and how they individually **correlate with QoL** could provide municipalities with targeted insights for improvement.

For sure though, the major upgrade that could be done from an econometric perspective to this study would be to deepen the understanding of **causation rather than correlation**. Further research studies should design empirical frameworks that would allow for stronger causal inferences about how changes in efficiency influence QoL directly.

All these ideas are certainly great ways to integrate this study from different methodological and data usage point of views. However, the most impacting way of continuing this research line would be to **expand the geographical horizon** of this study

from a national perspective to a European one. This presents a critical opportunity to address wider disparities across EU regions. Adopting a comparative, cross-national approach, future research can deliver essential insights to EU and national policymakers, informing them with strategies that could foster greater alignment in QoL standards across member states. Such a shift in focus would support and help in one of the EU's foundational mission of "United in Diversity", ensuring in this way that every citizen, regardless of location, cultural background and economical condition can experience homogeneous standards of living all across Europe.

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A | Appendix A

Below the tables related to the paper considered and cited in the literature review.

Variables	Studies
Financial Inputs	
Total expenditure	Luca & Modrengo 2021, lo Storto 2016a, D'Inverno et.al. 2018, Agasisti & Porcelli 2023, Fusco & Allegrini 2020, Ferraro et.al. 2023, Agasisti et.al. 2015, lo Storto 2020, Vidoli et.al. 2023, Rella et. al. 2024, Frenda et. al. 2021
Labor Cost	Fusco & Allegrini 2020
Capital cost	Fusco & Allegrini 2020, Vidoli et. al. 2023
Speed of payments	Santolini et.al. 2020
Cost of waste	Romano & Molinos-Senante 2020, Lomardi et. al. 2021, Romano et. al. 2020
Cost per inhabitant	Lombardi et.al.2021
Non-Financial inputs	
Tourist arrival	Cuccia et.al. 2016
Accomodations capacity	Cuccia et.al. 2016
Population	lo Storto 2016b
Area	lo Storto 2016b
Total amount of waste collected	Lombardi et.al. 2021
Cultural heritage	Suzuki et. al. 2011
Labor units	Suzuki et. al. 2011, Piacetino & Vassallo 2011
Human capital	Suzuki et. al. 2011, Piacetino & Vassallo 2011
Lenght of Beaches	Suzuki et. al. 2011
Teacher-student Ratio	Sibiano & Agasisti 2013
Capital	Piacentino & Vassallo 2011

Table A.1: Italian studies use of Input Variables

Output Variables	Studies
Population	lo Storto 2016a, Agasisti & Porcelli 2023, Agasisti 2015
Total population + tourists	lo Storto 2016a, Agasisti & Porcelli 2023
Area	lo Storto 2016a
Service provision indicators	Luca & Modrengo 2021, Agasisti & Porcelli 2023, Vidoli et. al. 2023
Number of people assisted with Social Services	Agasisti & Porcelli 2023, lo Stoto 2020
Kids eligible for school meals	Agasisti & Porcelli 2023
Lengths of roads	lo Storto 2016a, Agasisti & Porcelli 2023, Agasisti 2015
Total night stayed	Cuccia et.al. 2016, Suzuki et.al. 2011
Depuration service coverage	lo Storto 2016b
Differentiated waste collection (Kg)	lo Storto 2016b, Lombardi et.al. 2021, Ferraro et.al. 2023, Agasisti 2015, Romano et. al. 2021, Romano & Molinos-Senante 2020
Unsorted waste (kg)	Ferraro et. al. 2023, Romano et. al. 2021, Romano & Molinos-Senante 2020
Photovoltaic power	lo Storto 2016b
Urban green space	lo Storto 2016b
Low energy transportation demand	lo Storto 2016b
Pollution	lo Storto 2016b
Non differentiated waste	lo Storto 2016b
Energy consumption	lo Storto 2016b
Distance Covered by police	Agasisti 2015
PISA 2009 scores	Sibiano & Agasisti 2013
Number of publications and patents	Rella et.al. 2024

Table A.2: Italian studies use of Output Variables

Contextual factors	Studies
A. Social & Demographic	
Population density	Luca & Modrengo 2021, lo Storto 2016a, D'Inverno et.al. 2018, Agasisti & Porcelli 2023, Fusco & Allegrini 2020, Ferraro et.al. 2023, Agasisti et.al. 2015, lo Storto 2020, Vidoli et.al. 2023, Rella et. al. 2024, Frenda et. al. 2021
Population Size	D'Inverno et. al. 2018, Fusco & Allegrini 2020, Suzuki et. al. 2011, lo Storto 2020, Agasisti & Porcelli 2023, Vidoli et. al. 2023, Santolini 2020, Perugini 2024, Romano & Molinos-Senante 2020, Romano et.al. 2021
Area	Romano & Molinos-Senante 2020, Romano et.al. 2021, lo Storto 2020
Age distribution	Agasisti & Porcelli 2023, Agasisti et.al. 2015, Romano & Molinos-Senante 2020, Lombardi et. al. 2021, Vidoli et. al. 2023
Gender Ratio	Romano & Molinos-Senante 2020
Crime	Luca & Modrengo 2021, lo Storto 2016a, Cuccia et.al. 2016
Level of Education	Luca & Modrengo 2021
Number of car accidents	Agasisti & Porcelli 2023
Vehicle density	Agasisti & Porcelli 2023
Incoming commuters	Agasisti & Porcelli 2023
Gender Ratio	Agasisti & Porcelli 2023
Property tax	Agasisti & Porcelli 2023
% foreigners residents	Agasisti & Porcelli 2023
Disabled students	Sibiano & Agasisti 2013
B. Economic	
Unemployment rate	Luca & Modrengo 2021, Perugini 2024
Value added per inhabitant	lo Storto 2016a, D'Inverno et. al. 2018,
Income per capita	Romano & Molinos-Senante 2020, Romano et.al. 2021
Infrastructure development	lo Storto 2016a, Agasisti & Porcelli 2023, Agasisti et.al. 2015, Cuccia et. al. 2016
GDP per capita	Sibiano & Agasisti 2013
Level of tourism	D'Inverno et. al. 2018, Romano & Molinos-Senante 2020, Romano et.al. 2021, Agasisti & Porcelli 2023
Economic deprivation	Agasisti & Porcelli 2023, Vidoli et. al. 2023
C. Geographical & Natural	
Altitude	Luca & Modrengo 2021
Mountainousness	D'Inverno et. al. 2018, Agasisti & Porcelli 2023
Earthquake prone areas	Agasisti & Porcelli 2023, Agasisti et.al. 2015
Coastal areas	Agasisti & Porcelli 2023
Geographical location	Lombardi et. al. 2021, Fusco & Allegrini 2020, lo Storto 2020, Vidoli et.al. 2023
Km of beaches	Cuccia et. al. 2016
Protected natural areas	Cuccia et. al. 2016
UNESCO heritage sites	Cuccia et. al. 2016
D. Political	
Election cycles	Luca & Modrengo 2021, Agasisti & Porcelli 2023
Second term mandate	D'inverno et. al. 2018, Agasisti & Porcelli 2023
Political orientation	Agasisti & Porcelli 2023, Agasisti et.al. 2015
Gender of the mayor	Agasisti & Porcelli 2023
Political competition	Padovano & Ricciuti 2009
E. Financial	
Higher service tarrifs	Lombardi et.al. 2021
F. Institutional/Managerial	
Governance practices	Luca & Modrengo 2021
Differentiated waste collection	Agasisti & Porcelli 2023
Waste management plants	Agasisti & Porcelli 2023, Fusco & Allegrini 2020
Service delivery method	Lombardi et. al. 2021, Agasisti & Porcelli 2023
Providers ownership	Romano et.al. 2021, Agasisti et.al. 2015
Digitalization level	Rella et.al. 2024
Reforms impact	Santolini et.al. 2020

Table A.3: Contextual factors controlled in Italian studies

Article	DMU	Methodology	Undesirable factors	Desirable factors	QoL - Local government efficiency relationship
Royuela et.al. 2003	Municipalities within the province of Barcelona	Indexes aggregation	Unemployment rate (Economic), Motorization index (Urban)	Per capita family wealth (Economic), Average tax return and tax paid per taxpayer (Economic), Per capita value added (Economic), Average years of study (Education), Housing conditions (Housing), Access to health (Health), Educational facilities (Education), Availability of public transport (Mobility), Services for the elderly (Social), Social equilibrium, including gender equality (Social), Air quality (Environment), Climate conditions (Environment), Theatres, museums, and sports centers (Culture & Sport)	Not explicit
Hashimoto et. al. 2009	Japanese prefectures	DEA	Suicides (Health), Recognized crimes (Safety), Traffic accidents (Safety), Bankruptcy cases (Economic)	Hospital beds (Health), Income per capita (Economic), Water Quality (Waste & Enviroment), Sewage (Waste & Environment)	Not explicit
Murias et.al. 2006	Spanish provinces	DEA	GINI index (Economic), Unemployment (Social), Population with minimum incomes (Economic)	Gross Disposable Income per Capita (Economic), Average Size of Dwelling (Housing), Stock of Total Net Capital per Capita (Economic), Population aged 25-34 with tertiary education (Education), Percentage of long term working contracts (Economic)	Not explicit
Gonzalez et. al. 2011	Spanish municipalities	DEA, VEA	Unemployment (Economic), Pollution (Waste & Environment), Lack of Parks (Waste & Environment), Lack of cleanliness (Waste & Environment), Acoustic pollution (Urban), Delinquency/vandalism (Safety), Bad communications (Urban transport), Time spent in journeys (Urban transport)	Socioeconomic condition index (Social/Economic), Commercial market share of municipality (Economic), Cultural and sports facilities (Culture and Sport), Health facilities (Health), Education facilities (Education), Social care facilities (Social), Average education level (Education), Post compulsory education (Education), People having university studies (Education), Average net usable area (Housing), Living conditions index (Housing)	Not explicit
Jurado & Perez-Mayo 2012	Spanish autonomous communities	DEA	Unemployment rate (Economic), Risk of illness (Health), Risk of poverty over 65 (Economic), GINI index (Social)	Life expectancy (Health), Adjusted private/public consumption (Economic), Physical capital (Economic), Proportion of the working-age population with higher education (Education), R&D Expenditure (Innovation), Company expenditure on environmental protection (Environment)	Not explicit
Martin & Mendoza 2013	Canary Island municipalities	DEA	Unemployment (Economic), Pollution (Waste & Environment), Lack of Parks (Waste & Environment), Lack of cleanliness (Waste & Environment), Acoustic pollution (Urban), Pollution (Waste & Environment) Delinquency/vandalism (Safety), Bad communications (Urban transport), Commuting time (Urban transport)	Socioeconomic condition index (Social/Economic), Cultural and sports facilities (Culture and Sport), Health facilities (Health), Education facilities (Education), Social care facilities (Social), Average education level (Education), Post compulsory education (Education), People having university studies (Education), Average net usable area (Housing), Average quality of the dwellings (Housing), Weight of tertiary sector (Economic)	Not explicit
Bigerna & Polinori 2015	Italian municipalities	DEA	Waste production (Waste & Environment), NO2 concentration in water (Waste & Environment), Water waste (Waste & Environment), Air pollutants (Waste & Environment), Mortality crime (Safety), Building abuses (Urban)	Wastewater treatment (Waste & Environment), Separate waste collection (Waste & Environment), Green areas (Waste & Environment), Pedestrian areas (Urban), Air quality monitoring stations (Waste & Environment), Elderly population (Demographic), Day-care nursery schools centers (Social)	Efficient management of resources by local governments correlates with higher QoL standards even if proved only for variables mainly related to Environmental & Waste management services.

Article	DMU	Methodology	Undesirable factors	Desirable factors	QoL - Local government efficiency relationship
lo Storto 2016a	Italian municipalities	DEA on efficiency, regression on quality variables	Amount of micro-crimes per inhabitant (Safety)	Percentage of collection of Urban Waste (Waste & Environment), Ratio of seated km per inhabitants (Transport), Index of Social infrastructure development (Social), Index of Education infrastructure development (Education), Index of cultural and sport infrastructure development (Culture & Sport)	Indirectly evaluates the cost efficiency and investigates whether there is an association between efficiency and the quality of public services provided controlling in the II stage of his study for some variables proxying QoL measures there exists a trade-off between cost efficiency and the quality of some public services such as public transportation and cultural facilities. Higher efficiency is associated with lower quality in these services, which can negatively impact QoL.
Gonzalez et. al. 2018	Spanish municipalities	DEA	Excess Mortality (Health), Particulate matter (Environment), Ozone (Environment), Unemployment (Economic), Crime rate (Safety), Average commuting time (Urban Transport)	Socioeconomic condition index (Social/Economic), Average quality of the dwellings (Housing), Avoidable mortality (Health), Average education level (Education), People with university studies (Education), Municipal Cash budget surplus (Financial), Citizens political participation (Political), Volunteering activities participation (Cultural), Number of cultural centers (Cultural), Commercial market share of municipality (Economic)	Not explicit
Doumpos et.al. 2020	French municipalities	DEA	"Crime rate (Safety), Unemployment rate (Economic), Percentage of part-time jobs (Social), Job concentration (Social), PM10 concentration (Environment), Total taxes for water (Environment), Population to water network subscribers ratio (Environment), Total taxes for sewerage (Environment), Population to sewerage network subscribers ratio (Environment)	Supermarkets and hypermarkets per population (Economic), Other food stores per population (Economic), Retail stores per population (Economic), Hardware stores and equipment per population (Economic) , Financial services per population (Economic) , Home repair services per population (Economic), Other services per population (Economic), Elementary schools per population (Education), High schools per population (Education), Professional training and higher education per population (Education), Average education level (Ecuation), Healthcare facilities per population (Health), Healthcare professionals per population (Health), Other healthcare services per population (Health), Services to the elderly per population (Social), Childcare services per population (Social), Care for disabled individuals per population (Social), Social care institutions per population (Social), Age dependency ratio (Social), Sports facilities per population (Culture & Sport), Cultural services (cinemas, theaters, etc.) per population (Culture & Sport), Train stations and airports per population (Transport) Taxis per population (Transport), Percentage of households who own their house (Housing), Rooms per person (Housing) , Percentage of houses with a bathroom (Housing), Percentage of houses with individual or collective heating (Housing), Median income per consumption unit (Social)"	Explored the relationship between QoL performance and the financial strength of municipalities. Particularly, financial aspects, such as the municipalities revenues, grants received by the central government as well as taxes were found to be strongly related to the QoL performance for French municipalities.
Carcaba et.al. 2022	Spain municipalities	Regression	/	Subjective Well-Being (Aggregate indicator)	Government efficiency is positively and significantly associated with subjective well-being SWB. Citizens in well-managed municipalities report higher levels of happiness.

Table A.4: Variables selection for QoL models in the literature

B | Appendix B

Efficiency scores tables:

#	Province	Eff_M1	# Eff_M1	Eff_M2	# Eff_M2
1	Alessandria	0,5891	49	0,8080	27
2	Ancona	0,4782	70	0,8457	13
3	Arezzo	0,6007	42	0,8600	6
4	Ascoli Piceno	0,5110	64	0,5716	63
5	Asti	0,6823	25	0,8129	21
6	Avellino	0,6169	36	0,5304	67
7	Bari	0,7801	15	0,4867	73
8	Barletta-Andria-Trani	0,9259	1	0,8822	3
9	Belluno	0,7360	20	0,8410	15
10	Benevento	0,6602	29	0,4797	76
11	Bergamo	0,6144	38	0,8695	4
12	Biella	0,8335	9	0,8562	12
13	Bologna	0,4707	72	0,8284	18
14	Brescia	0,6265	35	0,8086	26
15	Brindisi	0,9114	2	0,6594	52
16	Campobasso	0,6084	39	0,5084	69
17	Caserta	0,8882	5	0,7260	45
18	Catanzaro	0,7156	23	0,7438	42
19	Chieti	0,7426	19	0,8437	14
20	Como	0,5667	57	0,7053	46
21	Cosenza	0,7575	17	0,7832	38
22	Cremona	0,5655	58	0,8563	11
23	Crotone	0,8732	6	0,8069	30
24	Cuneo	0,5905	48	0,8097	24
25	Fermo	0,6434	31	0,8574	9

26	Ferrara	0,5946	46	0,5027	70
27	Firenze	0,4074	80	0,8047	35
28	Foggia	0,7582	16	0,6279	55
29	Forlì-Cesena	0,5123	63	0,6701	50
30	Frosinone	0,7192	22	0,6740	48
31	Genova	0,3431	84	0,5803	61
32	Grosseto	0,6799	26	0,3941	84
33	Imperia	0,4064	81	0,3692	85
34	Isernia	0,8018	12	0,8063	31
35	La spezia	0,4812	69	0,5358	66
36	Latina	0,6318	33	0,5016	71
37	Lecce	0,6398	32	0,4345	83
38	Lecco	0,6009	41	0,6895	47
39	Livorno	0,3940	83	0,5155	68
40	Lodi	0,7142	24	0,8357	16
41	Lucca	0,4648	73	0,8838	2
42	Macerata	0,4102	79	0,8061	33
43	Mantova	0,5888	50	0,7660	40
44	Massa-Carrara	0,5734	54	0,7478	41
45	Matera	0,8931	3	0,4847	74
46	Milano	0,4775	71	0,8112	22
47	Modena	0,4498	75	0,8589	7
48	Monza-Brianza	0,6589	30	0,8158	20
49	Napoli	0,7889	14	0,5761	62
50	Novara	0,5594	59	0,7335	44
51	Padova	0,5986	45	0,8584	8
52	Parma	0,4432	76	0,6184	58
53	Pavia	0,6002	44	0,8163	19
54	Perugia	0,4991	66	0,7852	37
55	Pesaro e Urbino	0,4857	67	0,8063	32
56	Pescara	0,5274	62	0,6434	54
57	Piacenza	0,6006	43	0,6731	49
58	Pisa	0,4639	74	0,4659	78
59	Pistoia	0,5697	56	0,5685	64

60	Potenza	0,8042	11	0,8069	29
61	Prato	0,6148	37	0,8110	23
62	Ravenna	0,4128	78	0,5002	72
63	Reggio Calabria	0,8082	10	0,6682	51
64	Reggio Emilia	0,4837	68	0,6245	56
65	Rieti	0,8385	8	0,6078	59
66	Rimini	0,4031	82	0,4811	75
67	Roma	0,7549	18	0,5631	65
68	Rovigo	0,6634	27	0,6049	60
69	Salerno	0,8596	7	0,6219	57
70	Savona	0,4160	77	0,4525	80
71	Siena	0,5865	51	0,7434	43
72	Sondrio	0,5819	53	0,4473	82
73	Taranto	0,5942	47	0,4585	79
74	Teramo	0,5090	65	0,7673	39
75	Terni	0,6317	34	0,8297	17
76	Torino	0,7943	13	0,8096	25
77	Treviso	0,7301	21	0,9218	1
78	Varese	0,5824	52	0,8566	10
79	Venezia	0,3428	85	0,8077	28
80	Verbano-Cusio-Ossola	0,5390	60	0,4695	77
81	Vercelli	0,6048	40	0,8653	5
82	Verona	0,5301	61	0,6500	53
83	Vibo Valentia	0,8883	4	0,8044	36
84	Vicenza	0,5725	55	0,8060	34
85	Viterbo	0,6623	28	0,4496	81

Table B.1: Technical efficiency scores and rankings

Quality of Life scores table

#	Province	QOL	# QOL	QOL direct	# QOL direct
1	Alessandria	0,8602	67	0,8040	64
2	Ancona	0,9074	44	0,8197	58
3	Arezzo	0,8689	62	0,8026	66
4	Ascoli Piceno	0,9474	31	0,9645	3
5	Asti	0,8195	76	0,7547	77
6	Avellino	0,8706	61	0,9002	29
7	Bari	0,8997	48	0,7162	80
8	Barletta-Andria-Trani	0,8024	81	0,7738	73
9	Belluno	0,9734	4	0,9387	12
10	Benevento	0,9755	3	0,9727	1
11	Bergamo	0,9157	41	0,8708	38
12	Biella	0,9269	38	0,8281	56
13	Bologna	0,9479	30	0,9280	18
14	Brescia	0,9530	26	0,9408	11
15	Brindisi	0,8118	79	0,7829	70
16	Campobasso	0,8772	59	0,8587	43
17	Caserta	0,8011	82	0,8048	63
18	Catanzaro	0,8892	54	0,8497	47
19	Chieti	0,9773	1	0,9584	6
20	Como	0,8945	51	0,8335	54
21	Cosenza	0,8366	73	0,9288	17
22	Cremona	0,9589	16	0,8571	45
23	Crotone	0,7828	84	0,8414	50
24	Cuneo	0,9538	25	0,9213	20
25	Fermo	0,9060	46	0,9366	13
26	Ferrara	0,9375	34	0,7784	71
27	Firenze	0,9628	12	0,7746	72
28	Foggia	0,7023	85	0,6635	84
29	Forlì-Cesena	0,9679	7	0,7732	74
30	Frosinone	0,9018	47	0,9152	24
31	Genova	0,9584	18	0,8771	34
32	Grosseto	0,8839	56	0,6856	81

33	Imperia	0,7861	83	0,5910	85
34	Isernia	0,8866	55	0,9113	25
35	La spezia	0,9677	8	0,8062	61
36	Latina	0,8117	80	0,8038	65
37	Lecce	0,8465	71	0,8441	49
38	Lecco	0,9278	37	0,9157	23
39	Livorno	0,9598	15	0,8872	32
40	Lodi	0,9567	20	0,9610	5
41	Lucca	0,8770	60	0,8057	62
42	Macerata	0,9666	9	0,9280	19
43	Mantova	0,8653	64	0,9098	26
44	Massa-Carrara	0,8407	72	0,7961	69
45	Matera	0,8677	63	0,9516	7
46	Milano	0,9290	36	0,9502	8
47	Modena	0,9588	17	0,8610	41
48	Monza-Brianza	0,9582	19	0,9041	27
49	Napoli	0,8160	78	0,7177	79
50	Novara	0,8896	53	0,8470	48
51	Padova	0,9548	24	0,7989	68
52	Parma	0,9629	11	0,8603	42
53	Pavia	0,8961	50	0,8218	57
54	Perugia	0,8941	52	0,8138	59
55	Pesaro e Urbino	0,8799	58	0,8707	39
56	Pescara	0,9060	45	0,8525	46
57	Piacenza	0,9113	43	0,8844	33
58	Pisa	0,9560	21	0,7589	76
59	Pistoia	0,8524	69	0,8313	55
60	Potenza	0,9422	33	0,9681	2
61	Prato	0,8815	57	0,6757	82
62	Ravenna	0,9458	32	0,7682	75
63	Reggio Calabria	0,8651	65	0,9208	21
64	Reggio Emilia	0,9557	22	0,8574	44
65	Rieti	0,8468	70	0,8101	60
66	Rimini	0,9308	35	0,8614	40

67	Roma	0,9615	13	0,8347	53
68	Rovigo	0,9707	6	0,9322	15
69	Salerno	0,8259	74	0,8721	37
70	Savona	0,9647	10	0,7547	78
71	Siena	0,9553	23	0,8743	35
72	Sondrio	0,9607	14	0,9432	10
73	Taranto	0,8231	75	0,8353	52
74	Teramo	0,8642	66	0,8902	31
75	Terni	0,9267	39	0,8019	67
76	Torino	0,8978	49	0,6656	83
77	Treviso	0,9510	28	0,9362	14
78	Varese	0,9187	40	0,9019	28
79	Venezia	0,9765	2	0,9196	22
80	Verbano-Cusio-Ossola	0,9154	42	0,9475	9
81	Vercelli	0,9512	27	0,8929	30
82	Verona	0,9714	5	0,9295	16
83	Vibo Valentia	0,8575	68	0,8740	36
84	Vicenza	0,9506	29	0,9622	4
85	Viterbo	0,8170	77	0,8363	51

Table B.2: Quality of Life scores and rankings

Prov	SE	#	TR	#	SCF	#	lSR	#	ED	#	EN	#
AL	0,62	16	0,72	20	0,84	7	0,96	1	0,75	32	0,26	51
AN	0,50	35	0,54	43	0,79	25	0,62	56	0,63	47	0,23	56
AR	0,51	34	0,39	68	0,52	62	0,65	51	0,62	48	0,34	37
AP	0,56	31	0,33	79	0,44	75	0,33	85	0,79	28	0,25	52
AT	0,59	23	0,50	49	0,84	8	0,75	38	0,87	3	0,65	9
AV	0,43	55	0,45	57	0,70	38	0,93	2	0,50	73	0,24	55
BA	0,35	74	0,63	30	0,63	48	0,53	69	0,51	68	0,20	65
BT	0,59	22	0,73	19	0,63	49	0,80	27	0,91	2	0,29	46
BL	0,76	9	0,26	84	0,79	19	0,77	35	0,79	30	0,70	3
BN	0,41	66	0,36	74	0,56	54	0,48	75	0,52	66	0,06	85
BG	0,71	10	0,55	39	0,55	56	0,76	37	0,55	59	0,52	28
BI	0,62	15	0,46	56	0,85	5	0,84	13	0,79	23	0,52	26
BO	0,50	38	0,84	4	0,79	20	0,80	23	0,57	57	0,52	27
BS	0,70	11	0,52	48	0,73	36	0,63	55	0,49	75	0,34	38
BR	0,46	49	0,80	8	0,56	55	0,88	5	0,66	45	0,26	50
CB	0,48	42	0,72	21	0,83	9	0,36	84	0,74	34	0,14	76
CE	0,47	43	0,92	1	0,80	14	0,90	4	0,84	6	0,20	66
CZ	0,50	36	0,81	5	0,47	70	0,86	7	0,84	5	0,10	83
CH	0,81	3	0,87	2	0,82	10	0,86	9	0,83	7	0,23	57
CO	0,62	18	0,48	54	0,67	41	0,65	52	0,57	56	0,29	43
CS	0,41	63	0,73	18	0,80	15	0,87	6	0,81	10	0,28	48
CR	0,61	19	0,48	52	0,86	3	0,61	60	0,79	18	0,64	14
KR	0,45	52	0,73	17	0,75	35	0,86	10	0,79	22	0,15	74
CN	0,77	6	0,58	35	0,54	57	0,68	48	0,79	17	0,32	39
FM	0,49	41	0,34	77	0,53	60	0,41	82	0,79	20	0,31	40
FE	0,41	61	0,39	65	0,50	64	0,72	41	0,56	58	0,65	6
FI	0,30	79	0,38	70	0,79	28	0,80	25	0,47	78	0,46	32
FG	0,49	39	0,72	24	0,47	71	0,79	32	0,66	44	0,22	59
FC	0,54	32	0,36	72	0,49	66	0,60	61	0,53	64	0,34	36
FR	0,57	28	0,55	37	0,69	39	0,66	49	0,61	51	0,30	42
GE	0,26	81	0,77	12	0,81	13	0,49	72	0,48	76	0,24	54
GR	0,22	85	0,27	82	0,27	85	0,85	12	0,51	71	0,20	63
IM	0,25	84	0,66	28	0,68	40	0,36	83	0,60	52	0,10	84

IS	0,45	51	0,67	27	0,78	29	0,48	74	0,32	85	0,64	21
SP	0,32	78	0,79	9	0,63	50	0,46	79	0,54	60	0,14	77
LT	0,33	77	0,54	44	0,87	2	0,69	45	0,73	36	0,14	80
LE	0,35	75	0,39	66	0,51	63	0,53	70	0,54	63	0,12	82
LC	0,76	8	0,58	33	0,66	44	0,80	29	0,51	69	0,72	2
LI	0,37	69	0,33	78	0,37	82	0,80	28	0,50	72	0,64	19
LO	0,64	14	0,55	41	0,85	4	0,80	24	0,79	25	0,64	16
LU	0,41	62	0,42	61	0,65	45	0,85	11	0,70	40	0,29	45
MC	0,41	58	0,49	50	0,79	22	0,49	73	0,79	15	0,22	60
MN	0,58	25	0,53	47	0,38	80	0,68	47	0,79	27	0,65	10
MS	0,43	56	0,36	73	0,50	65	0,82	14	0,79	19	0,19	71
MT	0,33	76	0,49	51	0,48	69	0,75	39	0,67	43	0,19	70
MI	0,45	50	0,72	22	0,79	21	0,80	26	0,78	31	0,65	12
MO	0,58	24	0,79	11	0,53	59	0,80	22	0,48	77	0,75	1
MB	0,87	1	0,81	7	0,79	18	0,82	15	0,79	14	0,64	20
NA	0,44	54	0,28	81	0,79	27	0,81	19	0,74	35	0,21	62
NO	0,62	17	0,53	46	0,90	1	0,69	44	0,91	1	0,61	24
PD	0,50	37	0,40	62	0,72	37	0,78	33	0,86	4	0,65	8
PR	0,60	20	0,67	26	0,66	43	0,46	77	0,49	74	0,51	29
PV	0,47	45	0,74	14	0,80	16	0,60	62	0,62	49	0,38	34
PG	0,46	48	0,74	13	0,79	24	0,70	42	0,66	46	0,19	69
PU	0,47	46	0,35	76	0,64	46	0,56	66	0,79	29	0,20	67
PE	0,38	68	0,58	32	0,78	30	0,57	65	0,79	21	0,20	64
PC	0,60	21	0,74	15	0,42	76	0,54	67	0,52	67	0,43	33
PI	0,47	44	0,40	64	0,82	11	0,77	34	0,42	82	0,30	41
PT	0,41	59	0,44	58	0,36	83	0,80	20	0,38	83	0,16	73
PZ	0,44	53	0,43	60	0,41	79	0,65	50	0,61	50	0,61	23
PO	0,70	13	0,74	16	0,78	32	0,79	31	0,46	80	0,65	11
RA	0,36	73	0,31	80	0,48	68	0,80	21	0,79	26	0,23	58
RC	0,49	40	0,84	3	0,45	73	0,82	17	0,81	11	0,21	61
RE	0,76	7	0,55	40	0,38	81	0,79	30	0,54	62	0,29	44
RI	0,41	64	0,81	6	0,63	51	0,64	53	0,72	38	0,65	13
RN	0,25	83	0,36	75	0,78	33	0,48	76	0,34	84	0,15	75
RM	0,26	82	0,55	38	0,79	23	0,53	68	0,51	70	0,17	72

RO	0,42	57	0,39	69	0,46	72	0,69	43	0,80	13	0,65	7
SA	0,41	65	0,53	45	0,59	53	0,59	64	0,81	12	0,29	47
SV	0,27	80	0,58	34	0,82	12	0,45	80	0,82	9	0,19	68
SI	0,41	60	0,79	10	0,41	78	0,82	18	0,42	81	0,50	30
SO	0,57	27	0,16	85	0,42	77	0,59	63	0,79	16	0,64	15
TA	0,39	67	0,47	55	0,79	26	0,61	59	0,70	41	0,14	78
TE	0,46	47	0,54	42	0,60	52	0,74	40	0,71	39	0,24	53
TR	0,57	29	0,63	29	0,49	67	0,63	54	0,68	42	0,49	31
TO	0,70	12	0,72	23	0,67	42	0,62	58	0,53	65	0,62	22
TV	0,83	2	0,71	25	0,63	47	0,92	3	0,73	37	0,64	17
VA	0,77	5	0,59	31	0,80	17	0,68	46	0,60	53	0,28	49
VE	0,36	72	0,56	36	0,78	31	0,44	81	0,54	61	0,64	18
VB	0,52	33	0,27	83	0,31	84	0,46	78	0,59	54	0,37	35
VC	0,56	30	0,48	53	0,77	34	0,62	57	0,83	8	0,60	25
VR	0,58	26	0,44	59	0,53	58	0,77	36	0,47	79	0,66	4
VV	0,37	70	0,39	67	0,85	6	0,82	16	0,79	24	0,13	81
VI	0,80	4	0,40	63	0,53	61	0,86	8	0,74	33	0,65	5
VT	0,37	71	0,38	71	0,44	74	0,50	71	0,58	55	0,14	79

Table B.3: Vertical DEAs efficiency scores and rankings

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List of Acronyms

Acronym	Description
DEA	Data Envelopment Analysis
DMU	Decision making unit
QoL	Quality of Life
	...
***M*1**	Technical efficiency - model 1
***M*2**	Technical efficiency - model 2
NPM	New Public Management

Acknowledgements

Here you might want to acknowledge someone.