



Ca' Foscari
University
of Venice

Master's Degree programme
in Global Development and
Entrepreneurship
curriculum Global Markets

Final Thesis

***Economic competitiveness of Italian
regions: a SMAA-based composite indicator
for strategic decisions applied to locate
recycling plants within a circular economy
project in the Fashion industry***

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Matriculation Number 872712

Academic Year

2022 / 2023

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Summary

(English version)

This thesis analyzes the level of competitiveness of the Italian regions, aiming to provide a useful tool to entrepreneurs during the decision-making processes of localization of their investments. The focus was on Italy, as a country that, despite having great economic potential, is underestimated, and ignored. The competitiveness of the regions was measured using 14 variables, which were grouped into a composite indicator, a tool that, by synthesizing a lot of information in a single value, allows several alternatives to be compared at the same time. After a precise polarization of the variables, these were aggregated into a weighted average, by applying the SMAA (Stochastic Multi-criteria Acceptability Analysis) method. Extracting the weights of the variables from a probabilistic distribution and aggregating them, allows to obtain an objective and unbiased ranking of the regions. Specifically, Chapter 1 presents the entire procedure followed for the building of the composite indicator, while Chapter 2 analyzes the Italian economic and social context. For easier discussion, the 14 variables have been divided into 4 sub-indicators, namely Quality of Life, Governance, Economics and Finance, and System of Innovation, and deeply described. In Chapter 3, socio-political variables are analyzed, i.e., those grouped as Quality of Life and Governance, such as the level of health and education of the population, the impact of crime and pollution, together with the level of public debt and the effect of bureaucracy. Instead, chapter 4 contains the purely economic-innovative variables that form the sub-indicators of Economics and Finance and System of Innovation, i.e., market share and export share, interest rate, and labor market, together with the transport efficiency, the research and development resources allocated by the regions, the level of digitalization and analysis of the energy sector. In both chapters, each variable's influence on the productivity of companies is emphasized, to define its positive or negative impact on the competitiveness of a region. Chapter 5 describes and analyzes the obtained ranking, which confirms the gap between the northern regions (Lombardy, Trentino – Alto Adige, Emilia – Romagna, and Lazio in the first positions) and the southern ones, (Molise, Sicily, and Calabria in the last positions). Based on such ranking, in chapters 6 and 7, a practical case is presented, assuming to carry out a circular economy project in the fashion sector in Italy. To increase the recycling and regeneration of textile materials, two plants for the collection and sorting of textile waste are strategically located in Lazio and Puglia, with the subsequent task of producing regenerated yarns, serving as raw materials for two production plants located in Campania and Abruzzo, to make sustainable and eco-friendly clothes.

(Italian version)

Questa tesi analizza il livello di competitività delle regioni italiane, ponendosi l'obiettivo di fornire uno strumento utile agli imprenditori durante i processi decisionali di localizzazione dei loro investimenti. L'attenzione è stata posta sull'Italia, in quanto paese che, pur avendo un grande potenziale economico, è sottovalutata e ignorata. La competitività delle regioni è stata misurata con l'uso di 14 variabili, che sono state raggruppate in un indicatore composito, uno strumento che, sintetizzando molte informazioni in un unico valore, permette di comparare diverse alternative allo stesso momento. Dopo una precisa polarizzazione delle variabili, queste sono state aggregate in una media ponderata, mediante l'applicazione del metodo SMAA (Stochastic Multi-criteria Acceptability Analysis). Questo ha estratto i pesi delle variabili da una distribuzione probabilistica e le ha aggregate, permettendo di ottenere una classifica oggettiva e imparziale delle regioni.

Nello specifico, nel capitolo 1 viene presentata l'intera procedura seguita per la formazione dell'indicatore composito, mentre nel capitolo 2 si analizza il contesto economico e sociale in cui si trova l'Italia. Per una trattazione più agevole, le 14 variabili sono state suddivise in 4 sotto-

indicatori Quality of Life, Governance, Economics and Finance, e System of Innovation, e descritte nei capitoli seguenti. Nel capitolo 3, vengono analizzate le variabili sociopolitiche, ovvero quelle raggruppate come Quality of Life e Governance, come il livello di salute e di istruzione della popolazione, l'impatto della criminalità e dell'inquinamento, insieme al livello di debito pubblico e all'effetto della burocrazia. Invece, il capitolo 4 contiene le variabili prettamente economico-innovative che compongono i sotto indicatori di Economics and Finance e System of Innovation, nello specifico la quota di mercato e la quota di export, il tasso di interesse e il mercato del lavoro, insieme all'efficienza dei trasporti, alle risorse per ricerca e sviluppo allocate dalle regioni, al livello di digitalizzazione e all'analisi del settore energetico. In entrambi i capitoli, viene sottolineata l'influenza che ogni variabile ha sulla produttività delle imprese, così da definire il suo impatto positivo o negativo sulla competitività di una regione. Nel capitolo 5 viene descritto e analizzato il ranking ottenuto, il quale conferma il divario tra le regioni settentrionali (Lombardia, Trentino – Alto Adige, Emilia – Romagna e Lazio in cima alla classifica) e quelle meridionali, (Molise, Sicilia e Calabria nelle ultime posizioni). Sulla base di questa classifica, nei capitoli 6 e 7, si procede con un caso pratico, ipotizzando di realizzare in Italia un progetto di economia circolare nel settore della moda. Per incrementare il riciclo e la rigenerazione di materiali tessili, vengono localizzati strategicamente due impianti per la raccolta e lo smistamento di rifiuti tessili nel Lazio e in Puglia, con il successivo compito di produrre filati rigenerati, che fungono da materie prime per due impianti di produzione localizzati in Campania e Abruzzo, per realizzare vestiti sostenibili e rispettosi dell'ambiente.

Introduction

The strategic location decision-making process involves the definition and the selection of potential locations for business premises thanks to the analysis of several characteristics of different locations. Aside from being a crucial decision for companies, investing in new premises is essential for stimulating the whole economy of a region, too. The creation of a new manufacturing plant or the move of an already existing one has many benefits for the level of development, as many new jobs are created, the level of social well-being is improved and the innovation and technology capability is enhanced (Coughlin, 1996; Betts, 1996).

In recent years, much attention has been put on the topic of the competitiveness of a country, used as a proxy of its attractive ability, also according to the OLI paradigm (O-ownership, L-location, and I-internationalization). Presented by Dunning in 1976, it states that a good location is one of the three pillars, together with ownership and internationalization, that positively affect investment realization (Sharmiladevi, 2017).

Italy is a country that attracts little investments, due to its nonstable governments, never-ending financial crises, mafia-like organizations, lack of digitalization, and high public debt. For these reasons, foreign investors are often afraid to invest, and Italy's potential is not adequately exploited, even if it can count on consistent know-how in many manufacturing sectors and a skilled workforce. Moreover, historically a dichotomy between the richer and more developed northern regions against the poorer and backward southern ones has further discouraged strategic investments.

This dissertation deals with the economic competitiveness of the Italian regions and aims to present a ranking of the Italian regions based on several variables. More in detail, the topic of this work is creating a composite indicator to assess the competitiveness of Italian regions and show their potential without misconceptions. To better grasp all the aspects affecting the economic competitiveness of a region, it is necessary to define a tool encompassing as many variables as possible, which go beyond classical variables such as GDP levels,

The composite indicator is expressed as a weighted sum of fourteen different variables, which represents peculiar aspects e.g., physical well-being, the level of education, or bureaucracy, and the quality of existing infrastructures. The data of the

variables are taken from authoritative sources and then arranged to allow comparisons. For the creation of such an indicator, it will be adopted the methodology of the Stochastic Multicriteria Acceptability Analysis (SMAA) of the family of the Multi Criteria Decision Aiding (MCDA) methods, which uses weights values that are randomly extracted by a probability distribution, permitting the creation of an unbiased ranking of the Italian regions.

This is, then used as a starting point for a real case application: the strategic decision-making process for the location of a new company in Italy, operating in the fashion industry, and adopting a circular business model.

Such a model, using waste as raw materials in manufacturing is a crucial step towards reducing the negative impact on the environment and achieving an ecological transition. The circular economy could make a significant difference, especially in the fashion industry, which is known for being one of the most polluting and wasteful.

The dissertation will be divided into 7 chapters. After the description of the Italian context in Chapter 1, useful for understanding the Italian political-economic situation, an overview of the precise steps taken to create the indicator with the SMAA method application is reported in Chapter 2. Chapters 3-4 are dedicated to the description of the variables used for the indicator: in Chapter 3 there are Quality of Life, subdivided into 4 variables, and Governance, grouping 2 variables, while in Chapter 4 there are Economics and Finance, encompassing 4 variables, and System of Innovation, split into other 4 variables. Then in Chapter 5, the obtained ranking is shown. Chapter 6 describes the context of the real case application for strategic location decisions for the circular economy in the Italian fashion industry, while Chapter 7 describes how the composite indicator has been tailored for such context.

This work is useful for both economic literature and decision-makers. Indeed, it considers a region as a complex and intriguing territorial entity, with specific and robust economic capacities, instead of ignoring it as in the neoclassical theory where it is defined as a “part of the whole” (Mustafakulov, 2017). Besides, it allows to simplify a location decision-making process, basing it on just one indicator that contains the information of fourteen variables at once.

Chapter I – Composite Indicator

This chapter will define the procedure used to build a composite indicator: the main steps will be described, followed by an overview of the methodologies that can be adopted to overcome ad hoc problems. Then, the SMAA method is applied in the generation of the weights data for the estimate of the composite indicator.

1.1 Definition of a composite indicator

A composite indicator is a widely used tool to provide a broader picture of the competitiveness of a region, as it can be composed of many aspects, that go beyond the economic one and which also account for the social and environmental ones (Freudenberg, 2003).

A composite indicator CI is, indeed, a cohesive measurement for the evaluation of a phenomenon, obtained by the aggregation of a large amount of information. Its meaningfulness lies in the aggregative property, that makes CI an easily readable and understandable communication tool, together with its huge explanatory power, that is hardly replicable with a single-alone indicator. Composite indicators are perfect to be used in any data aggregation process and are suitable for many areas, from the economic to the social, and finally to the political. They permit ranking and comparing countries' performances and so are widely utilized in decision-making processes, especially in economic and business statistics sectors. However, composite indicators, being a mathematical combination of different variables, present some methodological criticisms: the major problem is related to the quality of data used for the estimates, which could not be adequately standardized, not relevant enough or with missing values, with another big obstacle of the choice of the weighting process (Freudenberg, 2003).

1.2. Construction of a composite indicator¹

One of the methodologies used to construct a CI is described in the OECD paper (Freudenberg, 2003), but, for the estimate of this indicator, there will be the introduction of different methods, to properly deal with the toughest points.

¹ For more detailed information and examples see Freudenberg, (2003) – report OECD.

1.2.1 Step one: methodological framework

Step one is the definition of the theoretical framework behind the indicator: the chosen variables must have a meaning for the phenomenon to be analyzed and so carry relevant and useful information. Moreover, it is important to define the aggregation method that best fits the problem, however, though, as asserted by Arrow in 1951 in its “Arrow’s impossibility theorem”, there is no perfect aggregation rule (Greco et al.,2018). Usually, variables are aggregated as a linear or geometric mean, so that the value of the weight also plays a role in defining the importance of the single aspect concerning the whole indicator.

To create a more reliable competitiveness assessment, it has been preferred the form Weighted Average of the variables (1), each of which has a different weight, to, precisely, reflect their distinct effect on the studied phenomenon. This form is, indeed, the most suitable when it comes to evaluating different regions according to a range of characteristics (Freudenberg, 2003).

Weighted average

$$CI(z_i, w) = \frac{\sum_{j=1}^m z_{ij} w_j}{\sum_{j=1}^m w_j} \quad \text{s.t.} \quad w_j \geq 0 \quad \text{and} \quad \sum_{j=1}^m w_j = 1 \quad (1)$$

where z_{ij} is the normalized value of variable j related to alternative i , and w_j is its weight.

1.2.2. Step two: variable selection

Step two consists of selecting the variables whose quality directly affects the final assessment’s accuracy. Data should be chosen from authoritative and certified sources, and, in case of missing-value problems, these should be treated with techniques like a complete change of dataset, a regression to fill in the gaps, or a substitution with the mean of the available values (Freudenberg, 2003). Additionally, it is important to respect the timeline of the variables, to avoid the presence of misleading estimates subjected to timely-different conjunctures, and finally, it is advisable the use logarithmic transformations to get rid of the outliers.

1.2.3. Step three: standardization

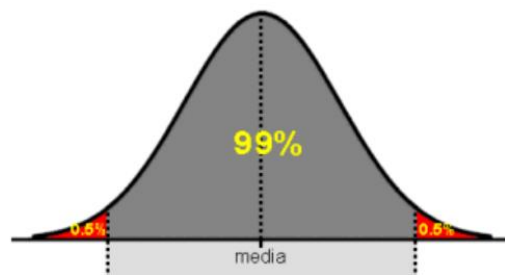
The third step is an important one because it is the one in which the variables are standardized. The data used to compose the indicator could be qualitative, quantitative, or dummies and could not be used as raw but need to be transposed on a common scale of measurement, to be aggregated without mixing problems. There exist various methods, the main ones are the standard deviation from the mean, the distance from the leader or from the mean, or the distance from the best/worst value (Freudenberg, (2003).

The methodology used to construct the CI is the Normalization, following which each raw value of any variable is transformed assuming the Normal Standardized Distribution N (0,1). This is, indeed, the most stable distribution and one of the easiest ones to deal with, as only the mean and the standard deviation are needed to define it.

$$z_i = \frac{x_i - \bar{x}}{\sigma} \quad \text{distributed as a N (0,1)} \quad (2)$$

Given the different values of the variables and their different units of measurement, it was preferred to implement a polarization, in which the normalization is automatically included. Following the procedure of Greco et al. (2018), the outliers of the polarization are fixed at 0 and 1, and to decide which is the threshold value (γ) above or below which the variable takes the value of the outliers, it is needed the set of a confidence level. Since the normalized variables' values are distributed as a Normal (0,1), the discriminator must be found using the tables of this distribution. To treat the variables, it has been used a confidence level of 99%, and its corresponding point is 2,57, which leaves a 99,5 % of probability at its left (Figure 1.1).

Fig. 1.1 Standardized normalized curve with 99% confidence level – Bottarelli (n.d.)



Once γ is fixed, variables need to be divided into bad and good, based on whether they have a negative or positive effect on the analyzed phenomenon: the higher the

negatively oriented variable's value, the worse the effect, while the higher the positively oriented variable's value, the better the effect. Such differentiation is important as proper treatment is required².

Positively oriented

x_j^* and x_{j*} are, respectively, the best and worst reference raw values to find the outliers of each alternative j. They are calculated as follows:

$$x_j^* = M_j + \gamma\sigma_j \quad \text{and} \quad x_{j*} = M_j - \gamma\sigma_j$$

Where M_j is the simple mean of each j-variable, γ is a constant indicating the accuracy of the measurement, and σ_j is the standard deviation of each j-variable.

The polarization is carried out using normalized values of the variables z_{ij} , where i stays for the alternative and the j variable.

$$y_{ij} = \begin{cases} 1 & x_{ij} \geq x_j^* \\ \frac{x_{ij}-x_{j*}}{x_j^*-x_{j*}} & x_{j*} < x_{ij} < x_j^* \\ 0 & x_{ij} \leq x_{j*} \end{cases} \quad y_{ij} = \begin{cases} 1 & z_{ij} \geq \gamma \\ 0.5 + \frac{z_{ij}}{6} & -\gamma < z_{ij} < \gamma^3 \\ 0 & z_{ij} \leq -\gamma \end{cases}$$

Negatively oriented

x_j^* and x_{j*} are, respectively, the best and worst reference raw values to find the outliers of each alternative j. They are calculated as follows:

$$x_j^* = M_j - \gamma\sigma_j \quad \text{and} \quad x_{j*} = M_j + \gamma\sigma_j$$

Where M_j is the simple mean of each j-variable, γ is a constant indicating the accuracy of the measurement, and σ_j is the standard deviation of each j-variable.

The polarization is carried out using normalized values of the variables z_{ij} , where i stays for the alternative and j the variable.

$$y_{ij} = \begin{cases} 0 & x_{ij} \geq x_{j*} \\ \frac{x_{ij}-x_{j*}}{x_j^*-x_{j*}} & x_{j*} < x_{ij} < x_{j*} \\ 1 & x_{ij} \leq x_j^* \end{cases} \quad y_{ij} = \begin{cases} 0 & z_{ij} \geq \gamma \\ 0.5 - \frac{z_{ij}}{6} & -\gamma < z_{ij} < \gamma^4 \\ 1 & z_{ij} \leq -\gamma \end{cases}$$

1.2.4. Step four: weighting process

The fourth step is the trickiest one, as it is related to the weighting procedure that, adequately, indicates the importance of the variables. The easiest way is the one in

² For more details see Appendix

³ For further details about the precise calculation, see the Appendix.

⁴ For further details about the precise calculation, see the Appendix.

which all criteria have the same impact on the phenomenon, and so, will receive the same weight (simple mean), but this is not feasible, because there could be variables that have a stronger effect, and need to be weighted more. A weighted average method, so, seems to provide a more reliable result, as it assigns a different weight to each variable, even if such value, is hard to assess. It could be useful to carry out a regression and take the correlation coefficients as starting points, even the opinion of experts or surveys conducted among the population could be effective, but it does not exist as a perfect methodology (Becker et al., 2017).

The crucial point of the weighted sum is that everyone who is asked for the weighting assignment will provide their values. Whether they are researchers, academics, scholars, or students, each of them will weigh the variables differently based on their own beliefs and considerations. Moreover, aside from the huge number of interviewed people that can provide the most various weights, it should also be considered that everyone's personality is divided into "multiple selves". As J. Elster assumed in 1987 in his "Plurality of selves" theory, every person has a variegated personality composed of a plurality of individuals that have been forming over time according to the experiences or situations in which it has found themselves in life. The presence of such many selves in the decision-making process damages the accuracy and reliability of the adopted behavior, as, depending on which personality trait is more preponderant at that moment, a different choice will be made (Greco et al., 2018). To curb such uncertainty and bias, and to provide a more reliable set of weights for the variables, it can be used methods belonging to the family of Multiple Criteria Decision Aiding (MCDA), as they allow a variety of values to be estimated, reflect all possible decision maker's choices. In case of a lack of initial weight information for the construction of the CI, so there is no insight like past surveys or objective reasons about why a variable weighs more than another one, it is impossible the use an MCDA. Thus, given that this is the case of no weight information, a different approach is required and, the selected one was the Stochastic Multicriteria Acceptability Analysis (SMAA). It can solve the weights problem because it implicitly considers a variety of points of view, by randomly extracting the weight values from a probability distribution, in doing so it can create the weights needed for the estimate by keeping them as more objective and causal as possible (Tervonen et al., 2007).

1.2.4.1. SMAA

The Stochastic Multicriteria Acceptability Analysis SMAA has been invented by Lahdema et al. and is required in case of uncertainty linked to unknown variable preferences. It is used in such situations because it is based on the concept of “inverse weight space analysis”, first presented by Charnetski and Soland. Such a process balances uncertainty by implicitly considering various points of view, which is achieved through the extraction of the values from a probability distribution. To make it clearer, given a single vector of alternatives, in the SMAA process, the sets of weights are randomly extracted by the feasible samples and distributed following a uniform distribution $[0;1]$, which, in turn, is the one required in case of complete absence of weight information (Ehrgott et al.,2010).

$$W = (w_1, w_2, w_3, \dots, w_m) \quad \text{s.t.} \quad w_j \geq 0 \quad \text{and} \quad \sum_{j=1}^m w_j = 1 \quad (3)$$

In the original version are used utility functions as decision models and given the individuals' purpose of maximizing their utility, the required weights must be non-negative and add up to 1. Only with the SMAA-2 extension, it has been introduced the value function, enable the creation of a ranking of the alternatives.

The main measurements that can be carried out are (Greco et al., 2018):

Rank acceptability index: probability of an alternative a_k being in the r -th position of the rank b_k^r .

$$b_k^r = \int_{\varepsilon \in X} f_x(\varepsilon) \int_{w \in W_k^r(\varepsilon)} f_w(w) \quad dw \, d\varepsilon \quad (4)$$

It is calculated considering $\int_{\varepsilon \in X} f_x(\varepsilon)$ which is the integer representing the function of the variable ε inside the variables space X , together with $\int_{w \in W_k^r(\varepsilon)} f_w(w)$, that is the integer representing the function of the weight w out of the $W_k^r(\varepsilon)$ weight space, previously calculated as the set of feasible weights related to alternative k , following variable ε , knowing that the rank position equals k .

Central weight vector: individual's average preference given the alternative a_k the best position.

$$w_k^c = \frac{1}{b_k^1} \int_{\varepsilon \in X} f_x(\varepsilon) \int_{w \in W^1(\varepsilon)} f_w(w) w \quad dw \, d\varepsilon \quad (5)$$

The calculation is based on the value of the Rank Acceptability Index and it is carried out considering the integer of the variable, together with $\int_{w \in W^1(\varepsilon)} f_w(w) w$, that is the

integer of the weight w out of the $W^1(\varepsilon)$ weight space, with the peculiarity of assuming that the first position of the alternative in the rank.

Confidence factor: frequency of an alternative a_k being the most preferred one.

$$p_k^c = \int_{\varepsilon \in X: u(\varepsilon_k; w_k^c) \geq u(\varepsilon_h; w_k^c) \forall h=1, \dots, l} f_x(\varepsilon) d\varepsilon \quad (6)$$

Based on the Central Weight Factor results, it uses each alternative's utility function, composed by variable and weight $u(\varepsilon_k; w_k^c)$, to find the most preferred one.

Pairwise winning index: frequency of an alternative being preferred or indifferent to another alternative.

$$p_{hk} = \int_{w \in W} f_w(w) \int_{\varepsilon \in X: u(\varepsilon_h; w) \geq u(\varepsilon_k; w)} f_x(\varepsilon) d\varepsilon dw \quad (7)$$

This is a more particular measure the Pairwise Winning Index. It is calculated as in Equation 7 using the utility functions of two precise different alternatives a_k and a_h made up of the variable and weight information, to provide the frequency of which of the two alternatives is the preferred or indifferent to the other, according to a single variable.

To execute these calculations, the SMAA model relies on the Monte Carlo Method. At its core, there is an algorithm, that, through simulations, generates noncorrelated values starting from random points. This process needs to be repeated k -times, and if k is greater than 25, according to the Central Limit Theorem, the resulting estimates can be normally distributed and be reliable according to a predetermined confidence level (Milton & Arnold, 1995; Ehrgott et al., 2010). The k -iterations are computed considering the error limit d , that must be as small as possible, together with the confidence level required (Ehrgott et al., 2010).

$$k = \frac{1.96^2}{4*d^2} \quad (8)$$

Where 1,96 represents the point corresponding to a confidence level of 95% and an $\alpha=5\%$ of a normal distribution.

1.2.5. Step five: robustness

During the last step, the fifth, it is analyzed the robustness of the indicator, to get rid of similarities and correlations between the variables. This step can also be simplified when the variables are chosen, since, from the beginning, the researcher can avoid the use of data that replicate the same information. This is the case of this CI, where it was

preferred to avoid the adoption of variables that could be correlated or could replicate each other (Freudenberg, 2003).

The procedure presented in the chapter resulted in importance in the accuracy of the variables chosen and the quality of the relative data. Moreover, even their weights are difficult to assess, which is why the use of the SMAA procedure is of help in providing a more objective and realistic composite indicator.

Chapter II – Context

This chapter presents the background context of Italy, the country object of the assessment. It finds itself in a peculiar situation being a member of the European Union. Given its supranational power though, it is impossible to properly analyze Italy, without an insight into the European reality.

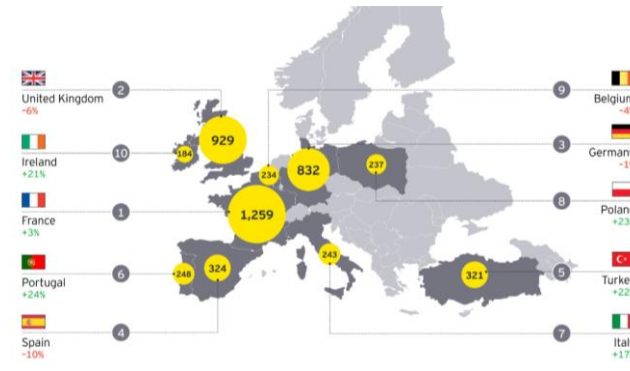
2.1. European Union and Eurozone

To provide a proper analysis of the Italian situation, firstly, it must be considered the European reality, being Italy one of the member countries of this supranational organization. Indeed, even if the main characters of the world economy are single nations, they cannot act so freely, especially at the European level, where the Union issues directives and regulations that must be received and applied by all the members. They have limited microeconomic freedom of acting, so it requires an assessment of what is decided at the macro level, as it is the one that provides the enabling and controlling the economic system (Barbiellini Amidei et al., 2018, 431).

The European Union has always attracted direct investments from foreign countries, mostly due to the specific capabilities and know-how of its members, and undoubtedly because of the availability of natural resources and capital. After the COVID-19 pandemic, the European economy has started to recover, reaching the level of +5% of FDI in 2021 (still below pre-pandemic levels), but the percentage dropped to only + 1% in 2022 (EY, 2022; EY, 2023)⁵. Figure 2.1 shows the top 10 European countries still able to attract investments in 2022. For Italy, the survey conducted by EY published in May 2023, estimated that it has been the destination of roughly 250 projects of foreign direct investments in 2022, confirming its position in the top 10 of European countries hosting FDI, even if always at one of the lowest levels in comparison to the major European countries i.e., Germany, France, and Spain.

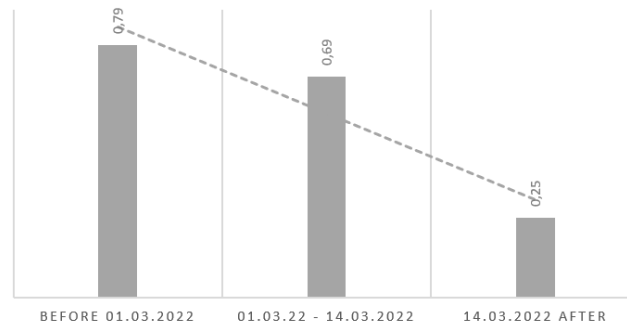
⁵ EY attractiveness survey 2022, 2023

Fig. 2.1 Market share of top 10 host countries for foreign investment projects in 2022 – EY (2023)



This turnaround has also been caused by the shock of the Russian-Ukrainian war. Indeed, geopolitical and macroeconomic uncertainty, resulting in restrictive policy of interest rates, inflationary tendencies, the energy crisis, and the consequent cuts of the supply chain, has been harming the perception of investing in Europe. Graph in Figure 2.1, shows how, in a month, roughly 70% of firms expressed their intention not to invest in European countries anymore, afraid, and aware of the negative repercussions of the war (AIBE & CENSIS, 2023).

Fig. 2.1. Tendency of IDE in Europe before and after the Russian-Ukrainian War



In this scenario, the European Union must help the most hurt states with resilience and recovery programs and continue improving their capacity to attract investments. Its focus needs to be put on boosting the Research and development process towards digital and green economy transitions, as these are the most important sectors in the future.

An economic union strictly connected to the European one is the Eurozone, which is composed of countries member of the European Union, that adopt the same common currency, namely, the Euro. The membership implies some conditions to respect and

rules to apply to maintain the member status, which in turn is fundamental to getting access to the benefits of the euro currency and the member status for the zone. Indeed, when investing in such countries, companies know that can exploit such advantages. They will take part in the relevant European market, which has a great influence on the global economy and where the freedom of movement for capital and goods is valid and the competition stimulated. Having a common currency makes a safer purchase and sell operations in the euro area, and keeps prices more stable, simplifying trade with the eurozone's members and with the rest of the world. Additionally, the financial market itself is integrated and more efficient, making investments in the area cheaper.

The situation, though, has worsened with the Ukrainian war, the government had already tried to offer incentives for the investors, but the only solution left to solve the problem seems to be the PNRR program, with a conjoint action with the European Union. The amount of 192 billion € provided by the Union, through the European funds called Next Generation EU, is allocated by the Italian country for the realization of the "Piano Nazionale di Ripresa e Resilienza" (PNRR⁶). An enhancement in the productivity of the Italian economic system and a consequent long-lasting and sustainable development in the economic sector will be realized following 6 missions:

Mission 1: Digitalization, innovation, competitiveness, and culture

Mission 2: Green revolution and ecological transition

Mission 3: Infrastructure for sustainable transportation

Mission 4: Education and research

Mission 5: Inclusivity and cohesion

Mission 6: Health

Most of the fund will be allocated to the green revolution and ecological transition mission (roughly 60 billion€) and to the one regarding digitalization, innovation, competitiveness, and culture (about 40 billion €) (Ministero delle Imprese e del Made in Italy, n.d.)⁷.

⁶<https://www.mimit.gov.it/it/pnrr/piano#:~:text=Le%20risorse%20stanziare%20per%20il,e%20culturala%20%2D%2040%2C32%20miliardi>

⁷<https://www.mimit.gov.it/it/pnrr/piano#:~:text=Le%20risorse%20stanziare%20per%20il,e%20culturala%20%2D%2040%2C32%20miliardi%C3%B9>

2.2 Italy

Made up of 20 regions, 5 of which have a special status, with a population of about 59.11 million people (Ista, 2021), Italy is famous for being a country of well-being, good food, amazing monuments and cities, great culture, but also political instability, unsustainable public debt, and mafia-like organizations. This Mediterranean country has always had an unstable economic development characterized by expansion phases and more recessive ones, and even nowadays, the situation is not so positive, because of the combined effect of the COVID-19 pandemic and its lockdowns, together with the consequences of the Russian-Ukrainian war. It is estimated a good recovery for the Italian GDP of +1.2% in 2023 and +1.1% in 2024 as reported by Istat (2023)⁸. The economic growth will be favored by a reduction of the cost of energy goods and the consequent inflation and an increase in consumption. Less unemployment and an improvement in the labor market are expected.

2.2.1 Italian productive system

Italy is characterized by a particular productive system that has a controversial effect on the economy. It can be described by the agglomeration effect and is made up of SMEs and businesses of artisans. Most of the time they are family-run and not interested in foreign capitals and in expanding abroad, but the peculiarity stays in their location. Many companies belonging to the same sector or market, find advantages in placing their activity close to those which they share similarities with, i.e., suppliers, raw materials, skilled workers, know-how, and market. Clusters dominate in the productive system, so that the number of industrial districts distributed alongside the country is very high e.g., the sport system cluster in Veneto, the wood-products one in Trentino, the leather cluster in Tuscany, and the fisheries one in Sicily. Such a system is self-sustaining because of a centrifugal force that leads new companies to establish only in the precise place where there are the enabling factors for the activity they want to carry out, and where other firms belonging to the same industry are present. Indeed, according to the New Economy and spatial selection theory of Baldwin and Okubo, the presence of an agglomeration economy creates a polarized distribution of

⁸ <https://www.istat.it/it/files//2023/06/Prospettive-economia-italiana-giugno-2023.pdf>

economic activities and income across a country (Degl'Innocenti et al., 2016). On the other side, agglomeration economies have a huge positive effect, because they make possible the sharing of knowledge through spillover effects, and better access to the labor market and skilled workers, as well as raw materials or intermediary products. The presence of industrial clusters though can be beneficial for new companies and can act positively in attracting foreign investments (Basile, 2008).

2.2.2. Advantages of investing in Italy

Italy has many positive aspects to attract investments, the main is the considerable technical know-how and quality of human capital in many productive sectors, summarized with the hallmark “Made in Italy”, which Italy has always been globally recognized for. Other important factors when investing in Italy are the presence of skilled workers with managerial capacities and the existence of a big market. Italy is also focusing on innovation, and it is putting a lot of effort into the development of its leadership in the innovation and sustainability sector. Important spheres of activity are indeed the export of green products, and Italy got the second place on the Green Complexity Index (Regioni e ambiente, 2020⁹), the renewable energy sector, with Enel Green Power being the biggest private operator in renewable energy worldwide, the digital economy, and sustainable agriculture sector. Such results are important to shape the trust and reliability of foreign investors these innovative and green sectors are fundamental for the economic development of Italy and, even at the international level, are the main goals for the economy to reach. Regions with good levels of development in sustainable and high-tech productive processes are of great interest to foreign investors.

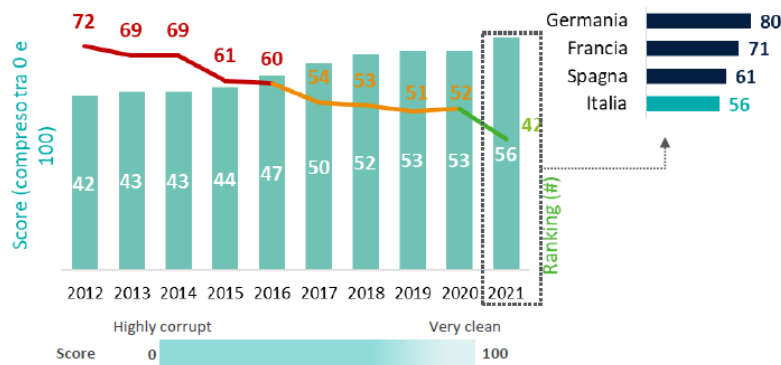
2.2.3. Disadvantages of investing in Italy

Aside from the positive elements, mention should also be made of the negative sides, especially the so-called country effect, due to which multinational companies limit their investments in Italian regions (Basile et al., 2004). Even though these are individual entities, they must respect the directions and regulations of the

⁹ <https://www.regionieambiente.it/prodotti-verdi-gci/>

government, being aware that a uniform administration with a common framework has a considerable impact on the quality of companies' choices. The main limit is indeed the Italian institutional system, which is characterized by a not-so-efficient public administration with heavy bureaucratic procedures, that tend to restrict and slow down the innovation process and whatever initiative. Moreover, the diffusion of mafia-like organizations and the corruption of politicians is not beneficial from a reputational point of view.

Fig. 2.2 Italy's Corruption Perception Index recorded - Deloitte (n.d.)



As shown in the graph in Figure 2.2 created by Deloitte (n.d.), Italy has the worst ranking compared to other European countries, even if a slight improvement is happening. Even the shadow and illegal markets play a negative role, accounting for an impact of more than 11% on GDP. The high level of public debt, monitoring of financial instability, and little reliance on the solvency of the country is reflected in the value of the Political Stability Index, where the Italian peninsula ranked at the latest places in Europe. The infrastructure sector is also a sore point because of the big gap between investments and needs, given that the expenditure for transport improvements is at the lowest. A country effect composed of so many moles in so many aspects of the economy makes Italy not too tempting for foreign investors, who, from their side, are afraid to reap a lower expected profit when localizing there, than the one in countries with similar conditions (Basile et al. 2004).

2.2.4. Regional situations

Italy is divided into regional entities, but they do not have such a wide and individual decision-making power and cannot be released by the main government. Although

differing in the single economic situations and having different allocations of capital and people, they must respect and apply what is decided by the central government, which enacts common policies regarding, for example, investment plans or infrastructure decisions, together with national economic regulations. Thus, given the strategic value of attracting investments in the country, the state must sustain the competitiveness of its territories, and act wisely and consciously when issuing regulations or incentives to ease the investment process or to boost the productive system. Anyway, the historical presence of a pronounced inhomogeneity between the regions has not simplified the duty of the government, because many times it required the creation of subsidiary help or precise reforms to treat local problems which are not spread everywhere. Historically, the northern regions are richer and wealthier with more jobs available and better living conditions, while the southern are more economically fragile, with high rates of unemployment and economic activities strictly controlled by mafia organizations. The north-middle has a GDP per capita which is roughly double (33,4 against 18,5 thousand Euro) the one in the south. As an example, the Abruzzo region has the highest GDP per capita among southern regions, which in turn is lower than the GDP of Liguria, the region with the lowest per capita GDP in the north (Istat, n.d.)¹⁰. Even the employment level of young people between 25 and 34 years old is higher in the North (75%), compared to the South (45,7%) (Istat, n.d.)¹¹. Not surprisingly, Lombardy with a GDP higher than one of many of the richest countries in Europe, has been consecrated, by Dijkstra et al. (2023), as the best-performing region and the most suitable to attract foreign investment. Such gap is rooted in the socio-economic Italian history, and its beginning in the 19th century, when, due to geographical advantage, industries were more favored to sit in the northern part of the peninsula, so the first “Industrial Triangle” was composed by the cities of Turin, Milan, and Genoa. The lack of ad hoc interventions by the government and the spreading of mafia-like organizations that gradually started to control the political and economic structure of the regions made this difference unbridgeable. The southern regions have a truly high potential to attract investments, since they have a

¹⁰https://esploradati.istat.it/databrowser/#/it/dw/categories/IT1,DATAWAREHOUSE,1.0/UP_ACC_TERRIT/IT1,93_500_DF_DCCN_TNA_6,1.0

¹¹<http://dati-giovani.istat.it/Index.aspx?QueryId=21686#>

considerable share of the domestic market and a skilled workforce, together with employees paid less and more free industrial areas (Daniele,2010; Marani, 2010).

As presented in the chapter, the political and economic freedom of Italy is limited by the power of the European Union, whose guidelines and regulations must be applied by the member countries. Additionally, Italy is characterized by a peculiar productive system composed of clusters and a strict social and economic dichotomy between northern and southern regions, with the latter being a little more underdeveloped than the former.

It will follow a detailed presentation of the variables chosen for the assessment of the composite indicator.

Chapter III – Quality of Life and Governance

This chapter presents two sub-indicators, the first is the Quality of Life, which encompasses information on Well-Being, Education, Crime, and Pollution, while the second is Governance, providing insights into the Public debt and the Bureaucratic level.

Such socio-politic aspects will be analyzed through their effect on the productivity of a company, to assess their impact on the economic competitiveness of a region. On one hand, variables such as health and education, together with political action are the basis for funding the economic development of a country. On the other hand, they also must deal with some drawbacks such as the level of crime and unsafety among the population, and the fear of pollution and climate change. Per each variable, there is also a session dedicated to observing the Italian situation, being this the case country of the paper.

3.1 Quality of life

In the following the variables that are considered for the Quality of Life sub-indicator are listed, namely Physical well-being, Education, Crime, and Pollution. Then, their impact on productivity and their evaluation of the Italian case are analyzed.

3.1.1. Physical Well-being

In a fast-paced society, people are more interested in making money than having a healthy lifestyle. Overtime is an integral part of working hours, little time to rest and take care of yourselves is the ordinary rule, and an unregulated diet, lack of sleep, and burnout problems close the list. The thoughtful phrase “just health” is sometimes forgotten, despite its relevance to individuals’ well-being and work productivity.

3.1.1.1. Well-being and productivity

Human capital is a fundamental input of the production function, so it is important to have healthy employees, as they work better and longer. A study conducted in England analyzing an entire century, showed that the improvement in people’s health conditions has enhanced the economic development by 30-40% (Gitto et al., 2008).

Indeed, Barro (1995;1997) asserted that people with a good level of physical health are the engine of a country's economic growth because they can learn more capabilities and be more productive, as sustained by Grossman (1972), and Bloom and Canning (2000). The Neoclassical growth theory instead, analyses the positive and negative effects of a healthy lifestyle. Better health conditions have an initial direct effect on the growing population, which in turn translates into the indirect effect of the reduction of per capita GDP (Gitto et al., 2008). Countries seem "poorer" due to better life standards, but the truth is that well-being level influences economic performances in the long run, so an increase in population is compensated consequently with higher labor productivity, increasing the production activities and companies' profitability. Healthy employees are, thus, less likely to apply for sick leave, so they don't subtract time from their work and provide better products (Gitto et al., 2008). Is physical well-being a cause of economic growth or thanks to economic development it has been possible the discovery of new products, which improve health conditions? (Gitto et al., 2008). The determinants of this process have not been defined yet, but as stated by Weil et al. (2005), the interaction between well-being and GDP per capita has two directions. Following the first effect, that is the effect of health on GDP, an increase in the level of physical well-being, creates more productive workers and consequently, a higher level of output level and income, while according to the second effect, a high level of the wealth of people, equals healthier and more productive employees (Figure 3.1). However, such effects are not separated, but two mutually reinforcing forces. As shown in the graph in Figure 3.2, (from point A to B), in case an increase in work productivity, happens for whatever reason and due to either health improvements or not, will raise the production level, which in turn will reflect an improvement in the well-being of the workers and consequently to an increase in output. This can be defined as the health multiplier effect, whereby an increase in productivity will always be followed by a greater increase in final output.

Fig. 3.1 Interaction between health level and GDP - Weil et al. (2005)

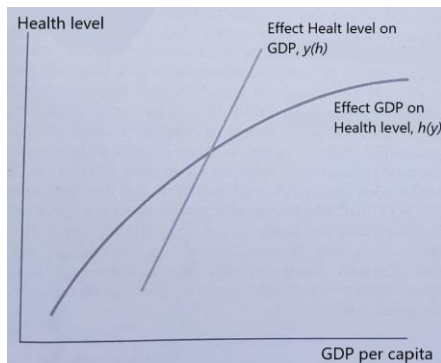
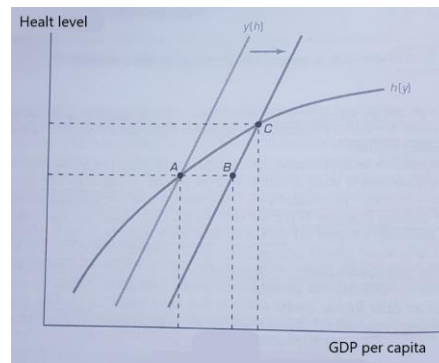


Fig. 3.2 Health multiplicative effect - Weil et al. (2005)



Elaboration of Weil et al. (2005)

Even the government has a role in the well-being of its population: it must provide public treatment to people who cannot access them privately, as sustained by Chernichovsky (1995), but such services have a cost, which must be supported by the state and, indirectly, by people through their fiscal expenditures (Gitto et al., 2008). Overall, a region with a healthy population has a healthy workforce, with less social costs and a lower expenditure for the healthcare system. This translates into higher productivity of companies and general economic development, thanks to employees who have a longer working life and greater participation in the labor market.

3.1.1.2. Italian situation

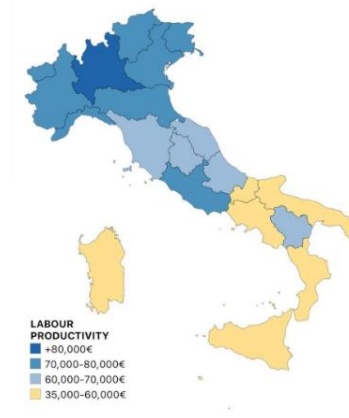
As shown in the map in Figure 3.3, the Italian situation is a bit fragmented, as the dichotomy north-south takes place as far as health. In “poorer” southern regions, the quality of the regional health system is lower than that of northern ones. Following the data used to assess the CI regarding the physical well-being of the Italian population, which represents the portion out of 100 same-aged people of the population with a good level of health (see further details in the Appendix), the best region is Trentino-Alto Adige with 79,6 points, against the worst one, Calabria, with a level of 64. More generally, the northern area averages 72,36, while the southern area achieves a mean of 69,38 points. In the end, the map in Figure 3.4 confirms that the per capita labor productivity (GDP per person employed) in southern regions is lower than in northern ones; a range between 35 000 and 60 000 € against more than 80 000€. As expected even if Lombardy, the most populated northern region with 9 965 046 inhabitants, has

a labor productivity that is higher compared to the most populated southern region, i.e., Campania region with (5 590 681 inhabitants) (Istat, 2021)¹².

Fig. 3.3 Quality of the healthcare system – mappaitalia (2022)



Fig. 3.4 Labor productivity (GDP per employee) – italianmaps (2022)



3.1.2. Pollution

“There is no planet B” is a famous slogan, that, simply, tells us a big truth: nobody can create or buy another Earth, there is no Ctrl+Z, thus, it is important to protect the one we have. The soil produces our food, the air we breathe, the water we drink, the animals we live with, the friends we meet, our enemies, our family, our home, our life, and future generations. The planet, indeed, provides some raw materials used as input in production processes, like cereals, aluminum, cocoa, timber, natural rubber, cotton, coal, and oil, and at the same time guarantees the absorption of pollutant emissions, assuring ecological and climate stability.

With the economic development, the world has been damaged, little by little, by man. There has been the reckless usage of non-renewable raw materials and the exploitation of the soil needed to produce them. The intensification of production processes and industrial discoveries, together with the rise of transport around the globe, have required an enormous usage of fossil fuels, resulting in the emission of significant amounts of particulates and harmful gases into the atmosphere. This has been the major cause of environmental problems and climate change, i.e., global warming, acid rains, deforestation, and watershed degradation. The energy industry is

¹² <https://www.istat.it/storage/ASI/2022/capitoli/C01.pdf>

the most polluting, followed by manufacturing and agriculture ones. More deeply, nitrogen oxides, sulfur dioxides, heavy metals (i.e., cadmium, mercury, lead), but also nitrogen and phosphorus, and other noxious substances are released during industrial processes, then concentrated in the so-called PM10 or PM2.5 particulates in the air, and finally inhaled by people (Istituto Superiore Sanità, n.d.; Helty, n.d.).

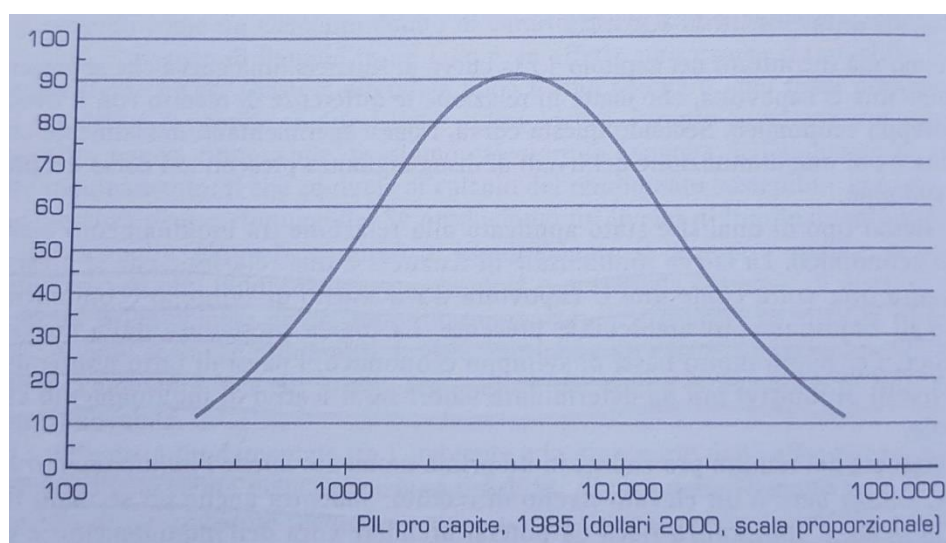
3.1.2.1. Pollution and productivity

Spoiling the environment, though, is not something to ignore, because it has negative repercussions on the population's health (in extreme cases, the existence), but also interactions with economic development as a consequent effect.

When workers suffer from pollution-related illnesses, their productivity decreases, and they become a liability for companies. Furthermore, pollution has negative effects on the environment by damaging natural resources that are necessary for manufacturing processes. This can harm a company's future production and existence. In a shorter time, if a company invests in a highly polluted region, it may face more stringent regulations for reducing pollution, which are more prevalent in these areas compared to others. Companies must invest in the appropriate machinery and production processes to meet environmental standards, which can be costly.

Residents of polluted regions often must pay fees for cleaning services, just because there is more attention on the topic. According to Kuznet, the relation between economic development and the level of pollution (Figure 3.5), though, is strong and can be graphed as Kuznet's bell-shaped environmental curve (Weil et al., 2005).

Fig. 3.5 Environmental Kuznet's Curve - Weil et al. (2005)¹³



Higher development results in higher income, and consequently in higher pollution, but this is true up to the point where the income is so high that wealthy people can afford to spend money to restore the environmental damages as if a clean planet were a luxury good. However, this theory cannot function forever, because some damages can be irreversible, and the situation be so serious that a backward step is not possible to make (Weil et al., 2005). Environmental damages represent the best example of negative externality, being actions performed by individuals that negatively impact the well-being of the rest of the population and the world. Indeed, economic agents impose on people a worsening of their living habitat, without them being able to do anything to rebel or directly solve the problem. This is a typical example of market inefficiency, where state intervention is needed and can be articulated in three different ways. The first is the imposition of an “Emissions tax”. It is a version of the Pigouvian fee, invented by A.C. Pigou in the '30, and is applied to each emission unit produced by a company, negatively impacting another's profitability, being an extra cost to be supported. Nevertheless, the state requires a precise emission tracking system to assess the tax the company must pay. The second type of intervention has the same limit as the Pigouvian fee and is called the “Cap & Trade system”. Production facilities receive emissions authorizations that they can use entirely if needed, or in

¹³ NOTE: the graph depicts the curve representing the relation between the number of fine particles in the atmosphere (vertical axis) and the GDP per capita (horizontal axis).

surplus cases, can sell to other companies, that the state has equipped with fewer permits as above, it is needed a monitor system used by the state to monitor the industrial activity and so to decide how many authorizations to give. Even if with such limitations, it is used and has been realized at the European level as the “Emission Trading System”. The third and last state’s intervention is called “Command & Control” and is the most effective because it is based on compulsory behavior/equipment that industrial activities must have to decrease pollution, otherwise, they will be fined. Thus, the peculiarity is that there cannot be the use of different types of machinery or methodologies, even if more effective, but the ones imposed by the state (Rosen et al., 2019).

Pollution has negative consequences for both the environment and companies, both in the short and long term. Corrective measures need to be taken, as companies that prioritize environmental responsibility are viewed positively by consumers and gain a competitive advantage (Chapple et al., 2001). Many companies are now utilizing ESG (Environmental, Social, and Governance) criteria to assess their commitment to environmental protection.

Governmental organizations enforce corrective actions on companies to ensure they comply with established goals and guidelines. One such example is the European Green Deal, which aims to make Europe the first Zero pollution country by 2050. As an intermediate goal, the member nations must reduce greenhouse gas emissions by 55% by 2030 (Fit for 55% program) and realize the industrial part of the Green Deal (Commissione Europea, n.d.)¹⁴. Investing in regions that are already active in climate neutrality is advantageous for companies because it reduces pollution and helps maintain a healthy workforce and natural resource availability. This leads to lower costs and a boost in productivity due to the introduction of more advanced technologies and a trained workforce on sustainable issues.

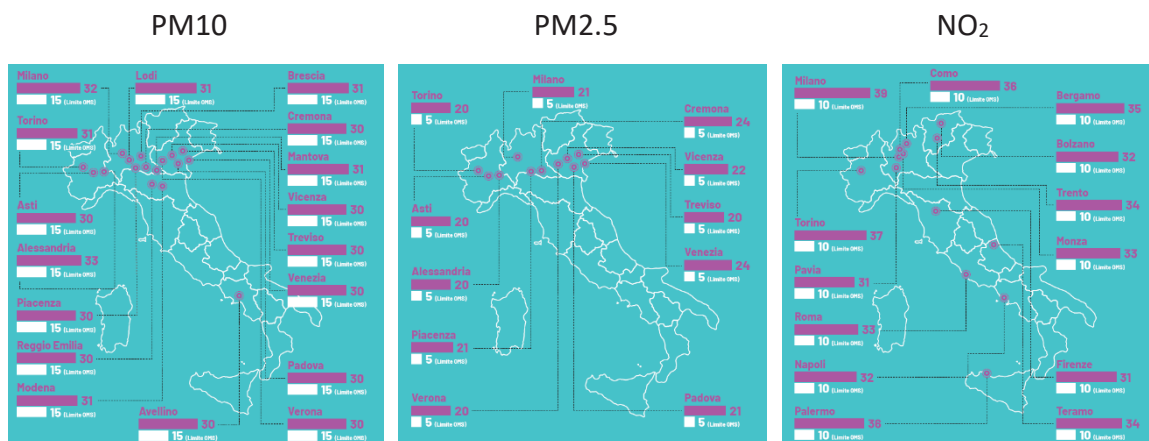
3.1.2.3. Italian situation

Italy must apply the European regulations and directives and do it promptly because it has not made much effort to reduce pollution. There are, indeed, three active violation

¹⁴ https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/european-green-deal_it

procedures against Italy for the over-emission of PM10, PM2.5, NO2, and one sentence (644/18) issued in November 2020 by the European Court of Justice, with the prosecution of having exceeded the maximum limit of particulates PM10 between 2008-2018. As shown in Figure 3.6 following Minutolo et al. (2022), the most polluted area is the one of Pianura Padana, with the cities of Milano, Bergamo, Brescia, Treviso, Torino, but also more southern ones such as Rome, Naples, Palermo, and Puglia region (Minutolo et al., 2022).

Fig. 3.6 Most Polluted Italian Cities - Minutolo et al. (2022)



The responsibility for such result, according to a survey conducted by EEA – European Environment Agency, the northern area is the most polluted due to its geographic position and because of the high concentration of industrial activities (Lightbox, 2023), while the southern ones have many refineries i.e. “Alcelor Mittal” in Taranto, “Api” in Falconara Marittima, “Eni” in Milazzo, and finally to the list need also to be included Fiumicino and Malpensa airports.

The value considered for the CI is indeed the “Average annual concentration of Particulates PM10 measured as micrograms released in a meter of air” in each Italian region (See the appendix for further details).

3.1.3. Education

Quit or do not quit? Going to work or keep studying? Every person has been faced with this decision at least once in his or her life. On one side, people continue to study beyond high school, obtain master's degrees, and take part in specialization courses. On the other one, some prefer not to even finish compulsory schooling or not to enroll

in university because of financial reasons or lack of willingness. The former renounce an immediate gain and decide to invest in their training, hoping that this will then be an advantage for their future work and be an objective benefit, repaying them for such initial sacrifice, while the latter enter the world of work immediately, and over the years already begin to gain experience and earn money. There are many shades between these extremes made up of people who resume their studies or who, thanks to the experience gained, better understand their passions and dedicate themselves to them. Which of the two is the right choice, nobody knows, but certain is that a good education level is the main thing that companies look for in their employees and that investing in educated human capital matters more than in physical one (Weil et al., 2005).

3.1.3.1. Education and productivity

Basic knowledge is a fundamental pillar for the working future, because the higher the level of skills and competencies, the greater the ability to perform well in the workplace. Moreover, expertise can be transferred and passed onto others, like a positive externality that infects all employees and makes a company perform better (Weil et al., 2005). Indeed, *ceteris paribus*, a boost in productivity, and higher profitability are the result of an educated workforce, and this is why schooling of the population positively and significantly impacts entrepreneurs' regional location choices. A study conducted by EY (2022) assessed that the presence of an educated workforce is the main criterion that human resources recruiter considers in location decisions. Management and leadership skills are the most requested, as well as innovation and technology skills are increasingly important. Skills and competencies useful for realizing and implementing sustainable projects and production processes play a key role, given that the world is engaged in realizing the so-called digital and sustainability transition.

As Basile et al. (2004) reported, though, a better-educated workforce has two effects on FDI attractiveness. The indirect one is negative, as having skilled employees implies higher labor costs, but what matters is the direct impact. With more educated personnel, the firm can lower its variable costs, because of a higher labor productivity. The gain is in the greater reward the company can make, derived from a higher output

(assuming complete availability of raw materials). The labor market is becoming more competitive and demanding regarding education, but the Italian situation is one of the worst in Europe.

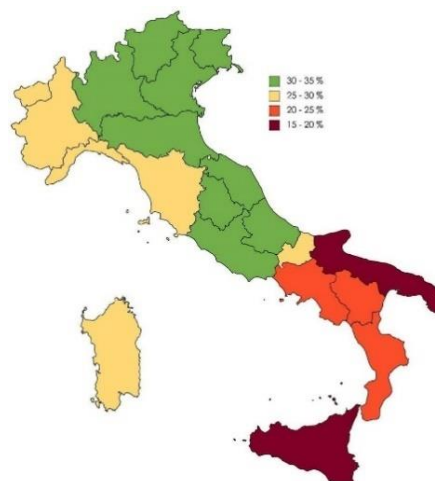
3.1.3.2. Italian situation

In Italy, there exists a big gap compared to the other European nations, with Romania being the worst one (Openpolis, 2022). The education outcomes indicate the education system's effectiveness, which is why the reduction of such disparity is of prior importance for the Italian government and is realized in the PNRR program. The present situation is very critical, as, together with the disappointing result at the European level, at the national one there are inequalities among regions. In the south there is a high level of early school leaving, sometimes families cannot provide economically for the school needs, or they need the child to work and contribute to the family budget. About 17% of students quit school before high school and less than half of the graduated ones decide to go to university (Openpolis, 2022). The map in Figure 3.7 shows that Sicily is the region where the percentage of people with a higher secondary education is the lowest compared to the rest of the nation, while the best performing one is Molise. In the analysis of the number of university graduates, the lowest levels are of Sicily and Apulia with a percentage ranging from 15 to 20%, against the leading position occupied by the north-east regions, namely Lombardy, Veneto, Trentino Alto-Adige, Friuli Venezia-Giulia, and Emilia-Romagna, with a percentage between 30 and 35% (Map 3.8).

Fig. 3.7 Percentage of people with higher secondary education – italianmaps (2022)



Fig. 3.8 Percentage of university graduates aged between 30 and 35 years per region - mappaitalia (2021)



Aside from the regional dichotomy, Italy is hurt by the Brain Drain phenomenon, too. According to the estimates, in 2019 roughly 120 million students with university education, left the country, with the aggravation that most of these young emigrants, are those who would have the greatest potential to found startups or start entrepreneurial activities. Despite the loss caused to companies and the possible negative cycle that can invest in Italy in the future, the presence of educated Italians abroad can be beneficial because it creates new networks for the export, innovation, and research sector (Anelli, 2023). The right solution seems to keep attracting well-educated workers, regardless of their origin country, that is why, for the assessment of the CI, it will be used the total number of university graduates at the regional level, both for bachelor- and master's degrees, with no distinction of students' nationalities

(See the appendix for further details).

3.1.4. Crime

From an early age, children are taught to abide by the rules, which does not just stack to the rules of a funny game but is also fundamental for human relationships. In communities where there is great respect for rules, citizens do not act for their gain or with detrimental purposes but believe in justice and are not reluctant to accept the rules imposed by the state. But the world is not perfect, and there are always those not respecting the rules, therefore, the state combines the executive and judicial functions, with the legislative one, to judge and punish crimes. The level of seriousness varies ranging from theft and robbery to money laundering, smuggling and corruption, to murders. So, countries with a high level of criminality do not provide a safe and secure image for people to live or businesses to rise there, and more importantly, they give the sign of an inefficient institutional system, unable to protect its citizens.

3.1.4.1. Crime and productivity

Olson (1984) asserted that “Crime has a depressive effect on the economy” (Daniele et al., 2008). Entrepreneurs are reluctant to invest in regions with high levels of crime, as, *ceteris paribus*, they provide a more dangerous productive system for companies: episodes of racketeering, usury, thefts, or fraud are strongly probable. They, thus, would support the higher cost of making more coverage insurance for their plants, together with experiencing many difficulties in borrowing money. Indeed, as studied by Bonaccorsi Di Patti (2009), in high-crime areas, financial institutions ask for higher interest rates and companies must pledge more collateral to have access to credit. Moreover, the fear of seeing patents and property rights violated, due to a non-adequately protective institutional system, discourages investors. Such a socio-institutional system does not encourage investments and economic growth but contributes to presenting an unstable legal and political system and increasing the country's risk (Daniele et al., 2010). As mentioned before, the state must act to punish such actions and to create a proper regulating system to provide a safe, challenging, and attractive environment for companies and business activities, but the pitfalls arise when the government institutions are the first corrupted and the one that does not respect rules or does not act honestly. Such phenomenon is called “Kleptocracy” and

can be described as the presence of corrupt politicians or institutions that, not respecting rules and regulations, exploit their position of power to act against the interest of the community, but in favor of their self- or others' benefit. Such a scenario is the worst for the economic growth of a country. If the main characters of crime actions are individual citizens or single entrepreneurs, the problem is easily solved with the sanction/punishment of the state, but when criminality spreads at the institutional level, the core of the enabling economic system is hurt. Rigged procurements, not granted loans, and denied approvals except in exchange for bribes are only examples of an undermined institutional system on which economic growth is grounded. Consequently, the struggle of the entire productive system is real, with fewer companies, and thus employees, resulting in a reduction of a region's productivity and competitiveness with other areas. However, only in 2002, the World Bank recognized corruption as the major deterrent to a country's growth (Weil et al., 2005).

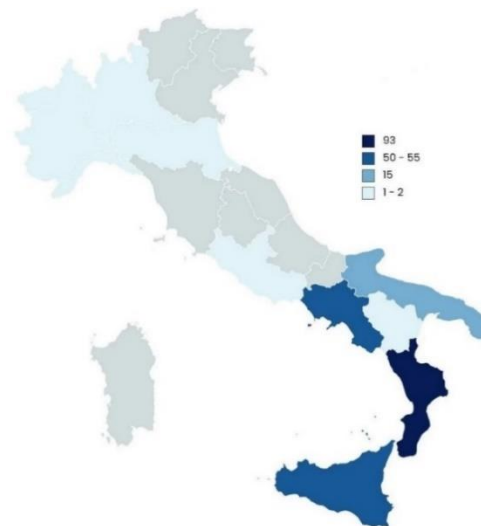
3.1.4.2. Italian situation

In Italy, in 2021, for example, more than 182 million crime episodes happened in a year, and they are more concentrated in the northern area. Milan being one of the most dangerous cities, with roughly 73 thousand theft complaints, is followed by Rimini with 255 allegations of robberies and Trieste with 48 claims for sexual violations (Lab 24, n.d.)¹⁵. Moreover, when it comes to criminality, aside from the usual type of crime, in Italy there is the peculiarity of mafia-like organizations. Their existence has historical roots and has always harmed the economic growth of southern regions, with Reggio Calabria, Vibo Valentia, and Foggia, being the top 3 respectively (Lab 24, n.d.). Indeed, the major presence of TNC in the north is a clear proxy of the effect that crime has on the decision-making process of companies, given that they follow economies of aggregation setting up new investments in places where other production plants already exist, as a sign of enough good quality of economic environment (Daniele et al., 2008). The lack of companies in the south, so, indicates a low-quality legal and political system, due to a high level of corruption. Most mafia organizations operate there, in Campania (Camorra), Calabria ('Ndrangheta), and Sicilia (Cosa Nostra)

¹⁵ <https://lab24.ilssole24ore.com/indice-della-criminalita/index.php>

controlling the economic sector and having many relationships with political agents (Navaretti et al., 2009). The Sicilian judge Paolo Borsellino, engaged in fighting mafia, said that "politica e mafia sono due poteri che vivono sul controllo dello stesso territorio, o si fanno la Guerra o si mettono d'accordo" ("Politics and mafia are two powers living and controlling the same territory: whether they fight or they agree"). Indeed, mafia organizations have a huge impact on the economic sector forcing companies to realize illicit trafficking, like weapons but also drugs and money, and even demanding the "pizzo" in exchange for protection. Moreover, as explained by Borsellino, such associations forge links with public officials and exert their pressure on the actions and decisions taken by institutions, to cover the illegal behavior. Their effect is mostly concentrated in the south, as shown in the map in Figure 3.9, which assesses the number of municipalities released due to mafia association, but the range of action is spreading also in the north, with lower percentages. The most hit is Calabria region with 93 dissolutions, followed by Sicilia with 51 and Puglia at 15.

Fig. 3.9 Municipalities dissolved due to mafia involvement between 2000 and 2021 – mappaitalia (2022)



Mafia is a major struggle for Italian development, as it plays a predominant role in composing the country risk assessment that the company performs before investing and dramatically reduces the attractiveness of the regions considered more unsafe to invest in. However, though, the data used for the indicator aim to provide the broadest view of crime per region: they encompass all the possible crimes and are indeed the sum of many illegal actions performed over 100 000 inhabitants, like thefts, robbery,

smuggling, violence, murders, mafia associations, money laundering and arrests (See the appendix for further details).

3.2. Governance

In the following the variables that are considered for the Governance sub-indicator are listed, namely Bureaucracy, and Public debt. Then, their impact on productivity and their evaluation for the Italian case are analyzed.

3.2.1. Bureaucracy and productivity

The central government most of the time is not aware of the problems happening in the smallest realities and cities, which is why the deployment of local offices helps to better grasp the local issues of the population, and issues regulations. Administrative decentralization is, indeed, the spreading over the territory of judicial offices and institutions with peculiar powers and functions, having the aim of being closer to the population and its needs (Treccani, n.d.)¹⁶. From the more general ones like Lands and provinces to the most specific ones as Municipalities, local employment offices, Chamber of Commerce, and courts, the presence of local offices, on one side, is beneficial for the population, as more closeness equals better treatment, but at the same time, if not correctly handled, an administrative organization with so many offices is the synonym of confusion and slowdowns. Moreover, such local offices are expenditure items in the public budget, so the higher their number, the more money the government must allocate. Theoretically, local offices should make easier any procedure the citizens are applying for, because they have to take care of just the closest ones. They have derived powers from the central government, so they require superiors' approval before approving or confirming something. The existence of so many rules, and the infinity of time needed for a response leads to time-consuming waits before having information from such offices for any requests, challenging and complicated procedures to complete for whatever initiative or activity, and consequent waste of time and money by individuals and companies. As reported by Barba Navaretti et al. (2009), such costs connected to bureaucratic procedures are defined as Bureaucratic red tape, and are part of the so-called country risk, as they

¹⁶ <https://www.treccani.it/enciclopedia/decentramento-amministrativo>

negatively affect the competitiveness and the investment potential of a region. A slow inefficient national administrative organization harms country's economic development and attractiveness. Accordingly, this phenomenon of regulatory inflation is not the best business card to present to companies during the investment decision-making process. In some cases, it can be corrected through appropriate policies; however, in most ones, it is a rooted factor in the set-up of advanced societies, like administrative decentralization. Moreover, nations are more integrated and dependent on each other, the participation in international organizations is growing, and this calls for a constant process of adjusting their internal regulations and constraints to keep pace with the socio-economic and technological developments happening in the world (Bassanini et al., 2005).

Such over-regulated reality, though, is lethal for boosting economic development. Companies must abide by rules in conducting their activities and in weaving relationships with others, they must comply with regulations on production methods and emissions or meet deadlines and procedures for applying for incentives or tax declarations; market competition itself is guaranteed by the existence of guidelines and supervisory bodies (Bassanini et al., 2005). Though the existence of rules is not a per se problem, it could become one if there are too many, which lack clarity, accuracy, and effectiveness. Indeed, companies are disincentivized to invest in countries where the administrative organization does not protect and encourage their rise and enhancement but acts as a deterrent by imposing useless procedures and excessive rules that take up a lot of time and money, which, in turn, is taken away from productivity. An efficient central government is such a relevant factor, that the lack of investments could not be due to the endowment of workforce, knowledge, or materials, but is caused by too many institutional constraints. Thus, it makes sense the statement that too many rules equal no rules. In trying to regulate everything in detail, you obtain nothing else, but confusion: if the specific situation does not reflect what the law requires or when there are so many rules that end up contradicting each other, uncertainty dominates, and the shadow of lawlessness approaches. Vague information leads to the spread of favoritism and corruption, which, for some people, becomes almost necessary not to get caught in the bureaucratic spider web (Basile et al., 2004).

3.2.1.1. Italian situation

Ahead only of Spain, Italy is one of the worst European nations as far as bureaucracy, as reported by Office Studies of PwC Italia (La Repubblica, 2022) and it is a country dominated by administrative decentralization, with a central government accounting for roughly 10500 institutions, some of which with overlapping powers. According to Deloitte, the bureaucratic system is worth about 1200 hours spent in administrative procedures for any company, 238 of which are dedicated to fiscal forms, and roughly 60 billion euros of expense (Noci, 2021). La Repubblica (2022)¹⁷, assumed that building a company in Italy are required about 20000 € just for administrative tasks and 312 hours to fill in certifications' paperwork. Such an environment is none but encouraging for investments of companies, as they want to have clear and linear judicial procedures to follow, and not many difficult quibbles to juggle. They aim to increase their production and profit, but such high regulation and administrative costs do not ease the process, they slow the productivity and jeopardize the economic development. The worst situation is recorded in the southern regions, where the local offices are so inefficient that administrative employees have to wait 17 days more than in northern ones to be paid. Still under the European average, the best regions are Emilia-Romagna, Lombardy, and Veneto, but there is still a long way to go (Deloitte, 2021). It is urgent to deal with the problem of bureaucracy, as it is putting in danger the economic development of the regions. The central government is the frame that has to provide the enabling factors for economic development, but if it is the first to be in trouble, the repercussions will spread all over the country. The PNRR plan already encompasses actions to reduce the bureaucracy level in Italy, as some actions have been taken by the past government to solve such issues, but Italy remains one of the worst nations in the world. A possible solution, considering the technological development of the world, is to invest in a digitalization of the Italian administrative sector, to make possible the remote and autonomous execution of many tasks and public procedures, with the consequent lightning of the bureaucratic system (Truenumb3rs, n.d.).

¹⁷ https://www.repubblica.it/dossier/economia/italia-2022-persone-lavoro-e-impresa/2022/04/11/news/il_peso_della_burocrazia_italiana_sulle_impese_cosi_tasse_e_procedur_e_rallentano_la_crescita-344677951/

The data used to assess the CI account for the total number of public entities (e.g., Universities, regional and governmental offices, Chambers of commerce, and Municipalities) located in each region (see the Appendix for further details).

3.2.2 Public debt

The public debt is considered at state level, given that the Italian single regions do not have freedom to act individually for their balances and must respect the choices made by the central government. However, each region owns a share of the total debt made by the state, according to the spendings that it did to run the region-controlled activities. It derives that the higher the share of GDP owned by the region, the more unstable and unsafe is its economic balance. Moreover, if the state is indebted, this translates in less resources available for the regions, and so less development and lower competitiveness and investments.

The government is the main structure providing the organizational framework for the population to live and work in a territory. It operates in many areas like the social and cultural ones, but also the environmental and economic spheres, and its function is to use the resources it has, to make transfers to its population, as well as to supply public goods and services. The state resembles the activity of a company: it has its balance sheet, which includes the expenditure areas and the resources it obtains, and it can resort to debts when it does not have enough capital to cover the expense. However, unlike a private company, the case is more delicate, first, because the government expenses are of national interest and then, as the weakening of the financial situation due to the use of debt, could impact the financial stability and the existence of the state itself. An increase in levies or a reduction in public spending could fill in the fiscal gap, but, at the same time, would worsen the budget deficit. So, to keep the fiscal situation stable, the only solution could be the issue of currency or government bonds, always considering that, if not kept under control, the former can create inflationary tendencies, while the latter can jeopardize the solvency of the state. Not every state, though, has monetary freedom, consequently, public spending is usually funded by issuing public debt bonds. They can be bought by private individuals or organizations, other states, or international organisms, and include the reimbursement at the maturity of the capital value plus interests. The interest rate is subject to variation depending on the reliability and economic uncertainty of the state. On one side, a

small level of public debt is feasible by the state, as it can be repaid in a few years and represents an alternative source of capital to taxes. On the other side, though, if the debt becomes too high, it is unsustainable and jeopardizes the certainty and stability of the state, together with harming its economic growth, so, the resort to debt plays a strong role in the competitiveness of a country.

3.2.2.1. Public debt's economic implications

Use of indebtedness sometimes is the only way the state must keep providing all the services and goods needed by the population, for example creating infrastructure or providing incentives for investing in less-favored regions. However, aside from such easily visible effects, there are indirect ones between public debt and economic development, some are strongly related to productivity, while others affect the general economic condition.

As far as the effect on productivity, in the short-term, resorting to public debt will lower taxes (T) and increase public spending (G), resulting in higher available income for consumers, which acts as a booster for the consumption of goods. The increase in the demand is beneficial for companies, that see a rise in their productivity, together with the reduction of the taxes to be paid. Indeed, as sustained by Keynes, a tax reduction (T) or an increase in public spending (G) via indebtedness can boost economic conditions during periods of recession. However, the situation turns in the long run, when the result is a decrease in the capital available for investments.

Starting from $Y = C + S + T$ (C: consumption, S: savings, T: tax) being the private income and $Y = C + I + G + NX$ (C: consumption, I: investments, G: public spending, NX: net trade balance¹⁸) being the public income, and knowing that $S + (T - G) = I + NX$ represents the equality between savings to the left (private and public surplus) and investments to the right, an increase of S must compensate a reduction on the budget surplus (T-G), otherwise the right part of the equation, the investment one, will suffer a reduction. (The equality between savings and investments is obtained by equalizing the private income function with the public income one).

In this case, the private savings (S) should act as a compensator, but if not, the

¹⁸ NX is the balance between import and exports; more specifically +export-import

shrinking in investments is inevitable and will lead to a lower stock of working capital and labor productivity, a reduction of salaries, and a decrease in the productivity of companies. So, the use of public debt would result in a drop in national investment and innovation of a state, which reflects a backward economic sector and a not favorable environment for companies (Blanchard et al., 2016). Such discouraging effects act on internal and external ones, threatening the competitiveness of the state. International companies are concerned about investing in a highly indebted state, as perceive it as economically unstable and unreliable and prefer diverting their investments elsewhere.

As far as the general economic condition of a state, the presence of public debt deeply affects its financial solvency and its existence. The widespread use of debt makes politicians act careless about their decisions regarding which areas to sustain with public expenses and which not. In the short-term government that appeals to indebtedness is perceived positively only by the population, who have more money at its disposal, while for both, future generations, and the financial markets, it will be a sentence. The former will be left with the burden of having to pay high taxes to pay off the debt made by previous governments, because, even if the repayment seems to be far in time, it will come the day when individuals and companies will have to pay extra taxes to restore the debt (Rosen et al., 2019). The latter will have to struggle with higher interest rates because the state will be perceived as riskier and debt holders will demand higher rates for fear of its default. The Central Bank would be forced to issue currency to lower real interest rates, but such action has positive effects just in the short-term because then, nominal rates would still rise due to inflationary trends. The worst case is the Spiral of the debt, namely when a state is forced to borrow not to cover public spending, but to pay off the interest on the debt it previously failed to pay. This occurs when a state cannot repay its debt or interest, causing it to become less financially stable. As a result, the interest on the debt increases, and the state is forced to take on more debt to repay past debt and interest, rather than to cover a budget deficit. Therefore, it is concerning when a state rapidly accumulates debt (Moscone F., Personal communication, November 2021).

It can be seen then, how public debt, is a negative factor for the competitiveness of regions, although it has immediate benefits, it has many indirect repercussions on the

productivity of companies and economic development. However, in the literature it does exist the theory of “Debt neutrality” was published by Ricardo in the 19s. He denied the negative effect of the debt, affirming that, whether an increase in taxation or indebtedness funds public spending, the long-run effect will be null, as consumers know that in case of resorting to debt, they must save money to repay it in the future. Such an idea of transferring taxation over time is unfeasible, firstly because families do have not the same possibility to save money or to easily borrow it at whatever rate, and secondly because leaving the burden of debt to future generations does not bode well for the country's development and competitiveness. On the contrary, it should be increased the efficiency of the state by implementing policies that limit the use of debt, and instead encourage entrepreneurial initiative and development (Spaventa, n.d.).

3.2.2.2. Italian situation

Italy has always been characterized by a high public debt, which negatively affects its competitiveness. Geopolitical crises, pandemics, and various environmental disasters during the years have not simplified the reimbursement, but, on the contrary, have made it necessary for the state to borrow money. Indeed, the growth of 84 billion € in 2022 is split between a 54 billion amount allocated to public spending and a remaining 34 reserved for adjustments connected to the energy inflation and redemption of already existing securities. The total debt is worth 2762 billion €, with an estimated reimbursement of roughly 8 years (Redazione Soldionline, 2023). The fear is the exponential growth of the Italian public debt, which would increase the interest rate and a loss of confidence in Italy from foreign investors. Moreover, since banks are the largest source of financing for companies, an increase in debt and the resulting lower credibility of the economic system would lead these financial institutions to raise interest rates and ration credit, also harming companies already in the state. The situation is always kept under control through the variations of the Spread, whose value is defined as the differential yield between Italian 10-year maturity bonds BTP and the 10-year bonds BUND of the most reliable European country, which is Germany. For example, with simple numbers, if the BTP's yield is 2% and the BUND's is 0,5%, the spread is worth 1,5%, which, expressed in basis points, given that 1% is equal

to 100 points, 1,5% corresponds to 150 points. Any state scoring higher than Germany in fact, is riskier and unable to repay debt the higher yield indicates there is a higher risk that investors are taking (Economiapertutti, 2022).

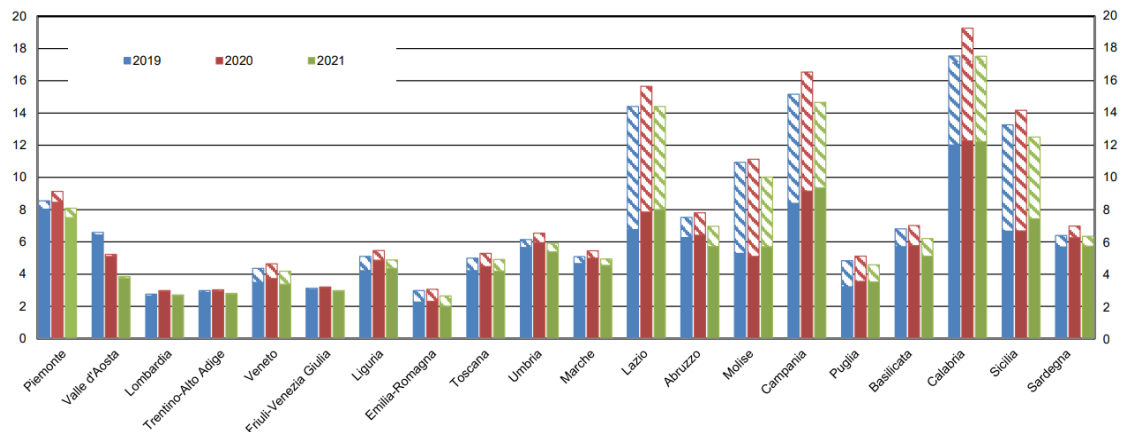
The roots of Italian debt are to be found in the economic expansion that started in the 80s, and not even the joining of the European Union served to solve the problem. Entering the European Union has reduced the freedom of action because the economic crisis can easily spread and affect all the European countries. First, the members do not have freedom of action as far as fiscal and monetary policies as stated by the Maastricht Treaty, and, secondly, they must respect the constraints of the "Stability and Growth Deal". In particular, the latter requires the deficit-to-GDP ratio to be less than 3% and the public debt to be less than 60 percent of GDP. Otherwise, given the country's critical economic situation, it could be subjected to tight accounting control procedures by the European Union to prevent the crisis from reaching other nations in the union (Guerrieri, n.d.). As Becchetti et al. (2019), the European Union provides some tools that states in financial trouble can refer to, such as the ESM (European Stability Mechanism) or the European Redemption Fund. The former is a fund formed by the dues paid by member states, which provides financial help and assistance to its members who find their selves in financial difficulty. However, the functioning is not so easy the ESM implies the respect of some conditions imposed by the European Union, which sometimes strongly interfere with the government activity, almost dictating its monetary and fiscal decisions and political direction. The latter is a fund that contains a share of the national debts of the Eurozone's countries, and its use involves an annual contribution from nations proportional to the share of debt transferred and wealth produced. For Italy, though, it is difficult to reduce the debt autonomously, as it must respect the monetary and fiscal European guidelines.

The only thing that can be done is a wiser allocation of resources, for example giving the right priority to what is effective and needed for the state: which spending it is right to keep and which ones can be cut, as the spread of public offices across the territory, or the high compensation that politicians are entitled to.

The impact of public debt on the economic development of a state is so negative that it can threaten the entire functioning of its economic system. This reasoning also

applies to regional realities, as shown in the graph in Figure 3.10, Lazio, Campania, Calabria, and Sicilia are the regions with the highest level of public debt and are also the ones with the least companies and economic development. On the contrary, Lombardia, Trentino-Alto Adige, Friuli-Venezia Giulia, and Emilia Romagna, with the lowest levels of debt, are more developed and competitive in the Italian market.

Fig. 3.10 Public debt of local administrations per region as percentage of GDP – Banca d’Italia (2022)¹⁹



Thus, the reduction of the public debt is fundamental to enhance the competitiveness of Italy as a whole and more specifically also to improve the economic performances of the backward regions. Otherwise, regions with high debt will always be dependent on wealthier ones that will have to pay for them and will also be perceived as unsafe as a destination for investment and fail to develop economically, always falling behind. That is why, for a better estimate of the regional competitiveness it will be used the data referred to the entire amount of debt over GDP per region (year 2021), without differences in maturity (See the appendix for further details). The use of the data on public debt over the GDP provides information on the real effect of the debt on the wealth produced by the region.

¹⁹ https://www.bancaditalia.it/pubblicazioni/debito-amministrazioni/2022-debito-amministrazioni/statistiche_FPR_20220225.pdf

NOTE: The entire column represents the whole debt, while the dashed part relates to the consolidation elements, i.e., that parts of the debt which, although short term, are converted to long term with a commitment to be repaid in subsequent years. Advances from the MEF to local bodies to repay commercial debts, or other funds granted by the MEF to purchase regional bonds or to clear health care deficits are of this type and are added to the already amount of consolidated debt i.e., the portion of long or indefinite maturity debt that is subscribed to meet long-lasting budget deficits.

During the chapter, it could be seen that crime and pollution lower the competitiveness of a region, as well as the limiting effect of a complicated and heavy bureaucracy. Investors fear the overregulation trap, which together with out-of-control public debt depicts a state with an inefficient political system and, which is not so safe to invest in. On the other side, a population in good health conditions is a capable and more educated workforce, that is exactly what entrepreneurs look for in the place where they would like to invest.

Chapter IV – Economic and Finance & System of Innovation

This chapter presents two sub-indicators, the first is Economics and Finance, which encompasses information on Market size, Exports, Interest rate, and Employment, while the second is the System of Innovation, dealing with the Transport Network Efficiency, Research & Development (R&D) resources, Digitalization, and Energy.

Such a chapter is more focused on the analysis of proper economic aspects, which are the straighter forward ones considered by entrepreneurs during processes of regional evaluation, from the financial to the international one, together with an overview of the innovative sectors that an important role in the economy of the country. An evaluation without information on the transportation quality or the digitalization level would have been incomplete and unsuitable for providing a consistent analysis of a nation's competitiveness. Each variable will be treated also according to the Italian reality.

4.1. Economic and Finance

In the following the variables that are considered for the Economic and Finance sub-indicator are listed, namely Market size, Interest rate, Employment, and Export. Then, their impact on productivity and their evaluation for the Italian case are analyzed.

4.1.1. Market size

The main aim of a company is to reap rewards and to create profit from the product or the service it offers. In doing this, deep understanding of consumers' preferences and habits is needed to provide them with a product they cannot avoid buying. Such number of buyers is defined as the market size, which is the portion of the market that directly affects the attractiveness of the companies operating in it. To be precise each industry has its market, with specific rules, types of buyers, and ideal customers, but in this case, it will be treated the whole market as the consumption of a country or a region. Thus, the indicator used to assess the composite indicator is the "Average monthly family expenditure in alimentary and non-goods" estimated by Istat. (See the appendix for further details)

4.1.1.1. Market size and productivity

Companies are tempted to settle and to invest in new productive plants in regions where there is a wide market, as they know they will benefit from the increase of their turnover given the large number of final consumers, and additionally that they can exploit economies of scale and reinvest the profit in innovation or research processes (Dijkstra et al., 2023). A high number of consumers, though, makes a region more attractive, increasing its competitiveness. Theoretically, the main indicator for the size of the market is the level of GDP, as it is thought as the amount of money that the individual will allocate to the consumption of goods, but there are two different approaches to consider: a more traditional one, the “Keynesian theory”, and a modern one “The permanent income hypothesis – life cycle model”.

The first is based on the classical idea that the level of consumption (C) is positively related to the current level of income at disposal (Y_d) and results in the Keynesian consumption function, Equation 1.

Eq.1 Keynesian consumption function

$$C = c_0 + c_1 * Y_d \quad (1)$$

where c_0 is the level of free consumption when the income is null and c_1 is the marginal propensity for consumption. Such consumption level is not influenced by temporary income fluctuations and is positively related to it, given a greater level of consumption deriving from a higher level of income. Please note that income could be not entirely consumed, but saved, too.

The second theory was presented in 1950 by Modigliani and Friedman, M&F, and has introduced the role of future expectations in consumption decisions. At the base of the first part, Friedman’s “Permanent income hypothesis”, is the concept that consumers buy according to the income they expect to have in their whole future life. This part of the theory relies on the ability of an economic agent to assess the fraction of income that they can afford to consume based on the evaluation of the whole income they will receive during their entire life. The second half of the theory, the “Life cycle model”, reflects Modigliani’s idea according to which, consumers set a stable consumption share they want to maintain during their lifetime, even during negative times.

This theory does not show a strong correlation between the current level of income and the current level of consumption, because the consumption share depends on the

permanent income expected in the future based on skills and professional competencies, capacity, and educational qualifications. The consumption level (C) strongly depends on the permanent income (Yp) and so the consumption function is as equation 2 (Chiovaro, 2007).

Eq.2 Permanent income consumption function

$$C = \alpha * Y_p \quad (2)$$

where α is a constant measuring the part of permanent income being consumed.

Consumers act, in fact, with the logic of the Consumption Smoothing, according to which they want stable and constant levels of consumption over time. The far-sighted consumer uses each year a fraction of its income and, according to Friedman, when a negative cycle arises, he/she is also ready to resort to debts or savings, to maintain constant its share of consumption. Moreover, consumption varies less than proportionally to income level, in fact in case of adverse transitory shocks individuals will reduce it less than proportionally, confident that the income level in the future will rise again.

But this M&F theory presents some limitations, firstly as it assumes the improbable existence of perfectly working and accessible by everyone financial markets to rebalance the negative periods, and secondly because consumers do not act so forward-thinking so that most of the time is driven by pressing needs without caring too much about the future.

At least, still counts the logic that consumption is an increasing function of wealth and that changes less proportionally than income, with future expectations playing a role in the process (Blanchard et al, 2016).

Aside from the fluctuations that can happen to the income level, there are also changes at the national or international level, which have repercussions on the size of the market and the profitability of companies, too. The best example is the inflation rate. The price of a final good is comprehensive of the costs of all the steps the product has to go through during its production processes and is the value that consumers pay on the market to buy it. Given that the open economy dominates the world market, a single item can be assembled or produced in different countries, encompassing the different manufacturing prices, or it can be formed with intermediate products, whose price reflects the economic conditions of the country where they are made. The

market price of the good groups all these phases and it will be higher, the higher the price of the material/manufacturing needed in the production process. Such transmission in international trade is called “pass-through” and happens when the energetic production input’s price rises and consequently makes the price of goods using energy increase, too (Istat, 2023)²⁰. The autarchy economy could avoid such problems, but is not sustainable anymore, as imported goods are a consistent part of the national demand. As an example, the effect of higher prices leads to the spread of inflation, the generalized increase in the prices of goods and services, and the decrease in the demand for products (mainly of the ones with elastic demand), as well as to a consequent reduction in companies’ turnover. The mechanism is simple, indeed, because as prices increase and salary not, consumers cannot afford to buy the goods and will save money because of economic uncertainty or will devolve them to buy necessary ones. As a possible solution, there should be a proper increase in the amount of salary, so as not to lose the purchasing power of the currency, but this would lead to the so-called “spiral prices-salaries”, which reinforces itself and instead of leading to an end, get to a worsening of the economy. At the national level, the consequence is the shrinking of the market size, while, internationally, national products will be perceived as more expensive and their competitiveness is reduced. This in turn affects the competitiveness of a region because companies will avoid setting up their production facility knowing that the production inputs of that place are so costly and that this will be reflected in a higher and non-competitive price for their good on the market and in a consequent loss of money. Indeed, during 2022 the European industrial turnover decreased, and the main nation economies suffered an inflation phase, with a +8.7% growth rate in prices, caused by the rise in the cost of energy (Istat, 2023)²¹.

4.1.1.2. Italian situation

Regions with higher levels of GDP are also those with the highest monthly household spending. Lombardia, Emilia-Romagna, and Lazio are some of the wealthiest regions and have an average monthly expense of goods worth respectively 2904,45 €,

²⁰ <https://www.istat.it/storage/settori-produttivi/2023/Rapporto-competitivita%20.pdf>

²¹ <https://www.istat.it/storage/settori-produttivi/2023/Rapporto-competitivita%20.pdf>

2658,74€ and 2711,70€²². Indeed, in 2021 the average monthly expenditure of Italian families has increased by 4,7%, hitting roughly 2400 €. The enhancement did not happen in all sectors: the travel and vacations category recorded a reduction in the whole country, while the decrease for clothes and footwear has been stringer in southern areas. The demand remained unchanged for inelastic products like food, medical checkups, and personal care products almost in the entire peninsula except the southern regions, which recorded the biggest reduction (Table 4.1) (Istat, 2022).

Tab. 4.1. Families limiting expenses on goods and services per geographic area – Istat, (2022)²³

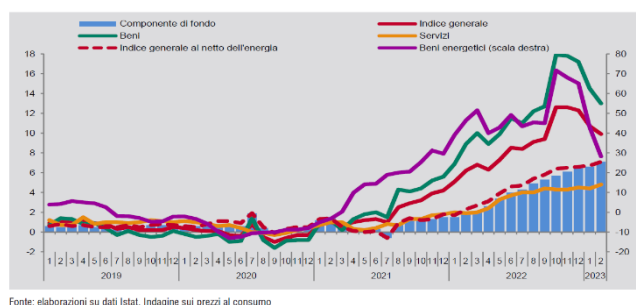
Anno 2021, valori percentuali

RIPARTIZIONE GEOGRAFICA	Alimentari	Bevande	Abbigliamento e calzature	Cura e igiene personale	Visite mediche e accertamenti periodici di controllo	Carburanti	Viaggi e vacanze
Nord-ovest	20,3	23,1	48,9	29,2	17,3	30,4	60,6
Nord-est	19,3	26,1	49,4	23,7	11,9	27,6	61,9
Centro	23,2	26,4	50,5	28,2	16,2	28,6	57,8
Sud	37,1	43,7	63,2	45,4	27,9	38,8	68,3
Isole	20,9	31,8	52,7	32,7	20,9	30,6	72,9
Italia	24,3	29,6	52,7	31,7	18,6	31,2	62,4

Fonte: Istat, Indagine sulle spese delle famiglie (R)

Consumption in real terms, however, grew by only 2,8 percent due to inflationary trends. As in the graph reported in Figure 4.1, in Italy there was an increase in the prices of goods worth +12,1% and the ones of services for +3,4% in 2022, marking a considerable boost concerning the previous year (Istat, 2023)²⁴.

Figure 4.1 Harmonized index consumption process. Jan 2019 – Feb 2023 – Istat, 2023²⁵
(Tendency values in percentages)



²² Data used to assess the CI, available in the Appendix at “Market Size.”

²³ <https://www.istat.it/storage/ASI/2022/capitoli/C09.pdf>

²⁴ <https://www.istat.it/storage/settori-produttivi/2023/Rapporto-competitivita%20C3%A0.pdf>

²⁵ <https://www.istat.it/storage/settori-produttivi/2023/Rapporto-competitivita%20C3%A0.pdf>

NOTE: the graph shows the projections of price increase for goods (green line), services (yellow line), and energetic goods (purple line). The dotted line depicts the rise in prices without considering the energetic ones, while the red line groups every change.

More deeply, in Italy during the inflation phase, there has been a big shock on the supply side, due to the increasing prices of energy and commodities. The main effect was in the agriculture sector, with the production of alimentary goods being the most hurt. Regions such as Emilia Romagna, Umbria, Campania, Puglia, and Veneto suffered the most from the inflation given the high presence of wine, pasta, and cheese factories, but general harm was suffered also by Sardegna, Sicilia, Liguria, and all the regions where there are heavy plants like refineries, metallurgical and mining facilities. No differences arise between north and south as far as inflation, what is needed is just a common action by the government to contrast it (Istat, 2023)²⁶.

4.1.2. Interest rate

The interest rate is the percentage added to the borrowed capital that borrowers must pay to their lender.

4.1.2.1. Financial availability as company attractor

The financial system of a country is an economic space where banks, insurance companies, savings and mutual funds, private and public financial institutions, and economic agents relate to each other and work together, respecting precise rules and regulations (Ezirim, 2005; Ogiriki, 2014). They offer financial instruments and services to private, and most importantly, to companies, which can refer to them mostly for capital provisioning (Di Giorgio et al., 2000). An advanced financial system is a key driver for economic development, so in the investment decision-making process companies prefer regions with many financial services and where the financial system is well developed with good interactions between institutions and economic agents. Indeed, as reported by Guiso et al. (2009), a higher number of acquisitions and creation of new companies is detected in regions with a quality financial sector. J. Schumpeter was the first to consider the strong relationship between economic development and finance. In its development theory, he asserted that the entrepreneur, being the engine of economic growth, has to resort to funding into the money market, which then is used to get the production factors he puts together to

²⁶ <https://www.istat.it/storage/settori-produttivi/2023/Rapporto-competitivita%20.pdf>

reap the wanted gain. The idea of the important role played by the positive correlation between the financial deepening and the productivity of the country contrasts with the Classical Growth Theory, though. This ignores financial intermediaries because it is based on the belief that the perfect competition rules in the market, where each agent is perfectly and completely informed and there is no need for extra intermediation. It is J. Stiglitz who supports that information asymmetries do exist and though it is required the intervention of an in-between agent or of a better regulation, to avoid the penalization of any parties of the financial interaction. Intermediaries, so, are key entities for boosting economic development, as they can simplify the processes of accumulation of capital, by providing the assistance and information needed by the economic agents. So, the unquestionable effect of a proper intermediation system on economic productivity is, again, emphasized by the Theory of Informative Costs (Braga Nonnenberg et al.,2004). A region with a good financial system and low interest rates contains fundamental enabling factors to foster its competitiveness because is synonymous with stable economic conditions and growth.

As reported in the Essay of Diamond 1934, banks play a peculiar role in the intermediation process between entrepreneurs and savers because they are the most widespread financial institutions that gather the savings of the population, and then lend money to entrepreneurs for their investments. Being a lucrative activity, banks have as their main goal the gain of profit from transactions, represented by the difference between the rate paid to savers and the one received by borrowers, and so, constantly test and control the creditworthiness of companies, to be sure to be paid back by the borrowing ones (Braga Nonnenberg et al., 2004). Such type of remuneration fee represents the cost of the capital suffered by companies, it is commonly defined as the interest rate and it is such strong the power of the possible (positive or negative) repercussions caused by its variations, that it is crucial when it comes to investment decisions for companies. Banks, above all national level ones, have the power to manage the interest rate and, when needed, to raise it to create credit rationing and reduce the money in the economy.

4.1.2.2 Interest rate and productivity

Investment capability is fundamental for the good development of companies, because it enables the expansion of the activity as far as new plants, new types of machinery, and new production processes, as well as a boost of research and development process, and increase in innovation. This is a retroactive circle that will provide the company with new capital, allowing it to realize the changes needed and required by the evolving consumers' needs, technological change, and administrative constraints. Money, though, is the major enabling factor for companies' activities, and the presence of good financial institutions, together with the great availability of capital are the main factors affecting the competitiveness of a region. But resorting to external sources of finance is always tricky for companies, firstly because it makes their financial position fragile by threatening the stability and solvency of the activity (amount of debt in their liabilities compared to the assets) and then, because it represents a cost to sustain, given that the reimbursement is calculated as the sum of the borrowed money plus its interests. Whether for upfront investments or subsequent recourse to external debt capital, money has a cost, indeed, the interest rate is always inversely correlated with the level of investments. With a decrease in the interest rate, companies are encouraged to borrow money, because its cost is lower, and to invest it into their business, doing so they can reap more rewards and repay the debt in less time and in a more cost-effective way. But if the interest rate increases, the scenario worsens: as the cost of capital grows, for companies is not so easy to ask for money, as, in this way, they would endanger their stability. Indeed, the use of external credit with increasing rates leads to an exacerbation of the financial position, followed by a reduction in the investment tendency. Consequently, when the fear of bankruptcy begins to hover, managers, depending on their freedom of action, try to gain in cost-effectiveness and start reducing as much as they could, to preserve the positive profit. The contraction of wages and the fewer hiring, together with the shrinking of working capital and investments, instead of helping the company out, only further aggravates its position, decreasing its productivity and competitiveness (Bassanini et al., 2005).

The implications are not bounded just to companies but spread across the whole economy. The sore of interest rate happens in times of economic uncertainty,

especially during periods with high inflation, to decrease the use of credit, given the increase in the cost of money. As reported by (Bassanini et al., 2005), this scenario results in two reinforcing effects, the first direct rise of the risk-free rate, i.e., the rate of return on risk-free investments, and second the indirect increase in the growth rate for risky investments, which accordingly to the level of debt the company already has and to the freedom of action of the managers, can lead to bankruptcy. The debt to repay will be higher, resulting in a worsening of the solvency, but, at the same time, the increase has a direct effect on the assets and participations of other firms owned by a company.

4.1.2.3. Italian situation

The cost of credit, regulatory framework, and currency market describe the Italian financial market (Magri et al., 2004). Banks are the major Italian financial institutions, reaching 400 units in 2020 (Messina, 2022), not only for companies and individuals but even for the government, given that some state obligations are held by these financial institutions. Owing their own state's public bonds could be risky and unfair, just like the controversial role of the national institution Banca d'Italia towards other private institutions. The Banca d'Italia oversees consumer protection, but holding shares and participations in other banks, finds itself in a self-controlling position, which makes it impossible to act as super parties, due to the conflict of interest (Di Giorgio et al., 2000). Moreover, Italy is a member of the European Union, and like the other members, cannot act individually and set its financial policy, but must accept and apply, through the Banca d'Italia, the decisions taken by the European Central Bank which has the monopoly for monetary strategies for national economies.

However, to assess the quality of the Italian system, a good proxy could be the analysis of the spreading of companies alongside the peninsula. They prefer to locate in a region where they can more easily get access to functioning and secure intermediates, to benefit from the "positive externalities" of the service they can provide. A high presence of good financial intermediation indicates the presence of much credit at disposal, whether from public or private sources, as well as a high level of savings is a sign of economic development. If banks have money available, they can grant loans and sustain companies' investments, and this will attract an ever-increasing number of

them until there will be an agglomeration of companies attracted by the availability of capital (Nachum, 2000). As a direct consequence, the usual differences between regions will arise, as southern ones are always the most disadvantaged, and lose competitiveness, on one hand, because of the lack of clusters and companies, and on the other because of the low level of trust between economic agents. Despite Italy's has no freedom in the set interest rate, it is still true that, in some cases, the financial intermediaries can fix a higher cost for the capital they lend, given the precarious credit – and trustworthiness or specific economic situation of the borrower they are dealing with.

The values used for the CI are the one of the “Active bank interest rates APR on loans related to investments needs²⁷” assessed by Banca d’Italia (see the Appendix for further details), and it clearly shows that the highest levels are in Sicilia and Calabria, around 3,25% yearly, against the average 1,90% yearly of Veneto and Friuli Venezia-Giulia.

4.1.3. Employment

The first article of the Italian constitution states that “Italy is a Republic found on work” because through it, people can express their selves, and their knowledge and earn the money needed to live. There are different kinds of employment, whether in a private company or organization, or public administration, it could be either a dependent or an independent job, and, generally, the set of people working is defined as the number of employed people in a state. The labor performances offered by the population meet the demand for labor issued by companies, in the so-called job market. The skills and knowledge, together with the cost of labor are the discriminant that can make hiring possible or not.

4.1.3.1. Employment and productivity

Labor is an important input of the production function, and it is composed of all employees, workers, managers, and directors who work in a company. They represent the factor enabling the use of raw materials and machinery, but also the brains who

²⁷ [See the appendix at “Interest Rate.”](#)

discover innovations, as well as the direct services providers, when it comes to companies of such type. Workers are fundamental to carrying out the production process, which is the reason why entrepreneurs put a lot of attention into choosing a region where there is a great availability of them (Basile et al., 2004). At the same time, though, employees have to be paid by the company in exchange for the activities they provide, so entrepreneurs always pay a lot of attention to the debated relationship between labor cost and workers' productivity. As reported by Basile et al. (2008), a low labor cost can be attractive at first because it seems convenient for the company's balance and an indicator of elevated availability of workers, but the truth is that employees with more skills and abilities can realize more quality products and be more productive, even if more expensive.

This is why fixed-term contracts are frequently carried out previously considering a definitive one or when the company cannot afford to pay extra employees because of a negative trend or economic uncertainty. Indeed, they could last the time required to properly assess the abilities of an employee before offering a permanent contract, or they can be used to make up for more work-loaded periods or to run special projects (PagePersonnel, n.d.). Such contracts are not so liked by employees, especially the younger ones, because, even if they provide flexibility and easy change of employment area, at the same time, they do not give any guarantees and a good economic perspective for the future. On-job education is discouraged as not useful, given the rapid turnover due to the expiration of contracts, which has strong negative repercussions on the company's productivity (Cirillo et al., 2019). Companies should try to attract and make stay the most skilled employees, and one of the best solutions is a permanent contract. In doing so, they have to invest in ad hoc training projects and recognize them as the correct wage, because more satisfied workers are more productive workers, which can benefit the profit of the company. The new resource to boost economic development is young employees. As reported by Barbiellini Amidei et al. (2018), a young workforce will make the employment rate rise, but also increase efficiency and productivity. Young employees may have the passion and the proper knowledge to start new activities in an area where technological updates and innovations set the pace. They can have more courage and be more familiar with the necessities and trends of the world.

4.1.3.2. Italian situation

When it comes to employment, the Italian situation complicates a little. The population is divided between employed, unemployed (composing the active workforce), and inactive people. The difference between the unemployed and the inactive is that the former are not working but still looking for a job, while the latter do not have a job and do not even search for it.

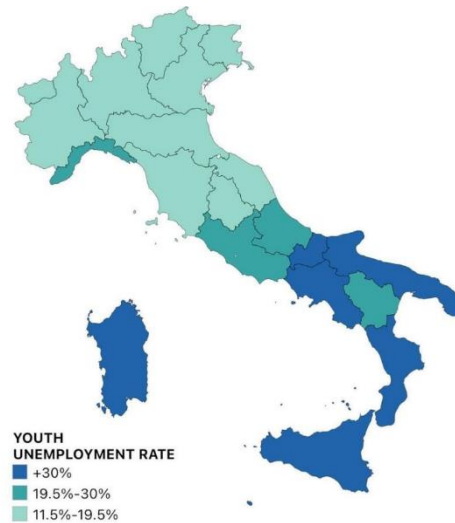
Still under the EU level, in 2022 the rate of employment increased by roughly 60,1%, with a decrease of 8,2% in the unemployment rate (unemployment/active workforce) and a 35,5% level of inactive people (Istat, 2023). The working situation seems to be favorable, except for the special young ones. Even if the youth unemployment rate (unemployed/active workforce) has diminished to 23,7%, this is just because of the rise of inactive people and the consequent decrease of the active ones. Indeed, such improvement is not relatable to a higher youth employment phase, rather is due to the conscious choice of many young people not to work, (Luca P., 2023) because of the new type of few-guarantees and low-wage contract that are spreading lately. They are fixed-term contracts, apprenticeships, and traineeship contracts carried out by entrepreneurs to benefit from tax relief and a lower cost of labor. Such cost, that they must sustain, is quite articulated since it encompasses the work salary and the amount of money, that is allocated to welfare institutions to ensure the workers with a proper benefit in case of illness, retirement, and maternity leave. That is why, entrepreneurs prefer such more favorable deals, which are ruled by the government and unions, but not so liked by employees.

The problem of unemployment is more present in southern regions. Even though according to the data of Istat (2022), the south has not been hurt so much by the COVID-19 pandemic, and has recorded an increase in employment in 2021, this stays true in relative levels, but not in absolute ones. As shown in the map in Figure 4.2, the data of the first trimester T1 of 2022 measure a critical situation in the southern areas where the unemployment rate is around 12 – 16%. The situation is not any better for younger ones, the map in Figure 4.3 clearly pictures a big difference of about 9 points between the northern and the southern levels of youth unemployment.

Fig. 4.2 The regional unemployment rate, T1 2022 – mappaitalia (2022)



Fig. 4.3 Youth unemployment rate – italianmaps (2022)

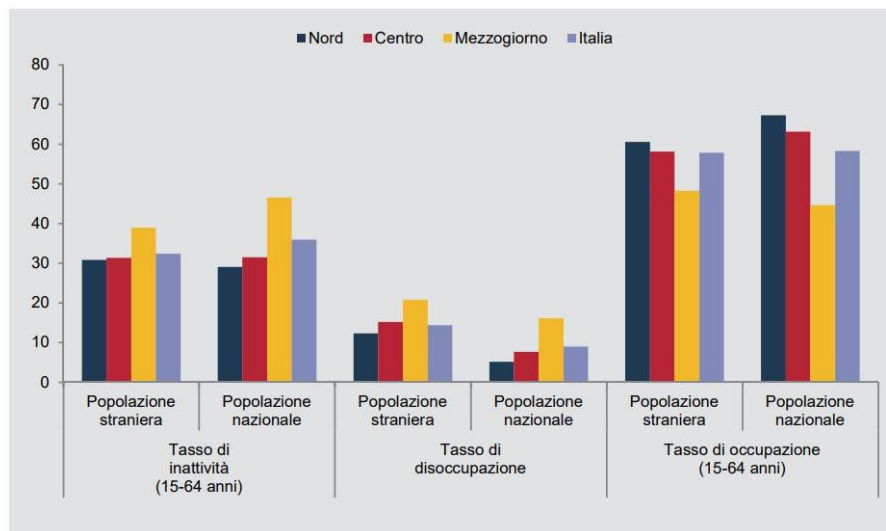


Even analyzing the youngest one, the best-performing regions are in the north of the country. Basile et al. (2009) state that in southern areas there is a negative unemployment spiral: on one side the cost of labor is low, given the surplus in the workforce and the consequent absence of bargaining power. On the other side, though, employees do not want such low wages, and so, most of the time, they consciously choose not to work or decide to move. A derogatory effect is also the presence of a more widespread corrupted system, which tends to favor only those who know powerful people or belong to certain families, like mafia-aggregated families or friends of people who hold important work positions. Entrepreneurs are not encouraged to invest there, and relying on that spirit of aggregation, prefer to replicate what others did before and set elsewhere. The devastating consequence is the general downturn of the region, which loses population and consumption, not paving a positive and full of opportunity future for future generations. Young people on their side cannot do anything but move to northern cities or abroad, the brain drain phenomenon is persistent in such regions. Maybe it is the young people the solution to this vicious cycle, to stop such a process and to create an enabling environment for companies to grow, to boost the demand for workers.

It is worth pointing out, also, the situation of foreigners. The usual preconceptions are of two directions: the first is that people from abroad come to Italy not to work and be

supported by the government, while the second is that they steal the work of Italians. As usual, the truth is probably in the middle, sure is, however, that the rate of employed foreigners is roughly as high as the one of Italians. More precisely, in southern areas their employment rate is higher than the Italian ones, as well as the inactivity rate is lower than Italians (Figure 4.4). For this reason, the data used to estimate the CI are related to the whole number of employed people in each Italian region (See the Appendix for further details). They are expressed in thousands and do not make any differences according to nationality.

Fig. 4.4 Main indicator in % of citizenship and geographic distribution, year 2021 – Istat (2022)²⁸



4.1.4. Export

In the modern world, states cannot live in autarky, as globalization has exposed people to a wide variety of goods, so the internal market is not sufficient anymore. Consumers want goods that come from other states because they have different characteristics or have some peculiarities or versions that better respect their wishes. Not to mention cases in which a good is a monopoly of a precise state because of the material used in the production process needed, so there is no way except buying it from the only place where it is produced. In economic theory, though, the idea of a market beyond the

²⁸ <https://www.istat.it/storage/ASI/2022/capitoli/C08.pdf>

NOTE: The four different colors define the part of Italy: the North is dark blue, the Center is red, and the South is yellow, while the average Italian value is light blue. The data are presented in separate sections for foreigners and Italians and cover the three divisions namely, inactivity rate, unemployment rate, and employment rate.

boundaries of states is not new. Already to David Ricardo, the existence of the Comparative Advantage Theory asserts that a country should specialize in the production of the good, that has the lowest opportunity cost concerning other countries. It will, so export such products in exchange with goods that are produced at a lower cost in other countries. Another important theory is the one presented by the Swedish economists Heckscher and Ohlin, which, based on the factor endowment of states, says that a country will focus on the production of goods that are intense in the factor that is abundant in it. Such goods will be exported, against the import of the ones that require the scarce factor (Paradiso A., personal communication, October 2022).

4.1.4.1. Export and productivity

Exported goods or services represent the foreign demand for national products and are measured in the trade balance, which accounts for the exports and imports amounts. Exports are a good indicator of the degree of openness of a state they are strongly dependent on international economic conditions. They are affected by the level of a foreign country's GDP (Y^*) and by the fluctuations in the real exchange rate (ϵ). The impact of the exchange rate is represented through the Marshall-Lerner condition: with a decrease in the real exchange rate, external goods are perceived as more expensive, and so the import value lowers, in favor of a boost in internal demand. On the other side, national goods are perceived cheaper in the international market, and there is an enhancement of foreign demand, so both situations are positive and make the national production grow. At the same time, the effect of the foreign GDP is also positive, as an income increase will translate into an increase in foreign demand. National companies are subjected to higher demand from other countries and need to enhance their production to satisfy foreign consumers. Through the multiplier effect, the consequence is a boost of the national demand, too (Blanchard et al., 2016).

Thus, exports do not have a direct effect on the competitiveness level of a region, as they depend on what happens at the international level, but they have an indirect effect on productivity. A company moving to a region with a high percentage of exported goods knows that can benefit from some advantages that the location

indirectly offers. First, high exports equal the existence of trade deals (ease of barriers and tariffs) with other countries and the real existence of another final market except the national one. Then, the state where you move could be part of any trade union or alliance, together with any international organizations that have conditions which the company can benefit from. As an example, the members of the World Trade Organization are ruled by the “most favorite nation” condition, which means that whenever two nations agree on a reciprocal reduction of tariffs for their trade, such favorite clause must also be applied to whatever third country will trade with the starting two. As reported by Weil et al. (2005), the whole region benefits from trade openness, as it boosts the national productivity, and profitability of companies, and it simplifies technological transfer (Weil et al., 2005). Though, aside from the pros, there is also a little con about international trade, which is the transfer of economic uncertainties through countries. Inflationary tendencies can reach also other countries via the trade deals that happen between them, and, at the same time, if a nation is experiencing a negative conjuncture with a shrinking of the GDP, it will lower the foreign demand, directly damaging its economic partners. Even geopolitical facts can damage exports as they hit the exchange rate of currency and disrupt the supply chain (Blanchard et al., 2016).

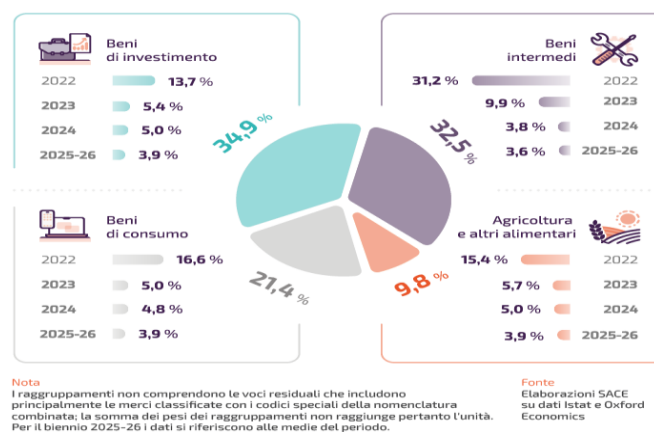
4.1.4.2. Italian situation

Italy can offer some advantages for the export of its companies it is a member of the area of free movement of goods, without tariffs and barriers, moreover is part of the World Trade Organization, so can expand to all the possible economic partners, favorable conditions it has granted and, finally, being in a period of depreciation for the Euro currency, can make its goods more competitive on the international market and for dollar area countries. According to the EU Regional Competitiveness Index (Dijkstra et al. 2023), Italy recorded a negative trade balance, with a 9,4% increase in exports against a +11,8% in imports²⁹, due to the inflation on energy prices, but the estimates of the Sace Report on Export 2023 (SACE, 2023), expect the export in 2023 to be worth more than 660 billion Euros, marking an increase of 6,8% compared to the

²⁹ Trade balance = export-import

previous year. Indeed, the export sector has always been fundamental and one of the milestones of Italian economic activity. This country is famous worldwide for its Made in Italy label, which encompasses a variety of goods, that require specific know-how and quality materials and can be produced only there. The food industry can count on very high-quality products like cheese and cold cuts, wine, pasta, EVOO, and citrus (Co.Mark, n.d.), but the luxury fashion industry is leading, too, with brands like D&G, Prada, Gucci, Fendi, Emporio Armani, Bottega Veneta. Furthermore, in the automotive industry, some of the strongest world players like Ferrari, Lamborghini, and Maserati, have huge export values in the furnishing sector, the pharmaceutical industry, and the machinery (Italia in Dati, n.d.). The variety of export percentages derives from all the other different conditions, which can be strictly connected with the territory (soil and natural resources), but which can also derive from other socio-economic aspects like the presence of few production plants or an educated workforce. So, in this case, there is not a direct motivated gap between north and south, but it is just the fact that the goods are not produced homogeneously alongside the peninsula, as they concentrate just in the regions where there are the perfect enabling conditions. In 2022 most exported goods were in the sector of investments assets (34,9%), followed by intermediary goods, which accounted for 32,5%, and then consumption goods 21,4% and agrifood the last 9,8% (Figure 4.5) (SACE, 2023).

Fig. 4.5 Italian exports of goods per sector, the year 2022 – SACE (2023)³⁰



³⁰ NOTE: The Graph represents the percentage of the export of four categories of goods i.e., Investment assets, intermediary goods, consumption goods, and agrifood. Each of them has also a percentage of export growth expected in the following years.

The main destinations were China, and the United States, whose trade was worth 65,1 billion euros, with Italy keeping its position in the international share of exports. Interestingly the new potential market destinations that are gaining importance are Thailand, Vietnam, Mexico, Brasile, India, and Gulf countries. As far as the European area, the main destination market was Germany (77,5 bln €), France (62,7 bln €), Spain (32 bln €), and the United Kingdom (27,3 bln €) (SACE, 2023).

For the estimate of the composite indicator, it will be used the value in billion Euro of exports per region, according to the Istat survey during the year 2022 (See the Appendix for further details).

4.2. System of Innovation

In the following the variables that are considered for the System of Innovation sub-indicator are listed, namely Transport Network Efficiency, Research and Development, Digitalization, and Energy. Then, their impact on productivity and their evaluation for the Italian case are analyzed.

4.2.1. Transport network efficiency

Infrastructures is the components of the state's capital stock and is defined as public goods because entirely or partially financed by the state to guarantee the non-excludability and non-rivalry. On the contrary, if managed by private individuals, they could impose taxes or fees to be paid to limit other people from using it or benefit from the positive externalities it produces (Costa P., personal communication, November 2022). This paper considers economic infrastructure as telecommunications, energy gas, and water supply, as well as transport networks. The attention will be put on the last ones, as they are the most important because they simplify connections between companies and raise their productivity levels. Such connecting facilities like ports, airports, railway lines, roads and highways, crossings, and tunnels, are fundamental for the realization of the business activity: they enable the procurement of the materials from the supply market and then the sale of final products to end consumers. If such facilities are well-functioning, efficient, and cost-effective, they represent a huge advantage for a region, as they enable the connection

of peripheral or backward ones and facilitate the transport of goods. Thus, having a quality infrastructure endowment is of major importance for the attractiveness of companies and consequently for the economic development of a region (Bucci et al., 2021).

4.2.1.1. Infrastructure improves productivity and growth

In investment decisions in a region, companies immediately interface with the local reality: the costs to be paid related to distance and the logistical difficulties to be overcome during the foundation and creation of the plants, are the same limits which they will clash with once the activity starts (Basile et al., 2008). When companies buy raw materials from other regions or states, they expect delivery to be efficient, i.e., to be fast, so that they can carry out the production process and satisfy their customers in the shortest time and at the cheapest cost possible. Infrastructure is, indeed, a productive factor: it has increasing returns and, allowing workers to produce more, increases productivity (Weil et al., 2005). The presence of transport infrastructure therefore becomes a crucial advantage in investment decision-making processes because it has the purpose of reducing the effects of physical distance. As reported by Basile et al. (2004), it plays a key role in the growth and development of a region, because companies tend to locate where the best facilities are present, to benefit from them in their upstream production process and to satisfy downstream customers. Sometimes the most peripheral or distant areas turn out to be the perfect market for the company, so it is of major importance to be able to reach every place. On the contrary, regions with a low and inefficient infrastructure do have fewer companies and therefore low levels of productivity and economic development like a vicious circle. Aside from the quality, infrastructure has to be efficient, so provide a rapid connection, but at a fair price. The transport cost increases the final price of the goods, negatively affecting the competitiveness first, and the profitability of the products, then. Companies can have low production costs due to the use of economies of scale or low-cost raw materials, but what is vital, however, is that they are then able to get their products to the markets, in such a time as not to make them deteriorate and with a low cost. If the infrastructure is poor, companies have to spend more money due to the difficulty in accessing transport networks. Consider that for every 1000km of

distance added between two countries, the cost of transport increases by 1% (Weil- et al., 2005).

4.2.1.2. New-infrastructure area

As further reiterated by Dijkstra et al. (2023), accessibility to a network of quality connections is fundamental for regional development, so it is decisive in the work of government and institutions regarding investments in infrastructure. The issue of infrastructure must not be ignored, on the contrary, money must be invested in efficiency to strengthen the competitiveness of a state. Two examples of the commitment of the state are the Belt and Road Initiative BRI (Figure 4.6) and the Trans European Network of Transport TENT-T (Figure 4.7). The former is a project carried out by the Chinese government with the aim of better connecting Europe and China as far as trade routes. While the latter has been started by the European Union and involves the creation of 9 corridors across Europe, to better connect the main nodes and ports (Costa P., personal communication, November 2022).

Fig. 4.6 BRI – (Costa P., personal communication, November 2022)



Fig. 4.7 TEN-T – (Costa P., personal communication, November 2022)



When it comes to transport facilities, many concerns arise about their sustainability and respect for the environment, as 90% of greenhouse emissions come from them. The most polluting is the plane, but also merchant ships, making weeks-long journeys around the world, and being powered with fossil fuels, are responsible for the emission of huge amounts of CO₂ in seas and oceans during crossings and mooring times, while the most ecological and eco-friendly transport is the train (Eon-energia, 2022). Thus, the challenge is to create strategic but, above all, sustainable transport facilities. For example, TAV (Treni Alta Velocità) is a project funded by the European Union and Italian and French states, which provides the creation of a 270-km tunnel through the Alps, to reduce the connection time between Turin and Lyon. A high-speed and high-capacity railway that makes it possible to decrease transport time between Italy and France, as well as bringing back to rail transport to light motorway congestion and greenhouse gas emissions in the Alps. International trade would benefit, as only 1 hour and 50 minutes will be needed for Turin-Lyon trips, 4 hours for the Milan-Paris route and 11 hours for the Madrid one, together with the improvement of the environment given that the expected reduction of CO₂ account for less than 3 million tons and less 1 million heavy vehicles on motorways (Geopop, n.d.). Another project to reduce the environmental impact is related to ports and is based on the “Cold ironing” technology. This allows the supply of electric energy via cable during stops at docks, to have zero-emission maritime transports. More deeply, the aim is to create a “green logistic”, an intermodal transport network that allows to integration of maritime routes with rail and motorway corridors (EnelX & Legambiente, 2021).

4.2.1.3 Italian situation

Franco (2011) sustains that the Italian infrastructural endowment is not competitive because the facilities are dated and inefficient, and there is the presence of substantial territorial gaps (Bergantino, 2013).

The first cause may be the existence of a sort of Bermuda Triangle composed of three limits. The first factor is related to funding, which is sometimes scarce due to a lack of capital from the government. Consensus is the second problem, in fact, very often large infrastructural projects find the contrary opinion of environmental lobbies that

are against the destruction of nature in favor of economic progress. Finally, the rules and too much bureaucracy close the circle, making any activity expensive both in terms of cost and time taken for the realization (Costa P., personal communication, November 2022). At the same time, a limiting factor is to be found in the conformation of the peninsula, which is formed by mountains and islands, with many areas difficult to reach since the presence of reliefs, makes it difficult to build adequate motorways or railway networks. Aside from geographical differences, a discriminant could also be found in the allocated budget and resources used to realize the project. Such territorial gaps are more present in the southern regions and give rise to a sort of vicious circle because few infrastructure services discourage investors from settling there, further reducing the demand for efficient plants and consequently economic development. For example, the bridge over the Strait of Messina is a work that has always been on the political agenda, which would make it easier to transport goods or people to and from the island, as well as facilitate European trade. However, the island annually slightly moves away from the peninsula, to make the realization difficult (Geopop, n.d.). In addition, this region does not have much available capital and is characterized by rampant crime among political bodies. A similar example was the construction of the Salerno-Reggio Calabria motorway, completed after 55 years of work. Thus, these southern regions are unattractive for companies because they have such structural defects and consequently are more backward economically and territorially.

The opposite situation is found in the north of the country. Even thanks to the expanse of the Po Valley, which facilitates the creation of road and rail connections without the need to dig tunnels, these regions enjoy a better network of connections, both land and sea. As it appears from Figure 4.8, there are more motorways i.e., A4 (Turin-Venice), A1 (Milan-Salerno), and A14 (Bologna-Taranto), while Figure 4.9 shows that the international airports are more concentrated in the north, Figure 4.10 depicts the more efficient railway stations that allow the transit of high-speed trains, as well as important ports for freight transport such as Venice, Genoa, Trieste, Livorno are shown in Figure 4.11.

Fig. 4.8 Motorway network – Autostrade

(n.d)



Fig. 4.9 Main Commercial Airports (n.d.)



Fig. 4.10 Railway network for good transport – RFI (n.d.)



Fig. 4.11 Main commercial ports -Canali (2020)



However, investment in infrastructure is strategic for economic development and in fact, there are some recently started entirely in Italy. The construction of a stretch of railway that crosses the Apennines aims to connect Naples to Bari, the west coast with the country’s east one, and it must be completed by 2026. While in northern regions another strategic project is that of the “Terzo Valico del Giovi”. The longest underground tunnel in Italy, which runs 27 km to connect Genoa to Tortona, acts as an excellent connection with the most important European routes. This passage would connect the Mediterranean more directly with the railway lines of the rest of Europe. The important port of Rotterdam would be more directly connected with the Mediterranean and could be more easily accessible with only 4 days of travel by land,

instead of 9 by sea (Geopop, n.d.).

Given the importance of sea and rail transport, the CI's variable will be an average of the values related to port accessibility and the rail endowment of Italian regions (see the Appendix for further details).

4.2.2. Research and development

The topic of innovation is nothing but simple, it encompasses many individuals or organizations that act and interact with each other, like research institutes, universities, or start-ups. From innovation processes, by chance or consciously, can derive discoveries that can be life- or history-changing. The outcome can be either a product or process innovation, whether it involves introducing a new product or process to the market and it can be a radical or incremental innovation, depending on whether it involves a completely new discovery or simply an improvement of something already existing.

You may not necessarily get an innovation on the first try, in fact sometimes a failure is the starting point for a life-changing discovery. States allocating much money to private and public research investments are, indeed, favored, as they are socially and economically more developed. They keep pushing forward the technological frontier and can guarantee better conditions as much of everyday- (more efficient health, new transport methods, up-to-date technological devices), as the work life. More specifically, as Draghi (2007) reported, a product or a process innovation is the different result of the R&D process. It is, though, important to encourage research and innovation in companies, because this helps to increase their productivity, with a percentage as high as 50 %, as shown by Geroski (1999), with a 3-year analysis of the growth of 79 British companies (Cameron, 1996). Of relevance is also the role of the state, which has to provide the best environment as far as protections, regulation, and incentives, to help innovation flourish. R&D resources increase the region's competitiveness for foreign investments (EY, 2022).

4.2.2.1. R&D and productivity

The more innovative capabilities have a country, the more developed its economic sector, relevant are the organizations spread over the regions, but a considerable part happens in the R&D labs internally the companies.

Innovations often come from the research and development processes that are conducted in a company's specialized laboratories. These innovations can be created within the company or through a process of knowledge-sharing with others. Research and development campaigns can produce valuable information that can be used by other companies as a starting point for their own R&D process. This creates a spillover of knowledge and information that can be beneficial to others. According to Arrow (1982), this cumulative effect is due to the interaction between foreign or rival companies, so it is important to maintain business relationships to stay informed about new technologies or discoveries (Potì et al., 2000).

R&D is important for companies as it can increase productivity, but its effects are not always straightforward. Solow's residual A represents everything else that contributes to output besides inputs, and it can improve technical and technological advancements by 87% and affect output growth.

However, the result is not so clear when labor is the only productive input, and the production function can be shown as $Y = A * L_y$ (Y: output, A: technology level, L_y : total workforce of a company). When the total workforce is split into R&D and production employees, an increase in R&D employment can lead to more innovation and better output. This is because an increase in A can result in more productivity per employee and greater profitability. In fact, according to Visco (2014), having just one skilled employee working in the innovative sector can lead to fewer employment opportunities in the production function.

It is important to underline that the function of production is not formed solely by labor as a productive input, and by upgrading the technical level of work, companies can increase productivity and subsequently raise wages for workers. This allows workers to consume more and boost demand for goods and services, which can lead to an increase in production.

As a company, it's important to carefully consider the introduction of new products in R&D, especially if they outperform existing offerings.

The cannibalization rate is, widely used in the internal audit of a company, when it comes to the situation that the introduction of a new product or process leads to the removal of an already existing one. Theoretically, it is the rate to which new sales come at the expense of existing products as it is calculated as the ratio between the contribution margin of the new product over the old's, more simply it represents the loss in sales that an existing product suffers, due to the introduction of new one (Hinterhuber A., personal communication, March 2023).

After examining the potential internal consequences, it becomes clear that introducing new products can greatly benefit a company if it can dominate the market. Weil et al. (2005) argue that achieving a monopoly and cost advantage over competitors are the primary competitive advantages a company should strive for. These advantages allow for complete market control or the ability to offer the lowest prices, ultimately leading to increased profitability and growth.

It is fundamental, though, for companies to set into regions that can provide them with a challenging and stimulating research environment, to constantly innovate and meet customers' needs.

4.2.2.2. Italian situation

Italy is falling behind as far as R&D because it has one of the lowest allocated expenses among the European Countries and a very low level of innovation (Visco, 2014).

The main causes can be found in the structure of the institutional and the industrial systems. The innovation process is, indeed, hindered by the heavy bureaucracy affecting investments and incentives decisions, as well as an inappropriate protection network able to preserve property rights, patents, and marks owned by companies. Even the smallest tempts to innovate and protect rights go unnoticed because of the type of companies present in the country. The dominating SMEs do not carry out impressive R&D campaign activities, and additionally, the little they do is not officially recognized or not so meaningful at the market level. On the contrary, following the theory of Marshall (1920), the many clusters spread over Italy should favor knowledge spillovers. Industrial districts, with a concentration of same-sector companies, are the ideal places to facilitate the flow of information, know-how, and productive secrets (Cameron, 1996).

The reality is that there are more innovative regions that contribute to mapping innovation and economic development. Not surprisingly, Lombardia is the region with the highest amount of allocated money, roughly 5 billion € (Istat, 2022)³¹, and is the region where it will raise the MIND “Milano Innovation District”, an international innovation district and knowledge center, which provide the perfect ecosystem for development of people well-being’s start ups and research labs (MIND, n.d.).

As reported by Basile et al. (2007) an important indicator for the level of innovation level still, remains the regional expenditure in R&D, because it is the simplest to record. Though to estimate the CI, it will be used the data, provided by Istat, relating to the regional R&D share of GDP, which consists of public, private, and non-profit institutions, firms, and universities expenses. (See the data in the Appendix)

4.2.3 Digitalization

Looking at the past, today’s life seems completely revolutionized. The technological process has made the world enter the digital area: people use digital devices for whatever reason, whether it is for talking to one another, checking their bank accounts for shopping, or running the house for work. A kind of dematerialization is taking place that sees the disappearance of many common actions and uses, for example, the introduction of e-commerce has changed the canonical way of selling products in physical shops, while telematic desks allow the streamlining of bureaucratic procedures and make life easier. Even companies, benefitting from digitalization, can rely on technological tools to speed up their production processes or to carry out administrative tasks directly through online services. That’s why, as reported by Dijkstra et al. (2023), countries digitally developed are preferred by investors, who know that they can boost their productivity thanks to the technologies and digital methodologies with which the region is equipped.

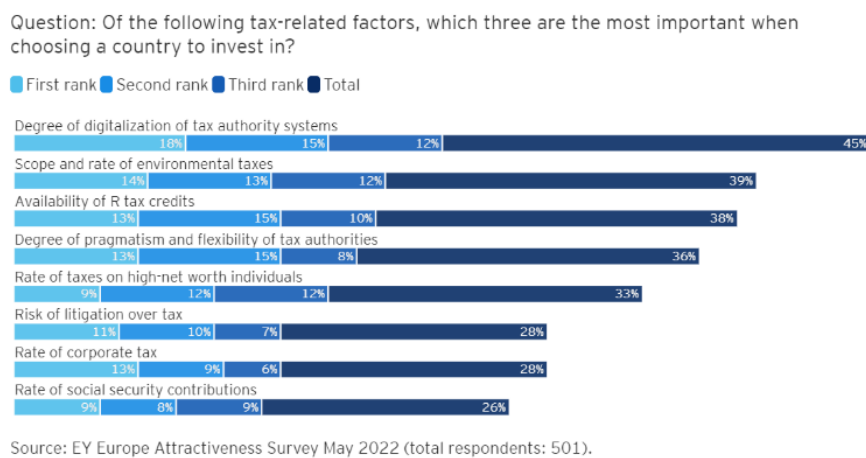
4.2.3.1. Digitalization and productivity

The digitalization process of the economic sector accelerated during the pandemic, leading to the so-called smart economy, a reality in which the economic agents work

³¹ <https://www.istat.it/storage/ASI/2022/capitoli/C21.pdf>

smartly and are interconnected in real-time. Whether brokers economic organizations, or companies as well, they all found beneficial the use of technological devices for the activities they had to carry out. Even many administrative and tedious tasks can be simplified and taken out more efficiently, thanks to technology. Specifically, as reported by the EY (2022) the fiscal duties are of major concern for entrepreneurs, thus, to boost investments, it is fundamental for a region to provide a digital and efficient tax system (Figure 4.12).

Fig. 4.12 Importance of digital tax system for investing companies – EY (2022)³²



The biggest impact and benefit, though, has been recorded in the productive and sales activity of a company, so at its core. When in the market customers started to have even increasing and fast-changing needs, companies were called up for the challenge of satisfying the new demand, which is made up of always more customized products, to be delivered in the shortest time possible. Relying on digitalization was the only way the companies have to keep pace and not lose customers. Indeed, the introduction of digital machines enables companies to rapidly realize the newly demanded products just by changing the setting of the machines or by using advanced techniques that a hand-made job cannot rely on. Doing so, they manage to keep the position of mass producers benefitting from economies of scale and optimizing the production processes, as well as satisfying customers and improving profits (Sew Eurodrive, n.d.).

³² NOTE: the graph represents the percentages of the importance of some aspects concerning taxes for a company. The different colors indicate the positions that the 501 respondents chose where to place each aspect. The highest percentage at 45% shows that a degree of digitalization of the tax authority systems is considered the most important to have.

The more advanced and technological companies employ sensors and digital connections, as well as high-tech machinery and methodologies, to take under control the whole productive process. As an example, an online platform and a cloud service can reduce up to 12% the operating costs and provide security and faster and more organized consultation of sensitive data like purchasing trends or employees' records. Failure in the process can also spoil right away, so interrupting the production, solves the problem in the 92% of the interventions, so, save resources from the waste as well as money for the fixing service. They even enable live control of the consumption of energy and resources by supervising the production process and the inventory. Such control enables timely filling up the needed or finished resources, to be ready and prepared for clients' orders, as well as cutting by half the possibility of wasting non-used materials. The delivery from suppliers can, also, be tracked, as well as the dispatching time of final goods, to better manage the time at disposal for the production and the quality of the service they provide to their customers (Pisoni, 2022). The Smart Factory is, indeed, a company with a digitally integrated structure is defined, which implements the Cyber-Physical System (CPS) and can manage a network of interconnected devices, sensors, and technological software simply by the central appliance. By doing so, the assigned workers can receive real-time information to immediately intervene in case a problem is spotted alongside the process (Soori et al., 2023).

Such an automatized framework seems to destroy the figure and the need for human employees, while, on the contrary, the human role is fundamental to handling such types of machinery, and more specifically, an educated workforce is the most required one. Not just because it has the technical competencies to deal with such high levels of technology, but also because, as reported by Visco (2014), the entire employment sector will benefit, as just one high-skilled job, contribute to the creation of 5 low-skilled jobs. Not to mention the role played by security. High levels of technology and interconnection are very suitable grounds for fraud or cybersecurity assaults to happen, which can cause the loss of sensitive data or amount of money. People developing a strong security system against hacker attacks is, though of vital importance for digital and high-tech companies. Moreover, an endowment of good quality infrastructure is an important enabling factor for proper technological

development to happen: internet connection or wide range routers, as well as investments made by the government so that an always-increasing number of places can benefit from fast and efficient internet coverage, are the starter pack for the digitalization (Soori et al., 2023).

So, companies wanting to compete in such a technological world are always looking for high-tech regions, where to establish. They look for good facilities and smart employees to realize their smart business and increase their productivity.

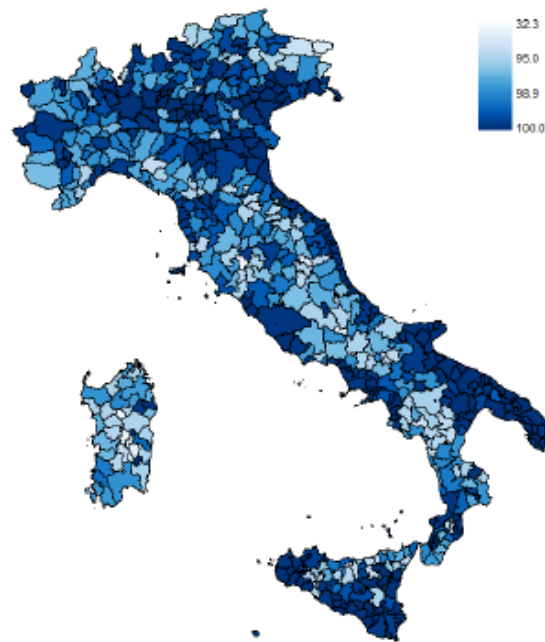
4.2.3.2. Italian situation

According to DESI (Digital Economy and Society Index) powered by the European Union, Italy is always a tail-end, in 2022 it was 18th out of 27 (Osservatorio Agenda Digitale, 2022), being one of the worst European countries. There have been many efforts to boost tech innovation law number 317/1991, was created to develop and diffuse new technologies inside companies (Normattiva, n.d.), and law number 46/1982 aimed at the creation of the FIT “Fondo Innovazione Tecnologica”, only later replaced by the “Fondo per la Crescita Sostenibile” (Ministero delle Imprese e del Made in Italy, n.d.)³³. Still active and helpful for companies is the national plan Transition 4.0 which grants tax credits for companies investing in facilities, instruments, and machinery that are functional to the tech and digital transformation of their productive activity (Ministero delle Imprese e del Made in Italy, n.d.)³⁴. Moreover, there is a lot of financial aid provided by the state to support the digital development. For example, the Simest group offers loans at preferential conditions to companies investing in the digital transition (Simest, n.d.). Despite all efforts, the results are lacking, likely due to a very low level of investment in the infrastructural endowment and the education of workers Figure 4.13 represents the spread of the telecommunications infrastructures in Italy and more specifically, the darker the pieces, the higher the percentage of 4g connection coverage. Even if there is no difference between north and south regions, some internal mountain areas are not efficiently reached by the signal.

³³ <https://www.mimit.gov.it/it/incentivi/fondo-innovazione-tecnologica-fi>

³⁴ <https://www.mimit.gov.it/index.php/it/incentivi/nuovo-piano-nazionale-transizione-4-0>

Fig. 4.13 Availability of mobile telecommunications infrastructures – Bucci et al. (2021)



Such infrastructures are strongly needed first to create industries that can be more connected, and so competitive, with other smart companies worldwide, and second, because, as the country could experience during the COVID-19 lockdowns, digital technology can be fundamental. Indeed, during the pandemic, just thanks to the digital development many public offices could continue providing their services to the population and companies thanks to the activation of digital platforms, online desks, or dedicated applications, while companies were able to bring some activities directly to employees' houses. Italian businesses are lagging, even if someone has started to become more technological. The Digital Intensity Index, created by Istat, records the adoption of 12 different digital technologies by firms (Tremolada, 2023). The results are reported in Table 4.2, where there are some interesting data, for example in 2022 82,8% and 96,1% of small (10+) and big (250+) companies respectively, had a download speed higher than 30 Mbit/s, or 74,4% of small and 95,8% of big used at least three information and communication technologies security measures.

Tab. 4.2 Indices of Italian digital transition – Istat (2023)³⁵

	Attività economiche												10+	250+
	C	D	E	F	G	H	I	J	L	M	N			
1. addetti connessi > 50%	36,7	86,4	40,9	35,2	66,9	49,1	39,8	96,6	72,5	96,6	43,7	49,3	57,9	
2. presenza specialisti ICT	14,0	33,7	16,9	6,6	12,6	10,9	3,2	59,9	18,2	22,1	11,3	13,4	75,0	
3. velocità download BL fissa >= 30 Mbit/s	80,3	93,4	83,4	80,5	83,0	76,2	89,1	95,6	82,9	92,9	80,9	82,8	96,1	
4. uso di riunioni online	47,9	84,4	55,4	41,1	41,0	38,0	15,9	82,5	59,8	84,7	45,7	44,3	93,4	
5. addetti formati su obblighi legati a sicurezza ICT	61,6	76,8	62,1	58,5	64,6	61,7	47,6	85,9	69,7	79,9	67,2	62,3	88,6	
6. formazione ICT nel corso del 2021	19,0	38,3	22,2	13,5	21,5	17,5	9,4	52,5	17,2	27,4	19,2	19,3	65,4	
7. utilizzo di almeno 3 misure sicurezza ICT	79,2	93,3	77,5	70,9	74,4	70,9	53,3	93,1	76,8	91,6	72,1	74,4	95,8	
8. adozione di doc su sicurezza ICT	49,1	79,2	51,9	42,8	48,0	45,2	33,7	78,1	57,6	71,2	49,6	48,3	88,4	
9. accesso remoto a e-mail, doc, app aziendali	73,9	92,7	76,5	75,7	69,7	71,0	64,1	89,2	76,9	89,5	72,1	73,2	96,9	
10. utilizzo di robot	19,1	1,9	2,4	2,4	5,4	4,6	0,7	1,2	0,5	2,1	3,0	8,7	29,8	
11. con valore vendite online >=1% ricavi tot	9,5	8,9	3,0	3,0	18,5	6,4	36,8	12,4	15,0	6,7	9,7	13,4	36,6	
12. con vendite web >1% ricavi tot e B2C >10% ricavi web	3,1	3,2	1,3	0,9	10,9	4,2	36,0	7,4	14,7	2,1	5,6	8,5	12,3	

Legenda Attività economiche: C-ATT. MANIFATTURIERE; D-FORNIT. ENERGIA; E-FORNIT. ACQUA; RETI FOGNARIE, GESTIONE RIFIUTI; F-COSTRUZIONI; G-COMM. INGROSSO E DETTAGLIO; H-TRASPORTO E MAGAZZINAGGIO; I- SERVIZI DI ALLOGGIO E RISTORAZIONE; J-SERVIZI DI INFORMAZIONE E COMUNICAZIONE; L-ATTIVITÀ IMMOBILIARI; M- ATTIVITÀ PROFESSIONALI, SCIENTIFICHE E TECNICHE; N-NOLEGGIO, AGENZIE VIAGGI, SUPPORTO ALLE IMPRESE

Meanwhile, more territory-specific information can be found with the DESI index. This is a composite indicator made up of four main dimensions Human capital, Connectivity, Digital technology integration, and Digital public services grouping 33 single indices, intending to track the digital performance and progress of European countries. According to the regional DESI estimate of 2021, Italy has the same level of development in each main dimension, while more in detail the Province of Trento is the best performing and most digital out of the Italian regions. The southern regions are the tail-end, recording the worst scenario, e.g., Molise is the worst region in 3 out of 4 main dimensions namely in Connectivity and Digital Technology integration with roughly 40%, and 35% as far as Digital public services, while the remaining dimension's worst place is occupied by Calabria, which scored less than 30% in the digital level of Human Capital. The leading positions are taken by northern regions, with Trento shining in Public Digital Services at 62% and Human Capital at 55%, together with Bolzano scoring 62% in Digital technologies integration, and Liguria heading the Connectivity dimension with 60% (Commissione Europea, 2022).

The data used to estimate the CI are taken from the DESI index of 2022 with data from 2021 (For more details see the Appendix).

Such a scenario is not encouraging companies to move to Italy, and above all to set their activity in regions that are not well connected or with enough endowment or human capital. But the world and the economy itself are switching to a digital version, so the Italian competition needs to invest and boost the technology sector.

³⁵ https://www.istat.it/it/files/2023/01/REPORTICTNELLEIMPRESE_2022.pdf

4.2.4. Energy

An entire productive plant, from the administrative offices to the assembly line or the inventory, works only with the supply of energy. It is, indeed, the fuel enabling the execution of whatever activity and can be obtained from non-renewable and renewable sources, where the former are the traditional ones such as fossil fuels (coal, oil, and natural gas), or nuclear fissions' outputs (uranium and plutonium), while the latter are the most sustainable ones, as solar and wind energy, hydropower and geothermal energy and the biomass one. Given the deterioration of the world's environmental conditions, mainly caused by the production and usage of non-renewable energy forms, renewable ones have gained importance, as they have a natural origin, which makes them environmentally friendly and capable of self-renewing in the future. However, the worsening of the climate conditions urged the improvement and boost, as well as the introduction of new technological processes, in their production. Such a scenario had been made more difficult by the Russian-Ukrainian War, which took energy prices to very high levels, e.g., coal's price increased by +421% in January 2022 (Felici et al., 2023), and, consequently, lead to the increase in the price of final goods as well. Such inflationary tendency is bad for the economy and mostly endangers companies, who see their profit reduced by the high cost of their production inputs and the low profit due to the increase in their goods' prices. Thus, resorting to renewable energy is needed and urgent.

4.2.4.1 Energy, productivity, and climate change

Energy is a fundamental input in the production function, but it has a controversial impact on profitability. There is a positive effect, given that without the energy supply companies could not work and there would be no production, but there are also some negative effects that hurt more or less directly. First, the energy supply is a cost that the company must sustain, and so it reduces its profit per definition but then comes the tricky effect on the final price of goods. Given that their value resembles the price of the inputs used for their production, it derives that the final price of such goods (excluding the addition of any mark-ups to the price) is higher, the higher the costs of productive inputs, and so, consequently, a rise in the cost of energy is straightly translated into a bigger price of goods sold and a lower level of profit for the firm.

Estimates assert that in 2022 energy costs accounted for 8,82% of total production costs, with companies downstream in the supply chain suffering the most, noting a reduction in their operating margins and failing to pass on price increases to the end consumers (Felici et al., 2023).

Long-lasting rises in energy prices, indeed, act as a limit for the development of the productive system and the companies, because it lowers the competitiveness of their goods in the national and international market, mining the economic development of a country and making it less attractive for new investments. Not to mention that countries with no sources of fossil fuels are forced, and indirectly force their companies, to be supplied by foreign countries, whether for the total or just a share of the energy demand and to be directly dependent on the decisions and condition of the suppliers. The Russian-Ukrainian War examined how precarious is the equilibrium of international relationships and how fragile a state becomes by energetically depending on another one. However, aside from the specific micro-economic effects of the energy price, its type and sources are to consider and contextualize in a period where the environment is deeply endangered, and the urgency of actions is very high. Companies can play a relevant role in this battle, because, during their production processes, they contribute to the pollution producing the energy needed by burning oil and other fossil fuels. They should switch to a greener power, to still carry out their activities, but still pay attention to the environment.

4.2.4.2. Renewable power as a solution.

The introduction of more clean actions and activities, e.g., replacing fossil fuels with renewable energy, becomes a competitive advantage for the company. Such engagement towards a more sustainable productive process is indirectly required by the stakeholders, but, at the same time, is a strong booster for the brand reputation and reliability. Customers will reward such attention to the planet, by being more loyal and prefer a company, that, in their eyes, has a heart, a conscience, and is aware and ready to protect the environment. This will become a competitive advantage that can be used to build future customer loyalty and boost the competitiveness and market position of the company (T-green, 2021). The use of renewable energies is, indeed, a benefit for its image and profitability, as well as a real plus for its activity. Renewable

energy can be created and stored autonomously by the company, wherever natural conditions exist, just by implementing the required production plants, i.e., a solar panels installation for solar energy, rather than wind turbines for wind power, and release it from the dependence on the energy suppliers. This could be providential whenever the price of energy rises for political instability or economic crisis because it would allow the company to use the existing stock and still be able to produce, maintaining the energy cost at its usual level.

4.2.4.3. Renewable power as a problem.

Renewable energy plants are expensive to install, in Italy, a company wanting to place a photovoltaic system with a medium power capacity of 30 kW can spend between 40.000 and 60.000 € (T-green, 2021). This is why it is important to the joint action with the governmental bodies, who have to grant incentives and fiscal help to relieve the company from such an indispensable burden. The European Union provided that the single governments should intervene and help entrepreneurs in such a delicate phase, pitching in covering parts of companies' spending on renewable power plants, more deeply, the guidelines accounted for a 45% cost coverage for big companies, a 55% for medium and finally a contribution of the 65% of the cost for small ones (Valore Community, n.d.). A stable and enabling political environment is peculiar because it creates the framework of incentives, policies, funds, and fiscal help that sustain and support companies in the renewable power investments process, as well as set up the proper infrastructures to simplify the place of the power plants. The capital investments should also be made by the country itself. New technology discoveries require a long period and a high upfront expense to sustain, but, in the end, they can make a difference in the type and efficiency of the facilities created. This process would be jeopardized by an unstable political situation of the state, characterized by political bodies that do not provide an adequate flourishing environment (Wang et al., 2021).

The endowment of energy is crucial for the competitiveness of a region in attracting investments, because on one side if it has fossil fuels it can secure a certain stability for its companies, without depending too much on foreign nations, but on the other side, even the investments towards a more ecofriendly power are of relevance nowadays.

4.2.4.4. Italian situation

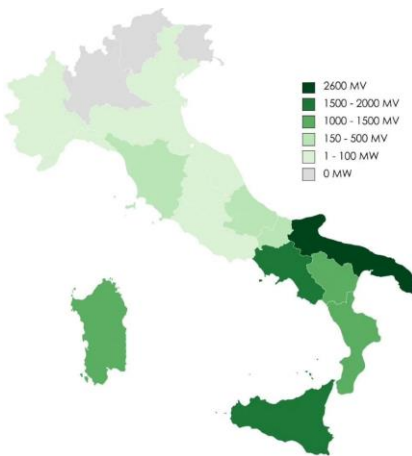
Italy is one of the least autonomous countries in Europe as far as energy stocks, although it has some deposits of oil and natural gas, and produces also small amounts of renewable energy, mostly wind, solar, and geothermic power, such supply is not enough to cover the national demand so that Italy is forced to import a big quantity of energy and fuels from other nations. Roughly 89% of oil, 94% of natural gas, and the total quantity of coal used are imported, with Russia being the main supplier (Beccarello et al., 2022). Because of the war, and the consequent increase in the oil price, the Italian economy has suffered a period of crisis due to sectoral interdependencies, given the direct use, at the same time, of gas as raw material and as production input in the oil refining industry and power generation. The high price of energy and the deriving inflation, together with guidelines issued by the European Union to limit the worsening of the environmental conditions, shed further light on the urgency to create an Italian economy less dependent on fossil fuels, and other nations' supply, and more focused towards a green economy.

Italy is not so underdeveloped as far as renewable energy, but as reported by the Terna Statistics, the power it produced from renewable sources in 2021 accounted only for roughly 115.000 GWh, satisfying just 38% of the national demand (Fondazione Centro Studi Enel, 2023). As shown in Figure 4.14 the different technologies are spread alongside the peninsula according to the geographic features of the region. The northern and more mountain regions can host hydropower plants (light blue ones), while the southern, being in a more open position toward the sea, can rely on an effective wind energy plant structure (green ones). In fact, as in Figure 4.15, such regions are in the most powerful installations.

Fig. 4.14 Source of renewable energy per region in 2020 – mappaitalia (2022)



Fig. 4.15 Wind power installed per Italian regions in the year 2020 – mappaitalia (2023)



According to Fondazione Centro Studi Enel (2023), Italy owns its strength and competitiveness in the market of small components, maintenance services of the plants, engineering operations, and smart energy solutions, given the presence of considerable know-how and high-level skills. The Italian firm ENEL is, indeed, the biggest reality in Europe engaged in the energy transition and the biggest private company worldwide in the sector of renewable power with 59 GW (Enel, n.d.)³⁶ of energy capacity already installed (Fondazione Centro Studi Enel, 2023). However, the projects for the future are wider and aim at the decarbonization and complete power independence of the country. This result will have a big impact on the competitiveness of Italian regions, as it would enable companies to set their activities in a reality where there is attention to the environment, together with the availability of energy without depending on other countries. DESIRE (Digital Efficient Sustainable Innovative Renewable Energy) is, indeed, the new model thought to switch towards a greener power, that can be generated by more technological and digital facilities. It is

³⁶ <https://www.enel.com/it/azienda/il-nostro-impegno/transizione-energetica>

articulated on four main objectives: high-tech power generators, adequate infrastructures, electrification of the energy supply, and more digitalization, and for its realization are required financial resources worth about 310 billion € (Fondazione Centro Studi Enel, 2023). The intervention of the state is, though, essential, in creating an adequate background made of less bureaucratic procedures for the receiving of authorizations and incentives, lighter/helpful fiscal constraints, as well as support for start-ups and research centers to operate. With DESIRE Italy will enhance its productive system, improving its international competitiveness and attracting new business activities. Whether employed in the energy industry or not, companies will be motivated by such an innovative and high-tech energy sector. The realization of such a smart energy sector is expected by 2030, but since for now Italy is still relying on imports, to assess the CI it will be used the data accounting for the imported quantity of energy that each region uses for its production. (See data in the Appendix).

From the results in the chapter, having an educated workforce and a wide final market, whether national or international is important for the profitability of companies, but fundamental is the process of investment. The financial part is of basic importance to boost the discoveries needed to take the technological frontier further and further. The benefits are spread in every corner, from the economic sector to society, up to climate change, and represent the factor that can strongly boost the competitiveness of a region and make a difference, a positive one. Table x will summarize the variables and their impact on competitiveness.

Table 4.3 Summary of the 14 variables

VARIABLE	CATEGORY
QUALITY OF LIFE	
Physical Well-being	Good
Education	Good
Crime	Bad
Pollution	Bad
GOVERNANCE	
Public Debt	Bad
Bureaucracy	Bad
ECONOMICS AND FINANCE	
Market Size	Good
Employment	Good
Interest Rate	Bad
Export	Good
SYSTEM OF INNOVATION	
Research and Development	Good
Transport Network Efficiency	Good
Digitalization	Good
Energy	Bad

Chapter V- Realization of the Composite Indicator

This chapter presents the complete procedure used to create the composite indicator, with precise details about each of the five steps given in Chapter 1. It focuses on applying the SMAA method to find the weights for the selected variables, and the final ranking of the regions.

5.1. Methodological framework

The phenomenon to be analyzed is the level of competitiveness of the Italian regions as investment destinations, so the alternatives are the regions, $I = \{1, \dots, m\}$ with $m=20$, which are analyzed according to each i variable, where $i = \{1, \dots, n\}$ and $n=14$. Each region must be assessed under each variable, and all the values together are aggregated following the weighted average function, to form the CI. Specifically, the CI will be composed of 14 variables, explained in the previous chapters, which try to capture the main factors influencing the competitiveness of a region and the consequent number of drawn investments. To give a clearer explanation, the variable can be grouped into 4 macro-areas. The first sub-indicator encompasses the data about "Quality of life" and it is composed of values of Physical Well-being, Education, Pollution and Crime, to provide a general view of life in the region. The second sub-indicator is more specific to the economic area, "Economic and Finance", so that it combines the indices of Market Size, Interest Rate, Employment and Export, to fully concentrate on the main aspects that entrepreneurs focus on in location decision-making processes. The "Governance" is the core of the third sub-indicator to analyze how Public debt and Bureaucracy can impact the competitiveness of a place. In the end, the fourth sub-indicator is concentrated on the "System of Innovation", which investigates areas like Transport Network Efficiency, Research & Development Resources, Digital Service Performance and Energy. The variables will be used to construct the CI, which measures the competitiveness of the 20 Italian regions and ranks them.

The data will be firstly organized in Excel and consequently, given the level of difficulty, the actual calculations for the CI are performed on RStudio, a statistical calculation software.

5.2. Selection of variables

The 14 variables used to estimate the CI are taken from official and authoritative sources like “Istat” or “Banca d’Italia” databases, together with “il Sole 24 ore Lab” and the European website, and finally from ad hoc institutional reports such as “Legambiente” and “Terna”. The data has been collected per single region, are referred to the year 2021, and do not have missing values.

The complete set of sources is shown in Table 5.1, while their raw values are available in Appendix.

Tab 5.1 Sources of variables

VARIABLE	SOURCE
Physical well-being	https://www.istat.it/storage/ASI/2022/capitoli/C04.pdf
Education	https://www.istat.it/storage/ASI/2022/capitoli/C07.pdf
Pollution	https://www.legambiente.it/wp-content/uploads/2021/11/malaria-di-citta-2022.pdf ; https://www.legambiente.it/wp-content/uploads/2022/11/Ecosistema-Urbano-2022.pdf
Crime	https://lab24.ilsole24ore.com/indice-della-criminalita/indexT.php
Market size	https://www.istat.it/storage/ASI/2022/capitoli/C09.pdf
Export	https://www.istat.it/storage/ASI/2022/capitoli/C15.pdf
Interest rate	https://www.bancaditalia.it/pubblicazioni/metodi-e-fonti-approfondimenti/metodi-fonti-2023/Metodi_e_Fonti_I_tassi_di_interesse.pdf
Employment	https://www.istat.it/storage/ASI/2022/capitoli/C08.pdf
Bureaucracy	https://esploradati.istat.it/databrowser/#/it/dw/categories/I1,T1,Z0910PUB,1.0/DCAR_UI/IT1,123_713_DF_DCAR_UI_1,1.0
Public debt	https://www.bancaditalia.it/pubblicazioni/debito-amministrazioni/2022-debito-amministrazioni/statistiche_FPR_20220225.pdf ; http://dati.istat.it/Index.aspx?DataSetCode=DCCN_PILT
Transport network	https://www.bancaditalia.it/pubblicazioni/qef/2021-0635/QEF_635_21.pdf

efficiency

R&D resources <https://www.istat.it/storage/ASI/2022/capitoli/C21.pdf>

Digitalization https://trendsanita.it/wp-content/uploads/2022/04/AD22_Webinar_DESIregionale.pdf

Energy https://download.terna.it/terna/Statistiche_Regionali_2021_8db10445c332527.pdf

5.3. Standardization

A standardization for the raw variables is required to overcome the barriers of different units of measurement, so to enable adding and aggregating procedures. In this case, as explained in Chapter 1, the Normalization $N(0,1)$ has been the chosen one, followed by a polarization as explained in the Appendix. Polarized data of the variables were obtained with the use of Excel, together with the notation of the main statistics as Simple Mean, Standard Deviation, Minimum, and Maximum (See the Appendix for further details).

5.4. Weighting procedure

To find the weights of the variables is preferred to use a random approach, to keep the assessment impartial and unbiased, given that it lacks any information about the weights. Indeed, the model used was the SMAA (Stochastic Multicriteria Acceptability Analysis) because it runs as an extraction, from the Uniform distribution, of randomized sets of weights, which must have as many values, n-weights, as the number of the variables to be considered.

Given x^l is the vector of the n variables as $x^l = (x_1, x_2, \dots, x_n)$, the SMAA provides the extraction of k vector of n weights $j_k = (j_{1,k}, j_{2,k}, \dots, j_{n,k})$.

For example, with k=3, the result will be the following.

Vector of variables per region l

$$x^l = (x_1, x_2, \dots, x_n)$$

{

Vector of weights extracted k-times

$$j_1 = (j_{1,1}, j_{2,1}, \dots, j_{n,1})$$

$$j_2 = (j_{1,2}, j_{2,2}, \dots, j_{n,2})$$

$$j_3 = (j_{1,3}, j_{2,3}, \dots, j_{n,3})$$

K-iterations of the process derive from the Monte Carlo Method, at the base of the

concept of the SMAA, and they are used to provide more accurate and reality-like results. The k-number is chosen in an almost arbitrary way, because it is established according to the level of error and confidence wanted to be obtained from the estimate (Milton & Arnold, 1995; Ehrgott et al., 2010).

$$k = \frac{1.96^2}{4 * d^2}$$

For the CI, it will be used a K=9604, with a d=1% error.

RStudio carries out the k-iterations throughout the use of operation cycles, specifically FOR and WHILE cycles have been used, sometimes even in a combined structure as Nested Cycles. Their peculiarity stays in the possibility of introducing one cycle within another, running from the center to the outside: firstly, execute the internal commands and then circularly the external ones until the required repetitions are completed³⁷.

These two methods are a lot alike since in both cases there is the repetition of a command that occurs within a finite number of times. The difference is that for the FOR cycles, such a number can be established by a vector or a sequence, with a precise beginning and an end, while for the WHILE cycles, the repetitions are performed as long as a certain condition is true.

Then, to comply with the constraint that the single weight values are greater than zero, the extracted numbers must be sorted in ascending order in a vector with 0 and 1 in the first and last position respectively. In this regard, the extraction from the uniform must be performed of n-1 values since the other two places have fixed assigned values.

Once extracted and ordered, the raw weight values need to be normalized, so that they add up to 1. In each single vector, from the number in each position, it must be subtracted the number in the previous position.

The following example is just for explanatory purposes, and it does not contain real numbers.

You need to find the weights for 5 variables, namely x_1 , x_2 , x_3 , x_4 , and x_5 , so you need to

³⁷ For further details on the cycles - <https://alpha.dmi.unict.it/~alaimos/uploads/2013-2014/da-2013-14-introduction-to-r.pdf>

have 5 weights, $j_1, j_2, j_3, j_4,$ and j_5 .

Given $c1 (0.2, 0.7, 0.3, 0.4)$ as the raw vector of weights just extracted from the Uniform distribution, it becomes $c1 (0, 0.2, 0.3, 0.4, 0.7, 1)$ as sorted raw vector of weights with the identification of the fixed first and last positions.

$c1 (0.2, 0.1, 0.1, 0.3, 0.3)$ is the resulting normalized vector, with each weight non-negative and total sum equal to 1; where each value is obtained as follows: $c1 ((0.2 - 0), (0.3 - 0.2), (0.4 - 0.3), (0.7 - 0.4), (1 - 0.7))$. So, the resulting 5 weights are $j_1=0,2, j_2=0,1, j_3=0,1, j_4=0,3$ and $j_5=0,3$.

Once the weights have been obtained with such a procedure, it is useful to arrange them as a matrix, so that they can fit RStudio's package.

5.5. Arrangement of variables

Load the data set and make it take the desired shape. In this case, RStudio's "readxl" package contains the more specific function "read_excel", which was used to load the data and to structure them as a matrix using the "as.matrix" command. The dataset is available in the Appendix.

```
library(readxl)
variables <- read_excel("VARIABLES.xlsx")
View(variables)
data<-as.matrix(variables);data
```

However, such data cannot be presented in tabular or matrix $_{n \times m}$ form, as it must be organized in arrays, so in a multidimensional matrix that has as dimensions the individual values of the iterations, the alternatives, and the number variables. It must be a three-dimensions $k \times m \times n$ array, with m rows as the alternatives, and n columns as variables (proper pseudocode available in the Appendix).

5.6. Execution of the rank

To execute the Stochastic Multi-Criteria Acceptability Analysis, it is used a package of preset functions called smaa, which has been shortly released in April 2023. It was developed by Gert Valkenhoef and this study is one of the first attempts of its usage for scientific purposes. It allows the realization of the alternatives' rank, as well as many other useful measures, by deploying the Monte Carlo method (Van Valkenhoef,

2023)³⁸. The *smaa* package has been developed for ranking alternatives and obtaining other useful measures, which have been described in Chapter 1, but it has to be used on RStudio. This is a powerful statistical software, used mostly in scientific studies and research, that can contain many ad-hoc packages with preinstalled functions and commands, useful to analyze datasets and carry out difficult calculations, for example in statistical and econometric processes. Before using the functions, RStudio requires to install the *smaa* package by the code “install.packages (smaa)” followed by “library(smaa)” to recall it. The main function used is the *smaa (meas, pref)* where *meas* [i , ,] is referred to the array of the variables, while *pref* [i ,] is the matrix of the weights.

Pseudocode for the usage of *smaa* package

```
library(smaa)
rank<-smaa(v,n);rank
```

5.6.1. Easy SMAA example

This is the description of a small example of the SMAA method to better understand its results.

Supposing to have l=5 alternatives to rank according to n=10 variables. The construction of the CI involves the use of a weighted average, as explained in the previous chapters, and the usage of the SMAA method to solve the lack of weights, and to rank the alternatives.

The alternatives are A1, A2, A3, A4, and A5, and the respective 10 variables are contained in Table 5.2 (These values are samples and not real ones). The number of iterations is k=9604 corresponding to an error of 1%.

Tab. 5.2 Example variables

	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10
A1	0,12	21	3,2	410	0,5252	16	72	1	98	22
A2	0,14	23	3,4	430	0,5454	36	74	6	29	7
A3	0,16	25	3,6	450	0,5656	57	76	99	7	14
A4	0,18	27	3,8	479	0,5858	76	78	14	20	18
A5	0,20	29	4	490	0,606	96	80	3	23	5

Once the data are loaded into RStudio, it can be created the array of the variables and carried out the entire procedure to estimate the weight vectors. With the *smaa*

³⁸ <https://cran.r-project.org/web/packages/smaa/smaa.pdf>

package and the smaa function explained in the previous paragraph, it results in the values contained in Table 5.3.

Tab. 5.3 Result of SMAA example.

Rank acceptabilities (N = 9604 iterations):

	[,1]	[,2]	[,3]	[,4]	[,5]
A1	0.15930862	0.072053311	0.076218242	0.33808830	0.3543315285
A2	0.00000000	0.001561849	0.002811329	0.38848397	0.6071428571
A3	0.37401083	0.104956268	0.349958351	0.13629738	0.0347771762
A4	0.03956685	0.550083299	0.364847980	0.04529363	0.0002082466
A5	0.42711370	0.271345273	0.206164098	0.09183673	0.0035401916

The table has the alternatives labeling the rows (A1, A2, A3, A4, A5) and the rank position labeling the columns (1, 2, 3, 4, 5). The labels of rows and columns are essential to understand the numbers inside the table. Such numbers express the probability that the alternative in the row has, to occupy the position identified by the number in the column heading.

Consequently, the alternative A1's probability of being in the first position of the ranking is equal to 15,93%, second 7,20%, third 7,62%, fourth 33,80%, and fifth 35,43%.

Knowing that the alternative occupies the position that corresponds to its highest probability, the alternative A1 will be placed 5th. For the same reasoning, A4 will be first with a probability of 3,96%, second at 55,01%, third at 36,48%, fourth at 4,53%, and fifth at 0,02%. The alternative A2, for example, will never be ranked first because its probability for that position is null.

To obtain the final ranking, each region needs to be separately considered, once at a time, to spot the position where it has the highest probability. Some positions might stay vacant if no region has the highest probability for them, as well as the same position can be occupied by more than one region at the same time if two or more of them register the highest probability for that position. In the example, both alternatives A3 and A5 are ranked first, because under the first column, they have the highest probability values compared to their other positions, respectively 37,40% and 42,71%. To conclude, the small ranking resulting from Table 5.2 will be the following.

1st: A3; A5

2nd: A4

3rd:

4th:

5th: A1; A2

The same reasoning has been applied to rank the Italian regions. The results of this study, shown entirely in the Appendix, present the Italian regions defining the rows, while the numbers from one to twenty, as many as the regions, defining the columns. The actual ranking is available below, and in the Appendix, you can find the whole table of the results.

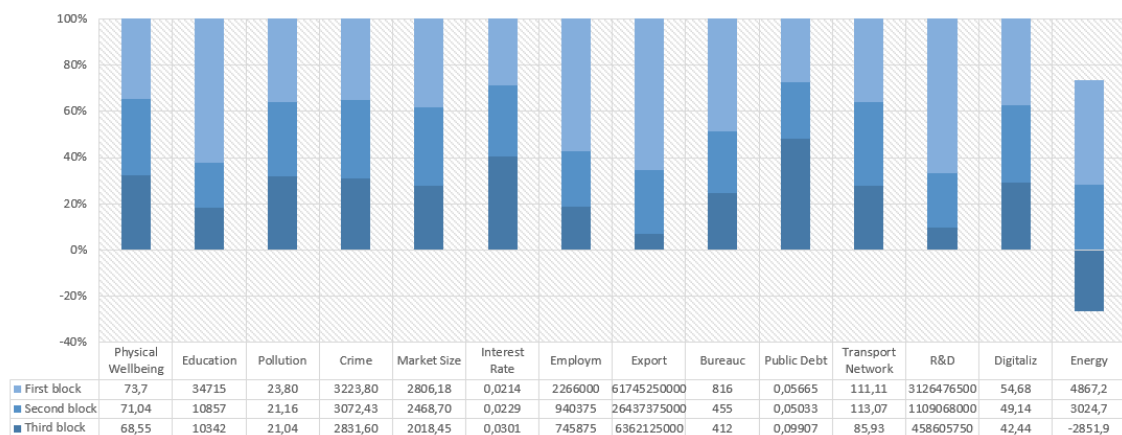
- 1st. Lombardia; Trentino - Alto Adige
- 2nd. Emilia - Romagna
- 3rd. Lazio
- 4th.
- 5th. Toscana
- 6th. Veneto
- 7th. Friuli – Venezia Giulia
- 8th. Piemonte
- 9th. Valle d’Aosta
- 10th. Liguria; Marche
- 11th. Umbria
- 12th.
- 13th. Puglia
- 14th. Campania
- 15th. Abruzzo
- 16th. Basilicata
- 17th. Sardegna
- 18th. Sicilia
- 19th. Molise
- 20th. Calabria

5.7. Analysis of the ranking

The ranking can be split into three blocks, composed of regions with similarities and some exceptions. The first interesting aspect is that the bottom of the ranking is entirely composed of regions geographically located in the south of Italy.

Figure 5.1 shows the average values of each variable, according to the three blocks, in which the ranking can be split.

Fig. 5.1 Average values of the variables according to the ranking positions³⁹



- First block (Lombardia, Trentino-Alto Adige, Emilia-Romagna and Lazio)
- Second block (Toscana, Veneto, Friuli-Venezia Giulia, Piemonte, Valle d'Aosta, Liguria, Marche and Umbria)
- Third block (Puglia, Campania, Abruzzo, Basilicata, Sardegna, Sicilia, Molise and Calabria)

The first block groups the first three positions, namely Lombardia, Trentino-Alto Adige, Emilia-Romagna, and Lazio, the second block contains the middle of the ranking, namely Toscana, Veneto, Friuli-Venezia Giulia, Piemonte, Valle d'Aosta, Liguria, Marche, and Umbria, while in the third one, there are Puglia, Campania, Abruzzo, Basilicata, Sardegna, Sicilia, Molise and Calabria.

5.7.1. First block

The first block is composed of the northern regions, scoring the best average value in all the positive variables considered, while recording the worst one as far as crime and quantity of institutions reaching an average of 3223,8 complaints and 816 public offices. The worst average values of pollution and energy imports (23,80 micrograms

³⁹NOTE: The table shows the average value of each variable obtain as a simple average of the values scored by the regions belonging to that precise block.

per meter of air and 4867,2 Gwh) are, though, justifiable given the number of companies and vehicles on the roads, airports, and ports in the area. These regions are in the area of Italy with the highest number of companies, which count on a transport network efficient and of quality, except for Trentino-Alto Adige for its mountain location which makes them miss the highest value in the transport variable (average 111,11). However, these regions can supply both the national and international markets, given that the presence of highways, commercial ports like and Ravenna, and commercial airports such as Milano, Bergamo are strong enablers for the efficient trade of goods and materials. The resources allocated to research and development among these regions are pretty high and above the average, making them among the most innovative ones, results confirmed by the above-average levels of digitalization among cities. Even the number of university graduates is sustained by the presence of important universities in Milano and Bologna. The investments are favored thanks to the low-interest rates granted by financial institutions, even if the incidence of the public debt is not so the lightest due to the inclusion of Lazio, which increases the average. The Lazio region ranked 3rd against expectations. The data, though, shows that the negative effects played by the high share of public debt over GDP (14,61%) and the level of criminality are counterbalanced by a wide share of university graduates and money allocated to the research and development sectors, as well as upper middle percentages in the export and transport networks. This is the region with the nation's capital city, Rome, so it makes sense the presence of international airports and important railway junctions, that allow it to gain positions.

5.7.2. Second block

On the other side Toscana 5th, Veneto 6th, Friuli-Venezia Giulia 7th and Piemonte 8th did not enter the top positions even if they have many companies, are very economically active, and are located near virtuous regions. They have pretty high levels of exports and monthly expenses, as well as low-interest rates and public debt/GDP ratios. Even the transport network is very efficient thanks to many ports like Venezia, Piombino, and Livorno, together with efficient highways and railways connections, and makes this section reach the highest average value of 113,07 in the corresponding variable compared to the other blocks. The R&D is middle high, too, and the digitalization is a

little under the Italian average. The fact is that each of these regions has something negative that makes it lose position. Toscana is hit by a high percentage of crime, while Veneto region faces the negative side of having many companies, more specifically the highest number of 28,17 micrograms per meter of air released and the biggest amount of imported energy. Friuli-Venezia Giulia occupies just the 7th position probably because it has a not-so-developed industrial activity, with low levels of exports, a small market size, and a limited workforce, as well as few graduated students and a low level of R&D. Piemonte even if close to economically virtuous regions and to important transport networks, has a high level of pollution, mainly driven by the type of firms, and by a very high number of public institutions deployed on the territory (1435 offices). Liguria is also near wealthy regions, and even owing the important commercial port of Genova, records an unexpectedly low level of export, as well as a high interest rate and the highest level of crime, and this makes it reach just the 10th position. The remaining regions scored average values in the variables and do not have particularly positive or negative outliers, such as Valle d'Aosta, Umbria, and Marche.

5.7.3. Third block

The third block is composed of southern regions such as Puglia, Campania, Abruzzo, Molise, Basilicata, Sardegna, Sicilia, and Calabria, which scored the worst average values on many variables and even the lowest average ones in the positive variables. They are characterized by the average lowest level of crime, with just 2031,60 complaints, but show a high presence of mafia-like organizations that control the economic and political activities, this number can be justified by a widespread silence among the population. Even the incidence of public debt on GDP is at the highest, with Calabria scoring the maximum value of 17,74%, making these regions look less economically reliable. The business activity in this area is pretty much inexistent, investments are limited due to very high-interest rates, which, together with low percentages of exports, resemble regional realities that do not have private companies or industrial districts and whose population is mainly employed in the public sector. The infrastructure endowment is also penalized in these regions, specifically in Sicilia and in Sardegna, which, being islands, even if favored by the presence of ports, are more negatively affected by the difficulties in being reached by train and car. They

strongly contribute to the reduction of the average effectiveness of transport networks among southern regions. Even the innovation and technology sector is backward given the small amount of money, that these southern regions allocate to research and development activities, and the below-average values of digitalization, which are connected to the low level of graduates and universities compared to the northern regions. The positive aspect is that the southern regions produce the largest quantity of energy (average of 2851,9 Gwh), that is sold to other regions or abroad. They largely exploit the solar and wind panels due to the climate and their positions by the sea.

Puglia and Campania are in the lead of this block, being ranked in the highest positions, respectively 13th and 14th. Both have low digitalization levels and are characterized by a strong presence of crime, even in this case not so reported. Pollution is also high, due to the ports of Napoli, Salerno, and Bari, and the heavy industry plants located there. More specifically, Puglia is boosted by the great amount of produced energy, which is the highest in Italy, by an upper-high number of graduated students and by the amount of money for R&D, as well as by the low percentage of debt over GDP. Campania is sustained by the consistent network of transports, given the presence of Napoli port and airport and the railway hub of Napoli, and a decent number of exports. The level of R&D is considerable even in this region, along with the percentage of university students, whose main destination is the Federico II University of Napoli.

The various steps described the proper polarization of variables and normalization of the weights, up to the creation of the final ranking. It strongly confirmed the dichotomy between north and south (first block against third one), although it presents unexpected positions for regions that are penalized (Toscana, Veneto, Piemonte, and Friuli-Venezia Giulia) or for interesting realities not enough discovered (Lazio, Campania, Puglia).

Chapter VI – Fashion Circular Economy

This chapter will describe the Fashion industry, which is known to be wasteful and polluting, as well as based on an unsustainable process called fast fashion. It requires a change, which can be represented by the introduction of circular business models, to use textile waste as raw materials, and which better country to apply it if not Italy, where this sector hugely impacts economic activity.

6.1 Definition and effects

The traditional economic model starting with the processing of raw materials and ending with the accumulation of waste that can no longer be reused (take-make-waste), is becoming unsustainable (Ellen MacArthur Foundation, n.d.; Gueye, 2021)⁴⁰. Consumers continue to require more and more products and to use them for short periods, before throwing them away. They ignore that, in doing so, they foster the pollution caused by the production processes, especially about products in sectors of plastics and its derivatives, metals, and textiles, and contribute to the reckless pressure on the employment of raw materials, together with the accumulation of huge quantities of waste that can have only landfills and incinerators as final destination; as an example, just in Europe roughly 2⁴¹ billion tons of waste are produced every year (Parlamento Europeo, 2023). It is necessary, though, to introduce a new business model defined as “circular” in which new life is given to waste by reintroducing it in the manufacturing process as raw material.

The Circular Economy has been described by the architect Stahel and the sociologist Ready-Mulvey⁴² and is considered a new and more sustainable productive model with a positive social and environmental impact, that, at the same time, still aims at creating economic value (E.L., 2023). The circularity concerns the use of second-row material, i.e., the introduction into the production process of not newly extracted raw materials, but of existing goods that are given a second life through recycling and

⁴⁰ <https://ellenmacarthurfoundation.org/what-is-the-linear-economy>

⁴¹ <https://www.europarl.europa.eu/news/it/headlines/economy/20151201STO05603/economia-circolare-definizione-importanza-e-vantaggi>

⁴² <https://www.esg360.it/circular-economy/cose-leconomia-circolare-e-perche-e-un-vantaggio-per-le-aziende/>

reuse. By sharing, lending, reusing, repairing, reconditioning, and recycling the already existing goods as long as possible, their life can be extended by taking on new forms or usages. The environment will benefit because emissions of CO₂ and greenhouse gases will decrease, while the biodiversity will be protected given that fewer natural resources will be exploited. Not to mention that this is a huge advantage for countries that do not have independence in raw materials, because, by reusing / reintroducing products that have already been produced, they do not need to start from the virgin ones and are more released from external supply (Parlamento Europeo, 2023).

The circular economy sector is gaining prominence after people became aware of environmental problems, especially for companies that are driven to implement sustainable practices to meet social and ecological standards in their productive processes. Whether due to ESG criteria or government-imposed regulations, firms are strongly encouraged to participate in the economic transition towards greener and more eco-friendly productions, allowing them to pursue the Sustainable Development Goals SDGs established by the United Nations. At the same time, it is increasing the tendency where consumers are the first to choose and demand goods produced respecting and protecting the environment. The circular economy with its mantra of repair, reuse, and recycle, is the only solution to save the planet.

6.2 Problem of the fashion industry

The fashion industry plays a relevant role in the global economy and records a rate of +8,4% of growth between 2020-2024, hitting an amount of roughly 1.000.000 \$ in revenues in 2024 (Gazzola et al., 2020), but needs to be shifted towards a more sustainable route. Behind just the oil refinery sector, fashion is one of the most polluting worldwide, and it generates the biggest amount of waste. To meet the annual need for shoes and clothing of a single individual are consumed 400m² of land, 9 m³ of water, 391kg of raw materials along with a production of 270 kg of CO₂. Then, out of all the clothes produced, 73% are destined for landfills, 12% are recycled and just 1% is transformed into new garments (Parlamento Europeo, n.d.⁴³; Gueye, 2021). Thus, one of the useful solutions to reverse the process is the implementation of the

⁴³ <https://www.europarl.europa.eu/news/it/headlines/society/20201208STO93327/l-impatto-della-produzione-e-dei-rifiuti-tessili-sull-ambiente-infografica>

circular economy model. The traditional one, wasteful and harmful to the environment, is defined as fast fashion: apparel seems to have an expiry date and only lasts for a season, because of the constant demand for new and trendy clothing. Millennials, Generation Z, and generally young people are the prominent supporters of this type of fashion, they always ask for brand-new and fashionable clothing and use them as long as an Instagram story (Gueye, 2021). Such a system works and ensures cheap-price products, by using poor materials, such as low-cost synthetic fibers, and cheap labor (Modonutti, 2023), especially in China and Eastern Europe, so that people can afford to frequently change and reinvent their wardrobe, given that what matters to them is only to possess world's trendy and up-to-date new garments. Fast-fashion companies can release up to 50 new collections in a year, just to meet the wishes of consumers. (Perinelli, n.d.).

As reported by the Zero Waste EU report, though, the production of clothes has doubled, against a drop of 40% in their usage (Simon, 2023). Thus, there is a need to try to reverse the course of this business model that has consistent negative impacts on the environment.

It is a statement, though, that driven by the profit-making want, even manufacturers and important brands are led to promote expiring clothing. They will take them away from the market at the end of one season and will propose new arrivals inducing people to buy them, and the circle will start again in the following season, when different up-to-date creations will be newly distributed, with consumers repurchasing them (Salamone, 2020). Such a process showed the first scratch already in the past many campaigns were created to raise awareness about this topic and to spread the idea that a greener fashion industry could exist and be trendy while helping the planet. In 2017 the Circular Fashion System Commitment was launched in Copenhagen, together with the Make Fashion Circular project supported by the Ellen MacArthur Foundation, while the following year even the UN realized the Fashion Industry Charter for Global Climate Action (Fantin V. et al., 2020). According to the European Commission (2022), Europe has already begun the so-called textile economic transition, to be achieved by 2030, to create an industry with textiles that are durable, reusable, modifiable, recyclable, long-lasting, composed of recyclable fibers, free of

toxic substances, and respect social and environmental rights (Commissione Europea, 2022).

6.3. Circular economy as a solution

Circular economy business models applied to the fashion industry involve the reintegration or reuse of existing garments or fabrics as raw materials for future production processes, but more deeply require a change in the choices made during the product's planning and design phase, as most of the potential polluting processes derive from the decisions taken at this point (Dissanayake et al., 2021). Anyway, each step of the process is relevant and needs to be modified towards a circular view.

The use of recycled textiles, processing waste, or clothes destined for landfills as raw materials for future production processes is of fundamental importance because the reintroduction of an existing product at the end of its life in the manufacturing process allows the reduction of brand-new resources' demand and the consequent pressure on the planet. Even more crucial is the step of the project and the design of the clothing. Most of the environmental impact is indirectly decided during this phase: this is when stylists decide on colors, rather than fabric processing or the way textiles are assembled, as well as special treatments to ensure that the garment will hold up, perhaps to specific weather or stress conditions (Dissanayake et al., 2021; Gueye, 2021). A more ecological attitude could be the determination of all the clothing's possible future uses, its durability, or how it could be regenerated, perhaps deciding to assemble techniques to ease the future disassembly, or creating it directly with biodegradable or easy-to-recycle fabrics, to guarantee it a new life (Vecchi, 2020). Then, the manufacturing process takes place, and they will follow the guidelines decided in the planning stage. The productive location, the type of workforce, and the resources employed are the variables affecting the quality and sustainability, both social and environmental, of the final product. To produce just one t-shirt, it is needed the amount of 2700 liters of fresh water, which is an adult's water requirement for two years and a half (European Commission, 2022). As sustained by Gazzola et al. (2020), implementing circular business models helps reach some of the 17 Sustainable Development Goals (SDGs), established by the UN, to be completed by 2030. It realizes SDG number 12, the one related to sustainable models of production and

consumption, but at the same time, favors other goals like SDG number 6 about the decrease of pollution and use of water, SDG number 7 related to an increase in the use of energy from renewable sources in production processes to replace the one from traditional sources, as well as fighting climate change, protect oceans and seas and life on the hearth, i.e., the SDG number 13, the SDG number 14, the SDG number 15 respectively.

In the end, efforts should be made to educate and increase consumers' awareness regarding the heavy impacts that their style choices and a never-ending demand for new clothing could have. The consumption-retail phase, is actually, the one in which small more eco-friendly practices have already been introduced. Alternative solutions such as restoration of damaged garments, renting or swapping clothes, as well as consumption of biodegradable-based or recycled clothing, have gained momentum recently (Vecchi, 2020; Dissanayake et al., 2021). The Ellen MacArthur Foundation reports that the second-hand market will grow 1,5 times the size of the fast fashion industry by 2028 (Gueye, 2021), a trend that echoes the increasing number of both online and physical sales channels, e.g., Vinted, Vestiaire Collective, and Depop. The involvement of producers to humor a greener demand has been few. For example, the fast fashion giant H&M started the campaign of offering cashback to people who brought to their stores clothes that they no longer used and would throw away, but is still far from the pioneer Patagonia, who rejects the canons of fast fashion, urging its customers not to buy clothes unless strictly necessary, and strives to create products with recycled fabrics that last a long time, while also promoting after-sales assistance to repair or reuse damaged garments (Wolfe, 2023). They are becoming more intensified in the manufacturing processes involving the creation of clothing starting from the production scrap of foreign-to-fashion industries, namely shoes' soles made of grapes or clothes deriving from oranges.

At the same time, though, the Ellen MacArthur Foundation sustains that what is needed is a complete reform of the fashion business models. By simply using other productions' scraps like plastic or whatever, the result is not a sustainable process, because most of the time, the method (types of machinery and chemicals) necessary

to turn these materials into textiles is more polluting and environment hostile. So, waste is not the solution, the right answer is a new business model (Simon J.M, 2023). If no trend inversion occurs, by 2050 clothing production will triple causing the loss of landfills of roughly 460 billion \$, the consumption of 200 million tons of non-renewable resources, as well as the presence of 22 million of micro-plastic in the ocean (Gazzola et al., 2020).

6.4. Fashion circular economy applied to Italy.

The fashion industry is predominant in the Italian economy, being a strategic sector that in 2022 produced a turnover of about 100 billion euros, with an export share of roughly 80 billion euros (Casadei, 2023)⁴⁴. It boasts world-renowned brands such as Prada, Versace, Armani, Trussardi, Moschino, Dolce & Gabbana, Gucci, and many others, which are known and appraised worldwide for their unique quality and style, distinguishing features of the so-called Made in Italy. The production is mainly concentrated in industrial districts, that have historical importance in Italy, e.g., Toscana (Textile district of Prato), Veneto (Textile clothing district of Schio-Thiene-Valdagno, where are present firms working for important brands like Gucci, Dior and Chanel) and Lombardia. Sometimes, the more common and cheap brands, e.g., United Colors of Benetton, and Calzedonia, however, prefer to delocalize their production in foreign countries such as China, Eastern Europe, or Bangladesh, because they benefit from a local low-cost workforce. Aside from the historical brands and newly born ones, a lot of garments are also imported from other nations, mostly from China and other Asian countries, hitting roughly 30 billion €⁴⁵ in 2022 (Casadei, 2023).

Out of all the clothing produced and used in Italy, in 2020 just 1% (about 143 300 tons) of all recycled materials were textile waste, while the 5,7% of undifferentiated waste destined to landfills is still made of textiles (Fondazione per lo Sviluppo Sostenibile, 2022). Not to mention the fact that most of the recycled textile waste is composed of apparel (89%) while the remaining part (11%) is other textile articles such as mattresses (Fondazione per lo Sviluppo Sostenibile, 2022).

⁴⁴ <https://www.ilsole24ore.com/art/la-moda-italiana-i-102-miliardi-ma-corsa-ricavi-rallentera-4percento-AEkHaqjC>

⁴⁵ <https://www.ilsole24ore.com/art/la-moda-italiana-i-102-miliardi-ma-corsa-ricavi-rallentera-4percento-AEkHaqjC>

Being one of the most recycling countries in Europe (73% of recycled materials compared to a European average of 52%), and with a great level of circularity, as reported by Dissanayake et al. (2021) - Italian Rate of Circular Use of Material was worth 21,6% in 2020, ranking it in the top 4 among the 27 European countries - Italy decided to extend its activity and boost its gathering and sorting procedures of textile waste, to gain in sustainability and to regenerate and reintroduce in the manufacturing process scrap that is currently sold to foreign countries. They are worth between 250 and 420 €/t depending on the quality, and their main destinations are Tunisia and other African nations, together with Pakistan (Fondazione per lo Sviluppo Sostenibile, 2022).

So, given the importance of the fashion industry for its economic growth, there is an urgency for Italy to revolutionize this sector towards circular production processes. Pushed by the climate problems and by the *End of Waste* program launched by the European Union, Italy set the goal of becoming a 100%-recycled clothes country, thus, Italy was the first country in Europe to introduce the Union's directive of waste sorting for textiles, starting from January 2022, despite the waiting for the deadlines of 2025 set by the European Union (Fondazione per lo Sviluppo Sostenibile, 2022).

As presented in the *Riciclo in Italia 2022* report by Fondazione per lo Sviluppo Sostenibile (2022), the ideal supply chain of fashion starts with the gathering of garments by municipalities or private cooperatives, then takes place the storage and selection of such waste, whether to be reused or regenerated. The sanitization is the following step, before sending the collected clothing to its last destination, a second-hand shop, a regenerative plant, or, if not reused, disposed of in dumps. Therefore, wanting to develop specific know-how in the primary phases of clothes recycling, Italy started to create alongside the peninsula some textile hubs. These plants accept the waste, and, after a peculiar selection, create recycled textile fibers, that are ready to be used in new manufacturing processes. Within the scope of the "Piano Nazionale di Ripresa e Resilienza", Italy could assign 150 million € for Line D, regarding the textile sector, aiming at their creation (90 mln € for center and south regions, and 60 € for the northern ones), in the wider picture of mission 2, with the goal of an "Efficient management of waste, focusing on the production of second-first materials to reduce

the waste disposal” (Soricetti, 2022; Pillitu, 2022). Currently, most textile hubs are in the northern area, e.g., Parco Eco – Civico in Vicenza, Veneto, Aimag hub in Emilia-Romagna, Prato Textile hub in Toscana, Biella hub in Piemonte, and others in Lombardia, Umbria, and Marche, while there is a lack and need of action for the creation of such plants in the southern regions.

6.4.1 Benefits and limits of the circular economy implementation

Italy has a low endowment of natural fibers and energy, which are the inputs needed in the fashion productive processes, so, the introduction of a circular model that implies the regeneration of already existing garments could release the dependence on foreign countries’ supply. Not to mention the benefit that even the planet would receive as far as the emission of greenhouse gasses. Berti L. (2021) reported that a circular business model in the fashion industry would allow the sale of 23 million tons of oil and would reduce 63 million tons the amount of CO₂ emissions. Moreover, it could give a new and green trace to the Made in Italy in such sector, making it a synonym for quality clothes and a sustainability mark. Italy’s competitiveness will benefit, above all investors that care about the environment and sustainable processes. As sustained by Fondazione per lo Sviluppo Sostenibile (2022) it could also boost economic growth and create new jobs, not only in the restoration and storage center but also in the research and innovation labs and institutions.

Indeed, innovation centers should have a role in discovering and experimenting with new eco-fibers to produce clothes, as well as new methods of production to exploit textile waste better and more efficiently. In this case, even the government can effectively act by granting financial aid and assistance for such centers, and at the same time for companies entering such a new sector of circular fashion, and by organizing information campaigns to increase public awareness. Finally, the main actors of the process must change their vision it is still recognized, that to realize the revolution of this industry, the supply chain has to modify some behaviors: consumers should pay more attention to the clothes they buy as far as the material used and the frequency with which they buy new useless clothes, while the mindset of manufacturers should change too, towards a more transparent production, so that

their goods can be traceable from the very beginning (Fantin V. et al., 2020).

In the end, the circular economy could make a difference in the fashion industry, both worldwide and in Italy. By regenerating and recycling textile waste it will reduce the pressure on the planet as far as raw materials and greenhouse gas emissions, so it is crucial to increase the number of textile hubs, to boost citizens' awareness and induce them to recycle their clothes. The waste is a temporary solution, what is needed is a complete change of the system towards a greener and eco-friendly one.

Chapter VII – Real Case: Composite Indicator for recycling plants in the Fashion industry

This chapter will describe an investment project in the fashion industry in Italy, to create a sustainable clothing brand, produced by a company that applies the circular business model to its production and controls the entire supply chain, from the sorting to the final recycled clothes, in different Italian regions.

Following the decision-making process pictured below, it will be carefully analyzed the regional situation of the candidates, as far as enabling and limiting factors, before ending with the final decision.

7.1 Description of the decision-making process.

Fig. 7.1 Decision-making process

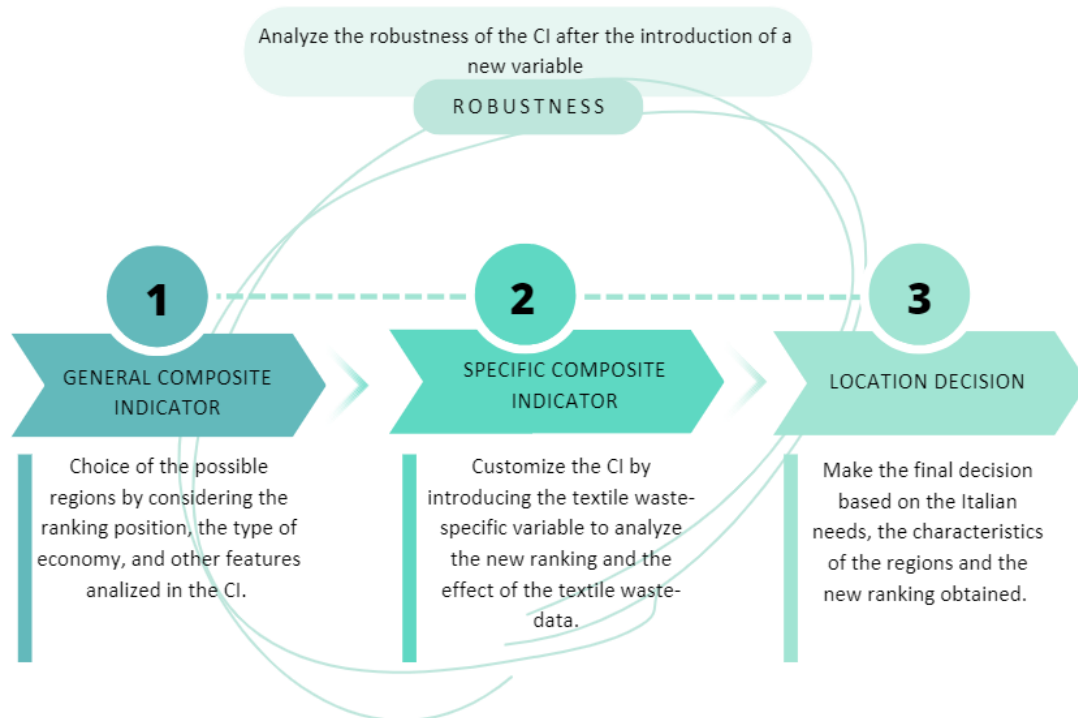


Figure 7.1. describes the strategic decision-making process followed to get to the final decisions of the project. In the first step, the location decision will be based on the ranking obtained in Chapter 5, while in the second step, the CI will be customized with a variable linked to the fashion industry and a new ranking will be released. This is the point when the provisional decision taken during the first step could be validated or not. In the end, the actual final location decision will be taken, after comparing the two

rankings obtained in each of the previous steps. The robustness of the CI had already been assessed in Chapter 5, as the CI was made of datasets with no missing values and with the same timeline, but further analysis is required after the introduction of the new variable, to register the changes from the initial ranking.

7.2. Description of the project

In the following paragraphs, it will be presented a project whose aim is to simulate a real situation and real investments, that could be done in Italy, in the context of the Fashion industry, given the extreme need for action towards circular economy models. The project was born from the news about the establishment of a new textile hub destined for the collection and regeneration of textile waste in Vicenza (Veneto region) (Comune di Vicenza, 2022), together with the news about the campaign launched by Gruppo Armani, to farm, in Puglia, sustainable cotton, which will be used for its clothing production (Bellini, 2023). The proposed project aims to group the problem of textile collection, with the use of sustainable raw materials.

Starting from the ranking obtained in Chapter 5, the project sees the creation of a new brand of clothing, owned by a company operating in the fashion industry, but with a sustainable and green circular business model. Thus, its production process will take place using textile waste as raw materials. There will be the establishment of a registered office, where all the administrative and financial activities will be carried out, plus two plants specialized in the collection of textile waste and the production of reclaimed yarn, which are directly linked with other two specialized facilities, that will use it to realize new garments. The strategic location of such plants is respectful of the features of specialization of the regions and their economies without distorting them nor breaking their historical and cultural knowledge in fashion, which represents the Made in Italy. Being part of the ecological transition to be realized by 2030, such a project cannot count on medium-long term structural changes, so it must weigh the shortest-time implications and repercussions on the environment and economic reality of the regions, as well as their present economic and infrastructural condition, to be as realistic as possible.

To provide a general overview of the initial direction and the possible future

development of the project, Table 7.1. provides an analysis of its Strengths, Weaknesses, Opportunities, and Threats (SWOT).

Tab. 7.1. Initial SWOT analysis

<p>Strengths</p> <ul style="list-style-type: none"> ▪ Plants are created thanks to the funds guaranteed by the state. ▪ The existing Italian know-how in fashion will be leveraged. ▪ The environmental problem of clothing waste will be reduced by the collection plants. 	<p>Weaknesses</p> <ul style="list-style-type: none"> ▪ The plants are far away; therefore, the supply chain is managed by the synergy between managers and supervisors. ▪ The regions where production plants are located will suffer an increase in pollution.
<p>Opportunities</p> <ul style="list-style-type: none"> ▪ Made in Italy increases its competitiveness and international importance increases and becomes sustainable. ▪ Strengthening of Italian manufacturing and creation of jobs. ▪ Research and training institutions in the fashion circular economy are incentivized. ▪ The creation of suitable infrastructure for the movement of goods is incentivized, as well as the digitalization of the regions. ▪ In the regions where collection plants are located, energy can be generated from waste. 	<p>Threats</p> <ul style="list-style-type: none"> ▪ The heavy bureaucracy could slow down authorizations and procedures. ▪ Waste is not the solution, rather a change of mentality is needed.

7.3. Headquarters

The administrative and legal headquarters will be in Lombardia, firstly because it is the top region of the ranking, and this objective superiority must be recognized, and then because it is the Italian financial capital. Even the design phase will be carried out in such region, as it allows stylists and artists' ideas and entrepreneurs to meet, as well as it hosts the *Milano Fashion Week*, one of the main events of the fashion industry that

every year welcomes the best national and international creations in Milano. Moreover, Lombardia invests a lot of money in research and development (the highest amount of 5087077 thousand €) and so it is very active in bringing new production ideas and alternative methods on catwalks. The clothing will be sold via e-commerce channels managed in the northern region to exploit its better technological level and know-how in the digital market (56,2 points out of 50). E-commerce is becoming the largest sales channel and even the fashion industry must move in this direction, especially since most of its customers are aged between 21 and 37 and are very active with digital devices (SACE Education, n.d.). In addition, through e-commerce, the clothing could be conveniently purchased by consumers all over the world, without waiting for the establishment of physical stores. The value of exports and trade channels, both at the European and international levels (the highest value of 135 883 billion €), of this region, are supported by a strong and efficient transportation network (113,1 points out of 100) and reinforce the choice of place here the sale sector of the company.

7.4. Collection and sorting plants

Collection and sorting plants are the first places where, after the separate waste collection, textile waste is taken and sorted, before being allocated to second-hand markets or regenerative processes. As reported by Fondazione per lo Sviluppo Sostenibile (2022), in Italy there exists a huge gap in the waste collection between the northern regions, where 70% of the specialized plants are already located, and the southern ones, which do not have adequate and up-to-date facilities nor machinery.

To compensate for this further difference between north and south, the Italian government has allocated within its “Piano Nazionale Ripresa e Resilienza”, 150 million € to be invested in “Infrastructure for the collection of the pre-consumption and post-consumption textile fractions, modernization of plant engineering and construction of new recycling plants for textile fractions in a systemic perspective s.c. Textile hubs” (MASE, n.d.), therefore increasing the Italian endowment of collective and storage plants, as well as the subsequent treatment of yarn and the strengthening of the entire network for the collection and reuse of products deriving from recycling. The largest percentage of 90 million € was devoted to the development of Central-southern

regions, to fill the existing gap, while the remaining 60 million € is destined for the northern. The money is used to update or buy from scratch, the plants in which the sorting process will take place. Such facilities require large spaces where the first division between the garments takes place, both by type (trousers, sweaters, skirts, jackets) and by season (spring-summer and autumn-winter). The ones dedicated to the regeneration process need to be divided by color and shape and stored waiting for the treatment. This procedure can be simplified by using a highly technological machine, which, using infrared technology, can autonomously sort the fabrics according to the type of material and color, to reduce waste storage time, before the dividing phase. (Bolelli, 2022). After the division, the resulting fibrous material is already colored and does not need further use of chemical agents. The torn phase is carried out by specialized and high-tech machinery, that tears the clothes and produces a sort of virgin fiber, which then, through convey rollers, is taken to the washing machine to be sanitized. Once dried, the fibers are turned into yarn and are ready to be reused directly or even to be sold to tailors and textile laboratories. Conveyor belts are fundamental to moving the fibers throughout the process up to the purification machines for the washing phase. Large spaces for storage are essential both for the collection, for the stock of recycled clothes ready to be resold, and finally for the rags waiting for tearing, as well as proper infrastructure is required for the transportation and export of goods in whatever stage of the process (Dw news, 2023). To conclude, given the difficult situation of backwardness in the management of textile waste in the south, given the amount of funds provided by the government and considering the characteristic requirements for a collection plant, the most reasonable choice is to concentrate on creating such plants in the southern regions, leaving out the uppers, where this need has already been met.

7.4.1. Decision according to the initial CI

According to the characteristics that a textile plant should have and to the considerations made in the previous paragraph, the CI estimated in Chapter 5 has been the tool on which to ground the first decision.

The selected regions, in this case, were Lazio and Puglia as destinations for the creation of a plant for collecting and sorting textile waste.

Lazio region has been chosen because it is in 3rd place in the ranking. Moreover, this region has many infrastructural connections for transport presenting a value of 115,35 points out of an Italian average of 100, as well as the highest level of funds allocated to the research and development sector (3.676.853 thousand €) among the central-southern regions, signaling a good predisposition towards discoveries about innovative collection and recycling techniques. Even the large number of graduates (42.495 students) is a good proxy for future researchers or employees in this new and important sector. Energy is the only problem of this region, which is why, being a big importer of power, it has been chosen as the location of just the collection plant. The fashion industry is not relevant to the economy of this region, as reported by SACE Education (n.d.), it accounts only for 9%, rather than the strong role played by tourism, theater, or cinematography, which are still producers of textile waste. Additionally, the geographic position of Lazio and its transport network allows it to be easily reached by the neighboring regions such as Abruzzo, Campania, and Marche, which in turn have big fashion plants and produce a lot of waste.

Puglia region has been chosen as the location for the second collecting and sorting facility. It occupies the highest position among the southern regions, 13th as it can count on the highest amount of energy produced in Italy. In doing so, it can guarantee the plant to function independently, without relying on the supply from foreign countries, and the releasement from the fluctuations of the cost of energy. Moreover, geographically speaking, it is located exactly in the middle of the southern regions and can be easily reached by almost all the surrounding Campania, Molise, Basilicata, and Calabria. It has a decent level of transport (motorway, ports, and airports), as well as a new stretch of rail connection with Campania to be realized by 2026. Even digitalization is the best compared to other southern regions (45,9 over an average of 50), so it is placed in a predominant position.

7.5. Introduction of the textile waste data

The conclusions drawn in the previous paragraph are entirely based on the general composite indicator and linked to the ranking estimated in Chapter 5. To provide a more consistent analysis, it is introduced proper data on textile waste.

Collection and sorting plants act as the first destination of textile waste obtained

through the separate collection, which in 2021 in Italy, amounted to about 154000 tons. As reported by Figure 7.1, only 0,8% out of all waste is textile-related, and, as sustained by ISPRA (2022), the most virtuous and performing regions are center-north located, namely Lombardia, Veneto, Emilia-Romagna, Piemonte, Lazio, Toscana, as shown in Figure 7.2. (ISPRA, 2022).

Fig. 7.1. Percentage of different collected goods, year 2022 – ISPRA (2022)

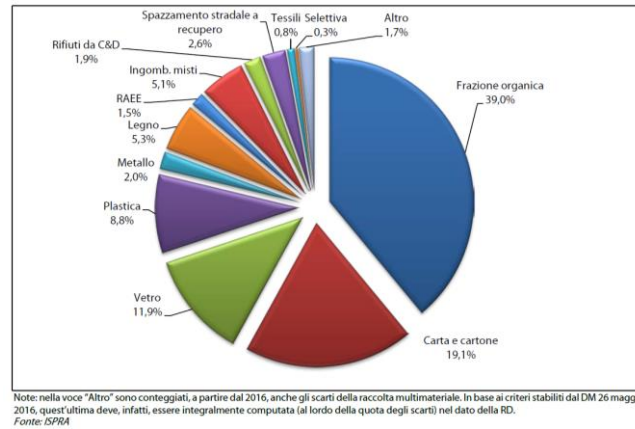
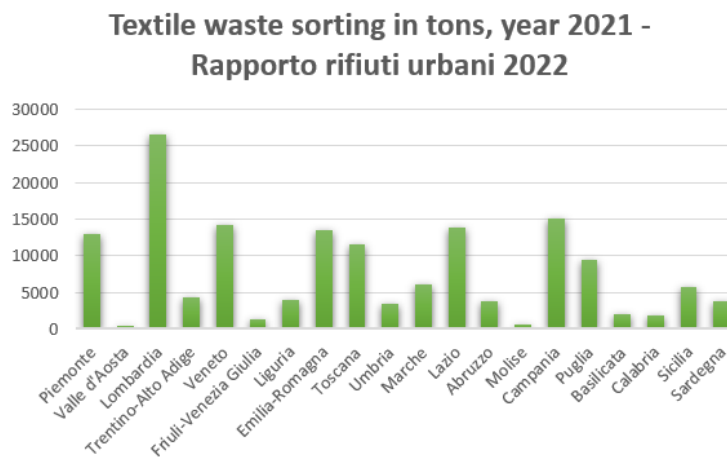
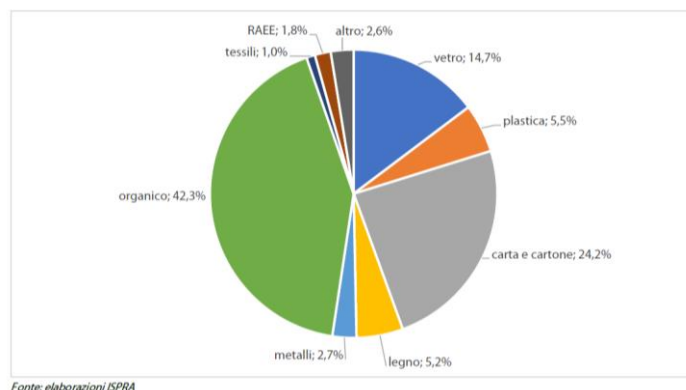


Fig. 7.2 Italian textile waste sorting in tons year 2021 – elaboration ISPRA (2022)



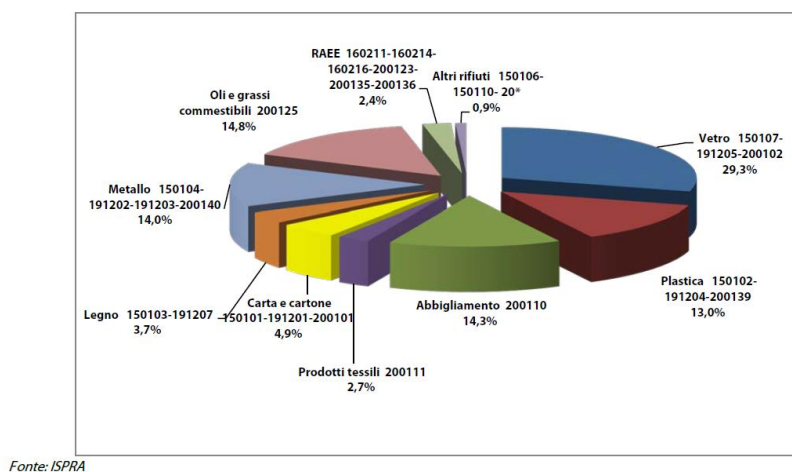
Only 1% of the entire quantity of collected textiles is destined for recycling as reported in Figure 7.3 ISPRA (2022), with the addition that this process is carried out the most in the northern regions, compared to the southern ones as seen before.

Fig. 7.3 Percentage of municipal waste sorted for recycling, year 2021 – ISPRA (2022)



In the collective plants, they should arrive at the waste produced by the population, the processing waste of any regional fashion district or textile factory, as well as the amount of textile that is imported from other Italian regions or foreign countries. As reported by (ISPRA, 2022), in 2021 Italy imported 37 thousand tons of clothing and textile products, accounting for about 17% of the total imported waste (Figure 7.4).

Fig 7.4. Types of municipal waste imported in the year 2021 – ISPRA (2022)



Germany is the main exporter with roughly 13 thousand tons, while Campania is the main receiving region. According to this information, what is interesting is that Campania does not have a large number of collecting plants (8866), despite receiving such a large amount of textile waste, while Puglia has more plants, 9611, but imports fewer tons than Campania (ISPRA, 2022).

Given the amount of textile waste arriving in the southern regions and the quantity produced in the northern-central ones, it is necessary to introduce some data on

textile waste collection in the calculation of the CI.

7.5.1. Decision according to the customized CI

The CI has been modified by inserting a new variable about textile waste, more specifically it has added the data regarding the per capita percentage (kg/inhabitant) of textile waste collected in 2021 in each Italian region. The new ranking has been created with the same methodology as before: after normalizing and polarizing the variables' data, the variables' array and the random weights' matrix have been combined by the function *smaa* in RStudio, and analyzing the resulting table, as did before, the following ranking has resulted (the new dataset and the pseudocodes are available in the Appendix).

Even in this case the position in the ranking derives from the calculation of the probability of the function to occupy that precise position. Additionally, the numbers in brackets indicate the changes in position occurred after the introduction of the textile waste information: a positive number stays for a higher position, while a negative for a worse position.

- 1st. Lombardia; Trentino-Alto Adige
- 2nd. Emilia - Romagna
- 3rd. Lazio
- 4th. Toscana (+1)
- 5th.
- 6th.
- 7th. Veneto; Piemonte (+1)
- 8th. Friuli – Venezia Giulia (-1)
- 9th. Valle d'Aosta
- 10th.
- 11th. Marche (-1); Umbria
- 12th. Liguria (-2)
- 13th. Puglia
- 14th. Campania
- 15th. Abruzzo
- 16th. Basilicata
- 17th. Sardegna
- 18th.
- 19th. Molise; Sicilia (-1)
- 20th. Calabria

After the introduction of the new variable, the decision of the regions where to place the collection plants does not change, but it is rather confirmed.

Lazio remains valid for what was mentioned in the previous paragraph, and additionally, because it is the region with the highest amount of textile waste collected (13 891,3 tons) among the center regions (ISPRA, 2022), and then due to the presence of 2 plants for the integrated anaerobic/aerobic treatment of waste, which, generating power from the unrecyclable/unregenerate textiles, can solve part of the energy-problem mentioned before (ISPRA, 2022).

Even the choice of Puglia remains valid for the reasons previously motivated, but also because this region has the second highest amount of textile waste produced among the southern regions (9440,2 tons in 2021) as reported by ISPRA (2022). In addition, Puglia has some important clusters of fashion, so it must be ready and have the right capacity to absorb their flow of waste and the one deriving from neighboring regions. The presence of one anaerobic treatment plant manages to obtain energy from the waste, too.

7.6. Robustness

The new variable introduced did not hugely impact the previous assessment it led just to a small switching of one or two positions between the regions. The biggest change is Liguria, which drops two positions, while Toscana and Piemonte benefit from one position, against Friuli-Venezia Giulia, Marche, and Sicilia which are reduced by one.

Nevertheless, 70% of the ranking remains exactly unchanged, given that only 6 regions out of 20 changed their position. The introduction of the new variable, adding information to the existing indicator, did not require a change in the algorithm, nor modified the choice of the two locations, but rather confirmed them.

Campania is the first rival for Puglia in the collective plant's decision, but it was not chosen, despite having a higher level of transport, because of the level of public debt three times higher than Puglia, as well as a consistent demand for energy, which is a strong factor to consider.

The remaining southern regions did not show any improvement after the introduction of the textile data, they rather confirmed their spot. This might be the signal of a very

low, quite irrelevant, activity in textile sorting. Except for the best three southern regions, the other five are not considered because of a lack of transport efficiency and digitalization, and above-average levels of indebtedness. The two islands Sicilia and Sardegna are further penalized because they do not have connections, nor digitalization level to even candidate them to welcome a plant and cover the surrounding regions. Sicilia's negative position has worsened with the customized ranking, further marking its inadequacy to host a collection plant, due to the lack of infrastructure and attention on textile waste.

7.7. Productive plants

In Italy, the fashion industry is strategic, but it must be adapted to face the new challenge of becoming sustainable and boosting Made in Italy's international image. The market's demand is changing, and consumers ask for complete traceability of clothing production processes, to verify the use of recycled and regenerated raw materials, as well as the implementation of manufacturing processes with a low environmental impact. A production caring about the environment and reflecting the Italian origin and know-how is still preserved, so that Made in Italy becomes synonymous with eco-friendly quality (SACE Education, n.d.). Therefore, instead of exporting the regenerated yarns, it seemed right to exploit the Italian knowledge and employ them in nation-based laboratories, duly served by the collective plants.

7.7.1 Characteristics of the plant

Most of the already existing textile hubs in Italy have a productive plant near the collective and sorting one, but according to this project, the production will be in adjacent regions to the collection. The main reason is related to the fact that the two plants have different functions and needs, so it is reasonable to locate them into separate regions that could better fit them as far as the type of economy or specific activity features. Consequently, even the production will take place in the south, founded on the vocation towards the fashion of southern regional economies, which seems to be strongly predominant, but not sufficiently motivated.

It is a statement though, that being in the same plant would ease many tasks, like the transport of the goods from one spot to the other, but the situation is not impossible

or so expensive to handle even in the case of different regions. Thus, an analysis must be done to find the best solution. Given that the regions are very close to each other, it can be rejected transported by ship or by train, but railway connections and road transport are preferred.

Transporting the regenerated yarn by truck could be more suitable because it can adapt to the needs and the flexible production of the productive plant, together with providing company delivery services. Moreover, relying on a leasing or rent contract permits to avoid the fixed cost of purchasing and maintaining the truck and the driver's monthly salary, as well as being independent of fixed schedules and third parties managing the goods. On the other side, this means of transport pollutes a lot, above all if large quantities are moved (Timocom, n.d.) and it is strongly dependent on weather conditions. Transport by train could have more benefits, as it is not weather-sensitive, is more eco-friendly, especially for long distances, and can move big loads at once, in fact, a freight wagon can carry up to 50 tons of weights (50 or 100 containers) and an entire train can fill up to 1000 tons, against roughly 40 tons of a big truck (Comito, 2021; Eurosender, n.d.⁴⁶). According to the price list of Mercitalia (2019), whenever a different deal is reached between the parties, for a minimum of 100km, the quote of 3,80€ per wagon/km would be applied (Mercitalia, n.d.)⁴⁷. Such economic proposals can be mixed according to the needs, the conditions, and the region of establishment of the plant. Aside from the proper means of transport, it is of major concern, to provide the productive plant with high-tech types of machinery, which can be purchased thanks to some incentives granted by the Italian government (Fund for IPCEI Microelectronics 2 or Sustainable Investments 4.0 - Investimenti sostenibili 4.0 - Call 2023)⁴⁸.

According to the type of economy, the transport infrastructure, and the estimated CI, the two chosen regions are Campania and Abruzzo, with the first being directly served by Puglia's collective plant, and Abruzzo by Lazio's.

⁴⁶ <https://www.eurosender.com/it/s/servizi/trasporto-ferroviario-merci>

⁴⁷ https://www.mercitaliarail.it/content/mercitalia_rail/it/offerta-e-servizi/servizi-di-trasporto.html

⁴⁸ For further details see: <https://www.incentivi.gov.it/it/catalogo>

7.7.2. Campania's plat

The first production plant is in Campania, the second highest among the southern regions, occupying the 14th place in both rankings, with a fashion economic specialization index of 114 points out of an average of 100 (SACE Education, n.d.). It hosts the largest number of graduates (35.596 students), counting on six physical universities, as well as the highest sum of resources allocated to research and development activities (1.370.664 thousand €) among the southern regions. The lowest and most attractive interest rate on investments is granted here (2,31%), while the presence of a large national and international consumer base for its products, motivated by the large amount of money spent monthly and the highest number of exports, 2.034,65 € and 13.146,00 billion € respectively, is a good omen for the clothes market. The transport network (103,9 over an average of 100) is fundamental to ease the process whether for receiving the yarn or delivering the final clothes, and this region can count on various sections of motorways (A1 highways) and some freight railway stations as Maddaloni Marcianise, Nola Interporto (Mercitalia, n.d.)⁴⁹.

Even though the bureaucracy is very persistent (706 institutions), and the crime (3060,68 average complaints) could make the region feel unsafe, Campania is very suitable for a green productive plant, because, as demonstrated by some past initiatives, it has already been very active in applying the circular economy to the fashion industry. As reported by Il Mattino (2022)⁵⁰, the company Remida Napoli, in collaboration with University L. Vanvitelli and its research department, has created a capsule collection of entirely eco-friendly clothing, starting from the waste from a textile company in Sondrio. With the introduction of the productive plant, it has the opportunity to ride the wave of green clothing of Neapolitan manufacturers, but more independently, being directly supplied by the dedicated Puglia plant, without relying on northern waste. Additionally, as sustained by Redazione (2021), in 2021, it was born the Sustainable Pole by the agreement between the University Federico II of Naples and the University of Salerno, with the initial aim of producing accessories substituting animal leather with sustainable materials. However, research has gone further to meet

⁴⁹ https://www.mercitaliarail.it/content/mercitalia_rail/it/offerta-e-servizi/il-network-nazionale.html

⁵⁰ https://www.ilmattino.it/societa/moda/moda_sostenibile_napoli_fiera_milano_unica-6468342.html?refresh_cens

the needs of the ecological transition, as well as many new investments have taken place in the field of green fabrics from fruit and vegetables (Redazione, 2021). Still in 2021, the five-year South Italian Fashion Consortium (SIFC) was born in Salerno, to reunite companies, textile laboratories, producers, and designers from all southern regions and offer them support throughout their whole activity, to enhance the name of southern tailoring in Italy and worldwide (Nuova Irpinia Redazione, 2021; Ifta, 2021). The production plant could collaborate closely with the Sustainable Pole, which is mainly focused on the research of innovative methodologies and materials, to exploit and contribute to practical research, discoveries, and innovations, bringing the innovation of regenerated yarn production. At the same time, the SIFC could be very beneficial in providing connections and aids that only experts still working in the sector can possess.

7.7.3. Abruzzo's plant

Abruzzo occupies the 15th position in both rankings and is in the top three regions among those in the south. As Campania its economy is largely devolved to fashion, scoring a fashion economic specialization index of 114 points out of an average of 100 (SACE Education, n.d.). With 2.226,14 € and 8.621,00 billion € it has the highest level of monthly expenditure and a medium-high level of exports respectively, demonstrating the presence of a national and international potential market for clothing. With a low amount of crime (2761,10 average complaints) it is a pretty safe region to invest in, even though the interest rate is at the highest in the south (3,66%). The transport network (99 out of 100) is developed enough to host some sections of the A24, A25, and A14 highways, as well as freight train stations like Fossacesia-Torino di Sangro, Interporto d'Abruzzo, Pescara Porta Nuova (Mercitalia, n.d.)⁵¹.

Even in Abruzzo, a new pole of Sustainable Fashion has been created as reported by Ciciotti (2023). It was founded to create an eco-friendly fashion production environment, which reflects the European Commission's circular and sustainable economy objectives regarding the elimination of fast fashion with its production in countries with no attention to the planet, or on the workers' rights. The productive plant could become part of and collaborate with this Pole, to boost the circularity of

⁵¹ https://www.mercitaliarail.it/content/mercitalia_rail/it/offerta-e-servizi/il-network-nazionale.html

fashion in Abruzzo.

Table 7.2 is the final SWOT analysis showing the additional effects of this project even on southern regions, not mentioned initially.

Tab. 7.2 Final SWOT analysis

Strengths <ul style="list-style-type: none">+ Online e-commerce is managed without the costs of a physical store.	Weaknesses <ul style="list-style-type: none">+ Southern regions have little infrastructure for transport, excluding the two islands.+ Part of design and administration remains in the north.
Opportunities <ul style="list-style-type: none">+ Creation of incentives to boost the south fashion industry both in terms of R&D and employment.	Threats <ul style="list-style-type: none">+ High interest rates in the southern regions could hinder the emergence of physical stores in the future.+ Mafia-like organizations in southern regions, that could take over the plants.

As presented in the chapter, the Italian regions and economy will benefit from the realization of such a project. The strategically chosen regions Lazio and Puglia for the collective plants, and Campania and Abruzzo for the productive ones, are the results of a customized CI, built to make the assessment more coherent. However, the CI was robust and allowed for a precise and widespread analysis of each region's characteristics.

Conclusions

The assessment of the economic competitiveness of Italian regions was the aim of this study, and, since much information was needed to consider, this was made possible by building of a composite indicator. It comprises 14 variables, aggregated in a weighted sum, thanks to applying the SMAA (Stochastic Multicriteria Acceptability Analysis). After each variable's analysis in the dissertation, it was found that the population's well-being and education positively impact the region's competitiveness. This is reflected in lower rates of sick leave among workers and higher levels of knowledge and skills. These factors contribute to a stronger and more prosperous region, while a high crime rate and pollution level have negative impacts. The first harms the regional safety perception, while the second damages the environment and represents a cost that companies must sustain due to their emission during production. It should be noted that the rate of public debt owned by regions has a negative impact on their competitiveness. This is due to the financial instability it creates within the regional public administration, further exacerbated by the many bureaucratic procedures required for new investments. Italy's competitiveness has suffered a lot from them, looking like an economically insecure and inefficient investment destination. Delving deeper into the economic and financial activity of the region, it becomes clear that a significant market share and a consistent number of exports demonstrate the existence of both an internal and external market for the goods produced in the region. Additionally, the employment level suggests ample labor input for companies, which ultimately contributes to their competitiveness. On the contrary, interest rates, if high, indicate low investment capacity and entrepreneurial activity in a region. Instead, the innovation system evaluates the technologies and infrastructures available in a region. Investing in research and development can positively impact on competitiveness by facilitating discoveries and innovations that could enhance the region's digital and transportation capabilities. This, in turn, can make production processes more technologically advanced and automated. Italy faces the most challenges in the energy sector, which is also crucial, given the environmental and geopolitical crises. Italian regions need to enhance their renewable energy production to become self-sufficient in production processes. However, the Italian government is working to strengthen weak sectors and bridge gaps by allocating funds through the

“Piano Nazionale Ripresa e Resilienza”.

RStudio software and the smaa package were used to apply the SMAA method and aggregate the variables in a weighted average. The weights were determined by a probability Uniform distribution, producing an impartial and unbiased composite indicator. The outcome of the ranking of the Italian regions validated the existing disparity between north and south, with Lombardia, Trentino – Alto Adige, Emilia – Romagna, and Lazio taking the top positions, while Basilicata, Sardegna, Sicilia, Molise, and Calabria secured the bottom ones.

Based on the obtained ranking, it was possible to simulate a circular-economy investment project in Italy's fashion industry. It addresses the need for a sustainable fashion industry and the improvement of textile waste collection, particularly in the southern regions. The placement of the plants was based on economic vocations and regional considerations: the administrative and financial plant has been based in Lombardia region, because this is a region with extensive expertise in finance and the fashion capital of Italy, the collection plants have been situated in Lazio, and Puglia to leverage their geographic features and positions, while the two productive plants have been located in Campania and Abruzzo, both for their positions and for their strong economic ties to the fashion industry.

The obtained composite indicator is robust and useful for understanding of regional realities to aid decision-making processes. To ensure a specific and customized composite indicator, it was necessary to include a project-specific variable before making a final decision. For future research, it may be beneficial to customize the CI from the beginning and discuss the inclusion of variables with decision-makers. Additionally, it might be worthwhile to improve the ranking tool by combining the SMAA method with other techniques.

To conclude, the SMAA method was used to define an unbiased CI, which managed to assess Italian regions' competitiveness and rank them, setting a small step to help entrepreneurs in strategic decision-making processes.

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APPENDIX

Dataset

INDICATOR:	QUALITY OF LIFE			
SUB-INDICATOR:	CRIME	EDUCATION	PHYSICAL WELL-BEING	POLLUTION
	CRIME INDEX (*)	TOTAL GRADUATES	POPULATION IN GOOD HEALTH	AVERAGE ANNUAL CONCENTRATION OF PARTICULATES PM10
	<i>Average number of complaints over 100 000 inhabitants of each Italian province</i>		<i>over 100 same aged people</i>	<i>measured in micrograms per meter of air</i>
Valle d'Aosta	2407,20	261	74,3	19,00
Piemonte	3141,03	23.063	70,3	25,38
Liguria	4119,55	4.932	71	15,67
Lombardia	3189,57	61.265	71,9	27,58
Veneto	2967,73	23.551	70,6	28,17
Trentino-Alto Adige	2500,55	4.394	79,6	19,50
Friuli-Venezia Giulia	2797,63	5.232	70,3	18,75
Emilia-Romagna	3979,12	30.705	70,9	26,30
Toscana	3609,66	18.222	72,3	19,82
Marche	2497,42	7.703	69,3	21,00
Lazio	3225,96	42.495	72,4	21,80
Umbria	3039,20	3.895	70,2	21,50
Abruzzo	2761,10	7.018	70,5	19,75
Molise	2804,20	1.091	67,3	17,00 (**)
Puglia	3129,40	12.240	70,3	21,71

Campania	3060,68	35.596	73,3	27,00
Basilicata	2473,70	808	65,8	20,50 (***)
Calabria	2982,02	5.666	64	22,00
Sicilia	2984,90	15.140	70,7	20,11
Sardegna	2456,78	5.174	66,5	20,25

NOTE:

(*): value obtained by the average of the available province data.

(**): value referred just to Campobasso province, because of the lack of data about Isernia.

(***): value referred just to Potenza, because of lack of data about Matera.

INDICATOR:	ECONOMIC AND FINANCE			
SUB-INDICATOR:	EXPORT	MARKET	INTEREST RATE	EMPLOYMENT
	EXPORTS PER REGIONS	AVERAGE MONTHLY FAMILY EXPENSES IN FOOD AND NON	BANK ACTIVE INTEREST RATES TAEG related to investment procedures	EMPLOYED
	<i>Billion €</i>		<i>%</i>	<i>thousand</i>
Valle d'Aosta	718,00 €	2.720,50 €	2,57	53
Piemonte	49.574,00 €	2.373,16 €	2,37	1.767
Liguria	7.846,00 €	2.339,13 €	3,00	595
Lombardia	135.883,00 €	2.904,45 €	2,21	4.333
Veneto	70.252,00 €	2.562,57 €	1,92	2.081
Trentino-Alto Adige	10.168,00 €	2.949,81 €	2,06	487
Friuli-Venezia Giulia	18.140,00 €	2.575,82 €	1,84	510
Emilia-Romagna	72.440,00 €	2.658,74 €	1,83	1.978
Toscana	47.720,00 €	2.593,95 €	2,21	1.546
Marche	12.561,00 €	2.170,21 €	2,11	617
Lazio	28.490,00 €	2.711,70 €	2,47	2.266
Umbria	4.688,00 €	2.414,28 €	2,31	354

Abruzzo	8.621,00 €	2.226,14 €	3,66	484
Molise	1.155,00 €	2.077,32 €	3,09	100
Puglia	8.606,00 €	1.807,67 €	2,88	1.207
Campania	13.146,00 €	2.034,65 €	2,58	1.592
Basilicata	2.818,00 €	2.028,93 €	2,85	189
Calabria	547,00 €	1.914,98 €	3,29	521
Sicilia	10.462,00 €	1.991,64 €	3,00	1.311
Sardegna	5.542,00 €	2.066,26 €	2,70	563

NOTE:

INDICATOR:	GOVERNANCE	
SUB-INDICATOR:	PUBLIC DEBT	BUREAUCRACY
	NON-CONSOLIDATED DEBT PER REGION over GDP	INSTITUTIONAL ENTITIES PER REGION
	<i>In percentage</i>	
Valle d'Aosta	3,95	97
Piemonte	8,08	1435
Liguria	4,98	324
Lombardia	2,64	1798
Veneto	4,17	703
Trentino-Alto Adige	2,79	368
Friuli-Venezia Giulia	3,03	273
Emilia-Romagna	2,61	447
Toscana	5,13	388
Marche	4,96	298
Lazio	14,61	650
Umbria	5,97	122
Abruzzo	7,05	373
Molise	10,18	173

Puglia	4,54	345
Campania	14,71	706
Basilicata	6,02	173
Calabria	17,74	453
Sicilia	12,65	591
Sardegna	6,36	483

NOTE: the value of public debt has been obtained by the ratio between the non-consolidated debt per region over the GDP produced by each region.

INDICATOR:	SYSTEM OF INNOVATION			
SUB-INDICATOR:	TRANSPORT NETWORK EFFICIENCY (*)	R&D RESOURCES	DIGITALIZATION	ENERGY (**)
	RAILWAY AND PORT EQUIPMENT FOR GOODS TRADE	R&D EXPENSE PER REGION by public, private, no-profit institutions, firms and universities	DIGITALIZATION	IMPORTED ENERGY BY ABROAD/OTHER REGIONS
	<i>Average Italian value of 100</i>	<i>Thousand Euro</i>	<i>Average Italian value of 50</i>	<i>Gwh</i>
Valle d'Aosta	89,4	25.995 €	48,4	- 2.016,30
Piemonte	117,85	2.975.758 €	51,5	- 5.473,80
Liguria	121,05	708.036 €	50,7	3.312,80
Lombardia	113,1	5.087.077 €	56,2	14.375,20
Veneto	122,15	2.111.081 €	49,4	16.786,10
Trentino-Alto Adige	87,9	534.497 €	56,8	- 4.835,50
Friuli-Venezia Giulia	123,3	635.436 €	50,8	2.667,40
Emilia-Romagna	128,1	3.207.479 €	52,9	1.673,80
Toscana	120,4	1.788.827 €	51,3	2.708,60
Marche	105,6	404.507 €	43,9	4.623,40
Lazio	115,35	3.676.853 €	52,8	8.255,10

Umbria	104,8	222.904 €	47,1	1.589,50
Abruzzo	99	311.899 €	43,5	- 260,10
Molise	94,7	63.838 €	38	- 1.431,90
Puglia	90,95	607.609 €	45,9	- 12.226,90
Campania	103,9	1.370.664 €	44,3	4.891,20
Basilicata	89,1	77.573 €	41,8	- 1.321,70
Calabria	89,2	190.164 €	38,5	- 10.134,00
Sicilia	68,35	754.895 €	42,4	1.026,70
Sardegna	52,2	292.204 €	45,1	- 3.358,80

NOTE:

(*): value obtained by averaging the equipment of railways and ports of each region.

(**): Energy value obtained by the difference between the consumed quantity and the internally produced one.

MAIN STATISTICS

VARIABLE	DESCRIPTION	CATEGORY	MEAN	STD	MIN	MAX
	Quality of life					
CRI	<i>The average number of complaints over 100 000 inhabitants of each Italian province</i>	Bad	3006,37	474,3569	2407,20	4119,55
EDU	<i>Total number of graduated students without nationalities differences</i>	Good	15422,55	16327,53	261	61625
PHYW	<i>Number of people in good health condition over a sample of 100</i>	Good	70,575	3,296549	64	79,6
POL	<i>Yearly average micrograms per meter of air of PM10 particulates released</i>	Bad	21,64	3,497935	15,67	28,17
	Economic and finance					
EXP	<i>Total value of exported goods expressed in billion Euro</i>	Good	25468850000	34309369022	547000000	135883000000
MKTS	<i>Average monthly family expenses in food and non</i>	Good	2356,10	340,833823	1807,67	2949,81
INT	<i>Bank active interest rate TAEG related to investment procedures</i>	Bad	0,03	0,005068	0,018	0,0366
EMP	<i>Number of employed people per region</i>	Good	1127700	1030316,206	53000	4333000
	Governance					
BUR	<i>Total institutional entities per region</i>	Bad	510	422,3583	97	1798

PDEBT	<i>Non-consolidate debt of public institutions, regional share</i>	Bad	0,07109180	0,045015491	2,61%	17,74%
	System of innovation					
TRANSP	<i>Average value of railway and port equipment over the Italian value of 100</i>	Good	101,82	19,60582	52,2	128,1
R&D	<i>Regional R&D expenses by public, private, non-profit institutions, companies, and universities</i>	Good	1252364800	1437840740	25995000	5087077000
DIGIT	<i>Level of digitalization over an average Italian value of 50</i>	Good	47,57	5,393785	38	56,8
ENE	<i>Gwh of imported energy</i>	Bad	1042,54	7021,3507	-12226,9	16786,1

Normalization and Polarization of the variables

$M_j = \frac{\sum_{i=1}^n x_i}{n}$ is the Simple Mean and $\sigma_j = \sqrt{\frac{\sum_{i=1}^n (x_i - M_j)^2}{n-1}}$ is the standard deviation of the data.

$z_{ij} = \frac{x_{ij} - M_j}{\sigma_j}$ is the standardized value of each observation following the normal distribution $N(0,1)$ and γ being the threshold value corresponding to the 99% confidence level under the curve.

POSITIVE: the higher the raw value the better the effect on the studied phenomenon

So that $x_{j*} = M_j - \gamma\sigma_j$ and $x_j^* = M_j + \gamma\sigma_j$, knowing that x_{j*} - WORST and x_j^* - BEST are the outliers.

$$y_{ij} = \begin{cases} 1 & x_{ij} \geq x_j^* \\ \frac{x_{ij} - x_{j*}}{x_j^* - x_{j*}} & x_{j*} < x_{ij} < x_j^* \\ 0 & x_{ij} \leq x_{j*} \end{cases} \quad y_{ij} = \begin{cases} 1 & z_{ij} \geq \gamma \\ 0.5 + \frac{z_{ij}}{6} & -\gamma < z_{ij} < \gamma \\ 0 & z_{ij} \leq -\gamma \end{cases}$$

Demonstration 1.

$$y_{ij} = \frac{x_{ij} - x_{j*}}{x_j^* - x_{j*}} \rightarrow y_{ij} = \frac{x_{ij} - (M_j - \gamma\sigma_j)}{M_j + \gamma\sigma_j - (M_j - \gamma\sigma_j)} \rightarrow y_{ij} = \frac{x_{ij} - M_j + \gamma\sigma_j}{M_j + \gamma\sigma_j - M_j + \gamma\sigma_j} \rightarrow y_{ij} = \frac{x_{ij} - M_j + \gamma\sigma_j}{2\gamma\sigma_j}$$

$$\rightarrow y_{ij} = \frac{x_{ij} - M_j}{2\gamma\sigma_j} + \frac{\gamma\sigma_j}{2\gamma\sigma_j} \rightarrow y_{ij} = \frac{1}{2\gamma} z + \frac{1}{2}$$

Demonstration 2.

$$1 \rightarrow \begin{aligned} y_{ij} &\geq M_j + \gamma\sigma_j \rightarrow M_j - y_{ij} \leq -\gamma\sigma_j \rightarrow y_{ij} - M_j \geq \gamma\sigma_j \rightarrow \\ \frac{y_{ij} - M_j}{\sigma_j} &\geq \gamma \end{aligned}$$

$$0 \rightarrow \begin{aligned} y_{ij} &\leq M_j - \gamma\sigma_j \rightarrow y_{ij} - M_j \leq -\gamma\sigma_j \rightarrow \frac{y_{ij} - M_j}{\sigma_j} \leq -\gamma \end{aligned}$$

NEGATIVE: the higher the raw value the worse the effect on the studied phenomenon

So that $x_{j*} = M_j + \gamma\sigma_j$ and $x_j^* = M_j - \gamma\sigma_j$, knowing that x_{j*} - WORST and x_j^* - BEST are the outliers.

$$y_{ij} = \begin{cases} 1 & x_{ij} \leq x_j^* \\ \frac{x_{ij} - x_{j*}}{x_j^* - x_{j*}} & x_j^* < x_{ij} < x_{j*} \\ 0 & x_{ij} \geq x_{j*} \end{cases} \quad y_{ij} = \begin{cases} 1 & z_{ij} \leq \gamma \\ 0.5 - \frac{z_{ij}}{6} & -\gamma < z_{ij} < \gamma \\ 0 & z_{ij} \geq -\gamma \end{cases}$$

Demonstration 1.

$$y_{ij} = \frac{x_{ij} - x_{j*}}{x_j^* - x_{j*}} \rightarrow y_{ij} = \frac{x_{ij} - (M_j + \gamma\sigma_j)}{M_j - \gamma\sigma_j - (M_j + \gamma\sigma_j)} \rightarrow y_{ij} = \frac{x_{ij} - M_j - \gamma\sigma_j}{M_j - \gamma\sigma_j - M_j - \gamma\sigma_j} \rightarrow y_{ij} = \frac{x_{ij} - M_j - \gamma\sigma_j}{-2\gamma\sigma_j}$$

$$\rightarrow y_{ij} = \frac{x_{ij} - M_j}{-2\gamma\sigma_j} + \frac{-\gamma\sigma_j}{-2\gamma\sigma_j} \rightarrow y_{ij} = -\frac{1}{2\gamma} z + \frac{1}{2}$$

Demonstration 2.

$$1 \rightarrow \begin{aligned} y_{ij} &\leq M_j - \gamma\sigma_j \rightarrow y_{ij} - M_j \leq -\gamma\sigma_j \rightarrow \frac{y_{ij} - M_j}{\sigma_j} \leq -\gamma \\ y_{ij} &\geq M_j + \gamma\sigma_j \rightarrow M_j - y_{ij} \leq -\gamma\sigma_j \rightarrow y_{ij} - M_j \geq \gamma\sigma_j \rightarrow \\ \frac{y_{ij} - M_j}{\sigma_j} &\geq \gamma \end{aligned}$$

RStudio pseudocodes for the execution of the Composite Indicator

Results f1, Extraction of k-vectors of weight from a uniform distribution.

Pseudocode for the extraction of k vectors from a uniform distribution.

```
f1<-function(k=NULL)
{ r<-matrix(ncol = 15, nrow = k, byrow = T)
j=1
while (j<=k){
  r[j,]<-c(0,sort(runif(13)),1)
  j=j+1 }

return(r)
}
> u<-f1(9604);u
```

Results f2, Normalization of the weights inside each vector.

Pseudocode for the Normalization of the weights

```
f2<-function(u,k=NULL, n=NULL)
{
  rs<-matrix(ncol=n, nrow = k, byrow = T)
  for (j in 1:k) {

    i=1
    while (i<=n) {
      rs[j,i]<- u[j,i+1]-u[j,i]
      i=i+1
    }

  }

  print(rs)
}
> n<-f2(u,9604,14);n
```

Results f3, Creation of the array of data deriving from the dataset containing the variables.

Pseudocode for the creation of the array with the variables.

```
f3<-function(data, n=NULL, k=NULL, m=NULL)
{
  val<-array(dim = c(k,20,n),
             dimnames = list(NULL,c("Valle d'Aosta","Piemonte","Liguria",
                                     "Lombardia","Veneto","Trentino-Alto Adige",
                                     "Friuli-Venezia Giulia","Emilia Romagna","Toscana",
                                     "Marche","Lazio","Umbria","Abruzzo","Molise",
                                     "Puglia","Campania","Basilicata","Calabria",
                                     "Sicilia","Sardegna"),NULL))

  i=1
  while(i<=n){
    val[,i]<-matrix(data[1:20,i], k,m,byrow=T)
    i=i+1
  }
  print(val)
}
> v<-f3(data,14,9604,20);v
```

Result Rank Acceptability Index and Central Weight Factor with the application of smaa package

```
library(smaa)
rank<-smaa(v,n);rank
```

Rank acceptabilities (N = 9604 iterations):

	[,1]	[,2]	[,3]	[,4]	[,5]	[,6]
Valle d'Aosta	0.001665973	0.068617243	0.0704914619	0.0550812162	0.0670553936	0.0818408996
Piemonte	0.000728863	0.006455643	0.0300916285	0.0629945856	0.0820491462	0.1127655144
Liguria	0.001978342	0.003436068	0.0037484382	0.0094752187	0.0160349854	0.0238442316
Lombardia	0.609641816	0.156080800	0.0498750521	0.0317576010	0.0281132861	0.0248854644
Veneto	0.000000000	0.009475219	0.0740316535	0.1020408163	0.1175551853	0.1296334860
Trentino-Alto Adige	0.309558517	0.222407330	0.1397334444	0.0824656393	0.0619533528	0.0609121200
Friuli-Venezia Giulia	0.016972095	0.065910037	0.1236984590	0.1362973761	0.1323406914	0.1470220741
Emilia-Romagna	0.054456476	0.355164515	0.2389629321	0.1021449396	0.0689296127	0.0511245314
Toscana	0.001770096	0.018846314	0.0933985839	0.2592669721	0.2824864640	0.1812786339
Marche	0.000000000	0.000000000	0.0015618492	0.0109329446	0.0136401499	0.0207205331
Lazio	0.001145356	0.086942940	0.1668054977	0.1348396501	0.1063098709	0.1207830071
Umbria	0.000000000	0.000000000	0.0000000000	0.0009371095	0.0023948355	0.0088504790
Abruzzo	0.000000000	0.000000000	0.0000000000	0.0000000000	0.0002082466	0.0005206164
Molise	0.000000000	0.000000000	0.0001041233	0.0005206164	0.0010412328	0.0031236985
Puglia	0.002082466	0.006663890	0.0069762599	0.0092669721	0.0128071637	0.0206164098
Campania	0.000000000	0.000000000	0.0002082466	0.0004164931	0.0022907122	0.0046855477
Basilicata	0.000000000	0.000000000	0.0000000000	0.0005206164	0.0022907122	0.0032278217
Calabria	0.000000000	0.000000000	0.0000000000	0.0005206164	0.0001041233	0.0004164931
Sicilia	0.000000000	0.000000000	0.0000000000	0.0000000000	0.0000000000	0.0000000000
Sardegna	0.000000000	0.000000000	0.0003123698	0.0005206164	0.0023948355	0.0037484382
	[,7]	[,8]	[,9]	[,10]	[,11]	[,12]
Valle d'Aosta	0.0953769263	0.1178675552	0.1754477301	0.1204706372	0.064035818	0.0362349021
Piemonte	0.1418159100	0.1561849229	0.1220324865	0.0669512703	0.051332778	0.0467513536
Liguria	0.0430029155	0.0648688047	0.1179716785	0.1365056227	0.107455227	0.1043315285
Lombardia	0.0213452728	0.0154102457	0.0095793419	0.0086422324	0.006872137	0.0056226572
Veneto	0.1285922532	0.1192211579	0.0795501874	0.0553935860	0.036234902	0.0268638067
Trentino-Alto Adige	0.0633069554	0.0399833403	0.0146813828	0.0034360683	0.001145356	0.0004164931
Friuli-Venezia Giulia	0.1567055394	0.1566014161	0.0487296960	0.0130154102	0.002082466	0.0002082466
Emilia-Romagna	0.0395668471	0.0274885464	0.0148896293	0.0094752187	0.006143274	0.0043731778
Toscana	0.0817367763	0.0371720117	0.0179092045	0.0103082049	0.004685548	0.0034360683
Marche	0.0362349021	0.0578925448	0.1179716785	0.1786755519	0.174822990	0.1729487713
Lazio	0.1152644731	0.0886089130	0.0532069971	0.0321740941	0.021657643	0.0185339442
Umbria	0.0200957934	0.0289462724	0.0773635985	0.1483756768	0.256247397	0.2038733861
Abruzzo	0.0014577259	0.0074968763	0.0094752187	0.0141607663	0.029779259	0.0587255310
Molise	0.0033319450	0.0039566847	0.0064556435	0.0091628488	0.011453561	0.0154102457
Puglia	0.0294668888	0.0394627239	0.0665347772	0.0935027072	0.110683049	0.1345272803
Campania	0.0136401499	0.0257184506	0.0511245314	0.0702832153	0.067367763	0.0820491462
Basilicata	0.0033319450	0.0052061641	0.0066638900	0.0122865473	0.016867972	0.0293627655

Calabria	0.0009371095	0.0008329863	0.0018742191	0.0009371095	0.002394835	0.0023948355
Sicilia	0.0001041233	0.0002082466	0.0009371095	0.0029154519	0.006455643	0.0142648896
Sardegna	0.0046855477	0.0068721366	0.0076009996	0.0133277801	0.022282382	0.0396709704
	[,13]	[,14]	[,15]	[,16]	[,17]	[,18]
Valle d'Aosta	0.0249895877	0.014681383	0.004477301	0.0015618492	0.0001041233	0.0000000000
Piemonte	0.0269679300	0.015514369	0.017700958	0.0170762182	0.0163473553	0.0107246980
Liguria	0.0856934611	0.070074969	0.046543107	0.0384214910	0.0299875052	0.0287380258
Lombardia	0.0043731778	0.005726781	0.006039150	0.0054144107	0.0041649313	0.0031236985
Veneto	0.0240524781	0.018013328	0.016243232	0.0119741774	0.0141607663	0.0118700541
Trentino-Alto Adige	0.0000000000	0.000000000	0.000000000	0.000000000	0.000000000	0.000000000
Friuli-Venezia Giulia	0.0004164931	0.000000000	0.000000000	0.000000000	0.000000000	0.000000000
Emilia-Romagna	0.0052061641	0.004685548	0.003956685	0.0047896710	0.0027072053	0.0030195752
Toscana	0.0024989588	0.002290712	0.000728863	0.0009371095	0.0008329863	0.0004164931
Marche	0.1188046647	0.060807997	0.021032903	0.0089546022	0.0027072053	0.0017700958
Lazio	0.0150978759	0.011349438	0.009995835	0.0100999584	0.0061432736	0.0007288630
Umbria	0.1364014994	0.063202832	0.029050396	0.0150978759	0.0064556435	0.0023948355
Abruzzo	0.1194294044	0.183361100	0.232923782	0.1380674719	0.0871511870	0.0556018326
Molise	0.0251978342	0.039566847	0.058204915	0.1190129113	0.2058517284	0.1801332778
Puglia	0.1756559767	0.157746772	0.077363599	0.0293627655	0.0174927114	0.0065597668
Campania	0.1017284465	0.124219075	0.087671803	0.0699708455	0.0888171595	0.0692419825
Basilicata	0.0494585589	0.080383174	0.148583923	0.2028321533	0.1637859225	0.2012703040
Calabria	0.0020824656	0.004164931	0.006247397	0.0107246980	0.0164514786	0.0522698875
Sicilia	0.0182215743	0.037380258	0.103915035	0.1692003332	0.1637859225	0.2689504373
Sardegna	0.0637234486	0.106830487	0.129321116	0.1465014577	0.1730528946	0.1031861724

	[,19]	[,20]
Valle d'Aosta	0.0000000000	0.0000000000
Piemonte	0.0100999584	0.0054144107
Liguria	0.0364431487	0.0314452312
Lombardia	0.0021865889	0.0011453561
Veneto	0.0115576843	0.0135360267
Trentino-Alto Adige	0.0000000000	0.0000000000
Friuli-Venezia Giulia	0.0000000000	0.0000000000
Emilia-Romagna	0.0026030820	0.0003123698
Toscana	0.0000000000	0.0000000000
Marche	0.0005206164	0.0000000000
Lazio	0.0003123698	0.0000000000
Umbria	0.0003123698	0.0000000000
Abruzzo	0.0523740108	0.0092669721
Molise	0.2962307372	0.0212411495
Puglia	0.0032278217	0.0000000000
Campania	0.1080799667	0.0324864640
Basilicata	0.0704914619	0.0034360683
Calabria	0.1002707205	0.7973760933
Sicilia	0.1848188255	0.0288421491
Sardegna	0.1204706372	0.0554977093

Central weights (N = 9604 iterations):

	[,1]	[,2]	[,3]	[,4]	[,5]	[,6]	[,7]
Valle d'Aosta	0.01546884	0.04198967	0.08165195	0.17589723	0.06375064	0.02652787	0.02949665

Piemonte	0.03845729	0.05325230	0.06277633	0.05850901	0.02836047	0.02741224	0.03505985
Liguria	0.04000165	0.05452280	0.37782091	0.02174576	0.03517324	0.02258428	0.05390306
Lombardia	0.06064231	0.08635803	0.05895348	0.06499264	0.07028859	0.06930522	0.08838815
Veneto	NA	NA	NA	NA	NA	NA	NA
Trentino-Alto Adige	0.10225819	0.04584821	0.09034086	0.09007993	0.07959669	0.07267713	0.04213654
Friuli-Venezia Giulia	0.02644003	0.03777561	0.14032380	0.08792794	0.04031428	0.11841471	0.03021841
Emilia-Romagna	0.03967344	0.05732299	0.04154165	0.02780747	0.05178406	0.10555601	0.04793255
Toscana	0.03887499	0.04799750	0.18187873	0.02010253	0.03929814	0.03374471	0.06920358
Marche	NA	NA	NA	NA	NA	NA	NA
Lazio	0.03249273	0.06764146	0.23372551	0.05373482	0.06171884	0.03739043	0.06174906
Umbria	NA	NA	NA	NA	NA	NA	NA
Abruzzo	NA	NA	NA	NA	NA	NA	NA
Molise	NA	NA	NA	NA	NA	NA	NA
Puglia	0.02825452	0.06310360	0.06039050	0.05190485	0.01663940	0.02247805	0.08725626
Campania	NA	NA	NA	NA	NA	NA	NA
Basilicata	NA	NA	NA	NA	NA	NA	NA
Calabria	NA	NA	NA	NA	NA	NA	NA
Sicilia	NA	NA	NA	NA	NA	NA	NA
Sardegna	NA	NA	NA	NA	NA	NA	NA
	[,8]	[,9]	[,10]	[,11]	[,12]	[,13]	[,14]
Valle d'Aosta	0.05180103	0.29039056	0.06615755	0.04746624	0.04448922	0.02052305	0.04438950
Piemonte	0.04476664	0.01885448	0.02268237	0.20277798	0.07932403	0.04706537	0.28070165
Liguria	0.04721184	0.07249541	0.05183623	0.07233098	0.05376877	0.04880741	0.04779766
Lombardia	0.08766147	0.05235517	0.07203675	0.07343672	0.08645621	0.07283224	0.05629305
Veneto	NA	NA	NA	NA	NA	NA	NA
Trentino-Alto Adige	0.04488219	0.08949845	0.07275733	0.05309544	0.04599447	0.07693904	0.09389552
Friuli-Venezia Giulia	0.04411603	0.10753678	0.06951513	0.16042133	0.03837485	0.04323943	0.05538166
Emilia-Romagna	0.05522744	0.15163384	0.07136737	0.13418739	0.06992370	0.05403919	0.09200290
Toscana	0.06727471	0.14756336	0.04309666	0.14393470	0.06268054	0.04553994	0.05880990
Marche	NA	NA	NA	NA	NA	NA	NA
Lazio	0.03368542	0.10579041	0.00927385	0.07385319	0.14888577	0.04986138	0.03019713
Umbria	NA	NA	NA	NA	NA	NA	NA
Abruzzo	NA	NA	NA	NA	NA	NA	NA
Molise	NA	NA	NA	NA	NA	NA	NA
Puglia	0.04132572	0.08622731	0.05914923	0.06269186	0.04685479	0.02160982	0.35211408
Campania	NA	NA	NA	NA	NA	NA	NA
Basilicata	NA	NA	NA	NA	NA	NA	NA
Calabria	NA	NA	NA	NA	NA	NA	NA
Sicilia	NA	NA	NA	NA	NA	NA	NA
Sardegna	NA	NA	NA	NA	NA	NA	NA

(*)NA Not Available: given that the Central weight is constructed starting from the hypothesis occupying the first position of the rank, in cases where such probability is null, the software does not even provide the assessment of the Central weight Vector.

Real case data

TEXTILE WASTE SEPARATION PRO CAPITE (kg/person) year 2021 - ISPRA (2022)

Valle d'A.	Piemo	Liguria	Lomb	Veneto	Trentino A.G.	Friuli V. Giulia	Emilia R.	Tosca	Marche	Lazio	Umbria	Abruzzo	Molise	Puglia	Campa	Basili	Calab	Sicilia	Sarde
0,0272	0,0305	0,0257	0,0267	0,0293	0,0401	0,0113	0,0305	0,0312	0,0405	0,0243	0,0407	0,0289	0,021	0,0241	0,0269	0,0382	0,01	0,0118	0,0236

VARIABLE	DESCRIPTION	CATEGORY	MEAN	STD	MIN	MAX
Textile waste	<i>Percentage of waste separation, pro person expressed as kg/person; 2021</i>	GOOD	0,027125	0,009030176	0,01	0,0407

New ranking after the introduction of the new variable about textile waste.

The procedure is the same as the previous ranking, the only changing value is the number of variables equal to 15. The number of iterations and the functions used are the same.

Extraction of k-vectors of weight from a uniform distribution.

```
f1<-function(k=NULL)
{ r<-matrix(ncol = 16, nrow = k, byrow = T)
j=1
while (j<=k){
  r[j,]<-c(0,sort(runif(14)),1)
  j=j+1 }

return(r)
}
```

`u<-f1(9604);u`

Normalization of the weights inside each vector

```
f2<-function(u,k=NULL, n=NULL)
{
  rs<-matrix(ncol=n, nrow = k, byrow = T)
  for (j in 1:k) {

    i=1
    while (i<=n) {
      rs[j,i]<- u[j,i+1]-u[j,i]
      i=i+1
    }

  }

  print(rs)
}
n<-f2(u,9604,15);n
```

Creation of the array of data deriving from the customized dataset

```
f3<-function(data, n=NULL, k=NULL, m=NULL)
{
  val<-array(dim = c(k,20,n),
            dimnames = list(NULL,c("Valle d'Aosta","Piemonte","Liguria",
                                   "Lombardia","Veneto","Trentino-Alto Adige",
                                   "Friuli-Venezia Giulia","Emilia Romagna",
                                   "Toscana","Marche",
                                   "Lazio","Umbria","Abruzzo","Molise",
                                   "Puglia","Campania","Basilicata","Calabria",
                                   "Sicilia","Sardegna"),
                            NULL))

  i=1
  while(i<=n){
    val[,i]<-matrix(data[1:20,i], k,m,byrow=T)
    i=i+1
  }
  print(val)
}
v<-f3(data,15,9604,20);v
```

Result Rank Acceptability Index and Central Weight Factor with the application of smaa package

library(smaa)

rank<-smaa(v,n);rank

Rank acceptabilities (N = 9604 iterations):

	[,1]	[,2]	[,3]	[,4]	[,5]	[,6]
Valle d'Aosta	0.0005206164	0.076009996	0.0669512703	0.0512286547	0.0714285714	0.0854852145
Piemonte	0.0008329863	0.008538109	0.0330070804	0.0680966264	0.0948563099	0.1353602666
Liguria	0.0020824656	0.003331945	0.0056226572	0.0106205748	0.0148896293	0.0231153686
Lombardia	0.5520616410	0.192107455	0.0632028322	0.0340483132	0.0282174094	0.0230112453
Veneto	0.0000000000	0.006039150	0.0694502291	0.1007913369	0.1188046647	0.1416076635
Trentino-Alto Adige	0.3904623074	0.246772178	0.1255726781	0.0717409413	0.0487296960	0.0458142441
Friuli-Venezia Giulia	0.0061432736	0.025301958	0.0553935860	0.0712203249	0.0941274469	0.1185964182
Emilia-Romagna	0.0440441483	0.332257393	0.2846730529	0.1013119534	0.0639316951	0.0407122032
Toscana	0.0019783424	0.035714286	0.1238025823	0.3003956685	0.2603082049	0.1403581841
Marche	0.0000000000	0.011141191	0.0216576426	0.0302998751	0.0319658476	0.0518533944
Lazio	0.0008329863	0.052165764	0.1323406914	0.1295293628	0.1283840067	0.1220324865
Umbria	0.0001041233	0.004060808	0.0092669721	0.0155143690	0.0221782591	0.0373802582
Abruzzo	0.0000000000	0.000000000	0.0000000000	0.0000000000	0.0002082466	0.0007288630
Molise	0.0000000000	0.000000000	0.0000000000	0.0001041233	0.0003123698	0.0020824656
Puglia	0.0009371095	0.006559767	0.0084339858	0.0094752187	0.0105164515	0.0169720950
Campania	0.0000000000	0.000000000	0.0001041233	0.0011453561	0.0015618492	0.0032278217
Basilicata	0.0000000000	0.000000000	0.0004164931	0.0039566847	0.0079133694	0.0088504790
Calabria	0.0000000000	0.000000000	0.0000000000	0.0001041233	0.0002082466	0.0002082466
Sicilia	0.0000000000	0.000000000	0.0000000000	0.0000000000	0.0000000000	0.0000000000
Sardegna	0.0000000000	0.000000000	0.0001041233	0.0004164931	0.0014577259	0.0026030820
	[,7]	[,8]	[,9]	[,10]	[,11]	[,12]
Valle d'Aosta	0.0998542274	0.1169304456	0.136089130	0.1048521449	0.080279050	0.0562265723
Piemonte	0.1457725948	0.1174510621	0.090691379	0.0717409413	0.061016243	0.0515410246
Liguria	0.0374843815	0.0519575177	0.084652228	0.0978758850	0.107246980	0.1410870471
Lombardia	0.0210329030	0.0124947938	0.012807164	0.0108288213	0.008017493	0.0083298626
Veneto	0.1429612661	0.0911078717	0.072886297	0.0548729696	0.040816327	0.0308204915
Trentino-Alto Adige	0.0439400250	0.0182215743	0.005310287	0.0018742191	0.001145356	0.0004164931
Friuli-Venezia Giulia	0.1314035818	0.1676384840	0.102144940	0.0660141608	0.053519367	0.0336318201
Emilia-Romagna	0.0338400666	0.0268638067	0.017388588	0.0131195335	0.008538109	0.0069762599
Toscana	0.0657017909	0.0304039983	0.015722616	0.0092669721	0.006351520	0.0035401916
Marche	0.0678883798	0.1059975010	0.150562266	0.1621199500	0.137859225	0.1279675135
Lazio	0.1043315285	0.0798625573	0.061120367	0.0492503124	0.040816327	0.0255102041
Umbria	0.0511245314	0.0866305706	0.131924198	0.1901291129	0.217305289	0.1289046231
Abruzzo	0.0021865889	0.0053102874	0.009579342	0.0153061224	0.029571012	0.0624739692
Molise	0.0032278217	0.0027072053	0.004685548	0.0054144107	0.009162849	0.0105164515
Puglia	0.0243648480	0.0381091212	0.041961683	0.0601832570	0.080070804	0.1266139109
Campania	0.0092669721	0.0314452312	0.034048313	0.0467513536	0.057163682	0.0899625156
Basilicata	0.0119741774	0.0129112870	0.020304040	0.0296751354	0.042690546	0.0646605581
Calabria	0.0005206164	0.0003123698	0.000728863	0.0005206164	0.001249479	0.0014577259
Sicilia	0.0001041233	0.0000000000	0.000000000	0.0004164931	0.001041233	0.0034360683
Sardegna	0.0030195752	0.0036443149	0.007392753	0.0097875885	0.016139109	0.0259266972
	[,13]	[,14]	[,15]	[,16]	[,17]	[,18]
Valle d'Aosta	0.031341108	0.017076218	0.0038525614	0.0017700958	0.0001041233	0.0000000000

Piemonte	0.029362766	0.023323615	0.0183256976	0.0167638484	0.0162432320	0.0074968763
Liguria	0.103915035	0.086109954	0.0542482299	0.0515410246	0.0398792170	0.0318617243
Lombardia	0.004685548	0.004581424	0.0061432736	0.0066638900	0.0041649313	0.0034360683
Veneto	0.024468971	0.021241150	0.0161391087	0.0158267389	0.0177009579	0.0117659309
Trentino-Alto Adige	0.000000000	0.000000000	0.0000000000	0.0000000000	0.0000000000	0.0000000000
Friuli-Venezia Giulia	0.022282382	0.016763848	0.0132236568	0.0141607663	0.0058309038	0.0024989588
Emilia-Romagna	0.006559767	0.005206164	0.0055185339	0.0029154519	0.0018742191	0.0026030820
Toscana	0.002498959	0.001978342	0.0008329863	0.0005206164	0.0004164931	0.0002082466
Marche	0.063306955	0.026447314	0.0069762599	0.0019783424	0.0011453561	0.0008329863
Lazio	0.023219492	0.016034985	0.0163473553	0.0118700541	0.0054144107	0.0008329863
Umbria	0.065181175	0.025718451	0.0094752187	0.0033319450	0.0014577259	0.0003123698
Abruzzo	0.137546855	0.201062057	0.2404206581	0.1422324032	0.0841316118	0.0416493128
Molise	0.016659725	0.030508122	0.0498750521	0.0989171179	0.2372969596	0.2515618492
Puglia	0.191170346	0.177426072	0.1185964182	0.0561224490	0.0231153686	0.0074968763
Campania	0.120678884	0.118388172	0.0996459808	0.0940233236	0.1114119117	0.0860058309
Basilicata	0.095793419	0.128592253	0.1706580591	0.1988754686	0.0962099125	0.0844439817
Calabria	0.001457726	0.002811329	0.0032278217	0.0055185339	0.0115576843	0.0324864640
Sicilia	0.006351520	0.011453561	0.0440441483	0.1022490629	0.1207830071	0.2890462307
Sardegna	0.053519367	0.085276968	0.1224489796	0.1747188671	0.2212619742	0.1454602249

[,19] [,20]

Valle d'Aosta	0.0000000000	0.0000000000
Piemonte	0.0060391504	0.0035401916
Liguria	0.0315493544	0.0209287797
Lombardia	0.0020824656	0.0020824656
Veneto	0.0104123282	0.0122865473
Trentino-Alto Adige	0.0000000000	0.0000000000
Friuli-Venezia Giulia	0.0001041233	0.0000000000
Emilia-Romagna	0.0015618492	0.0001041233
Toscana	0.0000000000	0.0000000000
Marche	0.0000000000	0.0000000000
Lazio	0.0001041233	0.0000000000
Umbria	0.0000000000	0.0000000000
Abruzzo	0.0249895877	0.0026030820
Molise	0.2644731362	0.0124947938
Puglia	0.0018742191	0.0000000000
Campania	0.0779883382	0.0171803415
Basilicata	0.0215535194	0.0005206164
Calabria	0.0769471054	0.8606830487
Sicilia	0.3811953353	0.0398792170
Sardegna	0.0991253644	0.0276967930

Central weights (N = 9604 iterations):

	[,1]	[,2]	[,3]	[,4]	[,5]	[,6]	[,7]
Valle d'Aosta	0.025889965	0.03052372	0.02824350	0.09636168	0.04651421	3.076545e-02	0.02816549
Piemonte	0.016048090	0.05477625	0.02094287	0.04746164	0.02004522	3.774602e-02	0.07133826
Liguria	0.024733109	0.04749538	0.35263577	0.01761423	0.03811894	2.469686e-02	0.05170706
Lombardia	0.055784370	0.08146584	0.05631467	0.06047516	0.06628091	6.400468e-02	0.08660048
Veneto	NA	NA	NA	NA	NA	NA	NA

Trentino-Alto Adige	0.087708059	0.04535487	0.08469940	0.08210337	0.06940627	6.569883e-02	0.04174258
Friuli-Venezia Giulia	0.024546410	0.03745611	0.16012809	0.07882359	0.03208211	1.004524e-01	0.03427387
Emilia-Romagna	0.037035700	0.05764494	0.04144116	0.02698772	0.04747801	9.683456e-02	0.04150689
Toscana	0.026571427	0.05650017	0.20197813	0.01352117	0.03203937	5.259346e-02	0.07810101
Marche	NA	NA	NA	NA	NA	NA	NA
Lazio	0.022309472	0.11977183	0.14038171	0.04625587	0.04710330	3.299212e-02	0.05292188
Umbria	0.005930607	0.15973493	0.01329416	0.03873918	0.02551107	6.759632e-05	0.05416338
Abruzzo	NA	NA	NA	NA	NA	NA	NA
Molise	NA	NA	NA	NA	NA	NA	NA
Puglia	0.015894059	0.05151311	0.07002855	0.04423333	0.02255299	2.589247e-02	0.07873648
Campania	NA	NA	NA	NA	NA	NA	NA
Basilicata	NA	NA	NA	NA	NA	NA	NA
Calabria	NA	NA	NA	NA	NA	NA	NA
Sicilia	NA	NA	NA	NA	NA	NA	NA
Sardegna	NA	NA	NA	NA	NA	NA	NA

	[,8]	[,9]	[,10]	[,11]	[,12]	[,13]	[,14]
Valle d'Aosta	0.043045912	0.42712662	0.03046278	0.08150641	0.02981772	0.01580004	0.0726164578
Piemonte	0.095720404	0.01829189	0.01844269	0.09157167	0.05000927	0.02525884	0.3287368343
Liguria	0.040649957	0.07125544	0.03848674	0.10803245	0.04146734	0.04589415	0.0623321182
Lombardia	0.084486976	0.04871221	0.06681875	0.06800596	0.08175384	0.06731249	0.0522123052
Veneto	NA	NA	NA	NA	NA	NA	NA
Trentino-Alto Adige	0.044508703	0.08038262	0.06654672	0.05155848	0.04584822	0.06964608	0.0857517251
Friuli-Venezia Giulia	0.045048735	0.10174221	0.07226627	0.17834982	0.03874255	0.03671139	0.0422506377
Emilia-Romagna	0.053233834	0.13547446	0.07136255	0.14076489	0.06556496	0.04878371	0.0762050997
Toscana	0.068510457	0.12962064	0.05115909	0.11125768	0.05196777	0.02534666	0.0540419396
Marche	NA	NA	NA	NA	NA	NA	NA
Lazio	0.016297225	0.19282343	0.01046698	0.08027609	0.14591391	0.03419264	0.0315497592
Umbria	0.006408596	0.41211615	0.01527005	0.01312169	0.02829428	0.05629211	0.0004728213
Abruzzo	NA	NA	NA	NA	NA	NA	NA
Molise	NA	NA	NA	NA	NA	NA	NA
Puglia	0.076448291	0.08890868	0.05101557	0.04705847	0.04739321	0.02483753	0.3343408022
Campania	NA	NA	NA	NA	NA	NA	NA
Basilicata	NA	NA	NA	NA	NA	NA	NA
Calabria	NA	NA	NA	NA	NA	NA	NA
Sicilia	NA	NA	NA	NA	NA	NA	NA
Sardegna	NA	NA	NA	NA	NA	NA	NA

	[,15]
Valle d'Aosta	0.01316005
Piemonte	0.10361005
Liguria	0.03488045
Lombardia	0.05977134
Veneto	NA
Trentino-Alto Adige	0.07904407
Friuli-Venezia Giulia	0.01712584
Emilia-Romagna	0.05968152
Toscana	0.04679102
Marche	NA
Lazio	0.02674379

Umbria	0.17058338
Abruzzo	NA
Molise	NA
Puglia	0.02114646
Campania	NA
Basilicata	NA
Calabria	NA
Sicilia	NA
Sardegna	NA

(*)NA Not Available: given that the Central weight is constructed starting from the hypothesis occupying the first position of the rank, in cases where such probability is null, the software does not even provide the assessment of the Central weight Vector