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"Productivity Dynamics and Business Networks"

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Abstract

Many economic studies have shown that Italy has essentially given up on growth since the 1990s, both in terms of Real GDP development and in terms of Total Factor Productivity (TFP). The main objective of this thesis is to verify which variables have mostly contributed to the lack of growth (in some cases to the decrease) of the Italian aggregate productivity during the last decade. In particular, Section 1 serves as an introductory chapter to the topics covered within this work; Section 2 is dedicated to a Literature Review focused on a series of works which study the relationship among productivity, innovation and company dimension. Subsequently, within Section 2 two multiple linear regression models and two vector autoregressive analyses are included, the purpose of which is to identify what are the best predictors of Total Factor Productivity (TFP) at the European level. Section 3, on the other hand, abandons the previously-adopted "International" approach and focuses on explaining intra-sectoral and inter-sectoral differences within Italy, through the use of two multiple linear regression models. After analysing the problems that have prevented and still prevent Italy from reaching acceptable economic development, Section 4 proposes a partial solution to the aforementioned issues. In particular, the role of a specific type of contract (the "Network contract") in the growth of Italian SMEs is discussed. Furthermore, Section 4 is dedicated to a Literature Review concerning the role that business networks play in the promotion of more sustainable and innovative production practices. Finally, Section 5 represents the concluding chapter of this thesis.

Section 1

1.1 Introduction to Growth and Development Dynamics in Italy

In 2015, through the subscription of the 2030 Agenda, 193 United Nations Member States declared their formal commitment towards the accomplishment of seventeen Sustainable Development Goals, also known as "SDGs". This list of objectives regards relevant issues, whose resolution can deeply influence socio-economic dynamics throughout the globe. Essentially, the aforementioned SDGs were defined in order to establish common goals among Governments and enhance socio-economic development at a global level. Among many, we can find references to the fight against hunger and poverty, promotion of lasting economic growth, industrial and infrastructural innovation, equality and responsible production (Istat, 2022b). In this scenario, the European Union and its Member States, including Italy, have immediately proposed themselves as trailblazers in the promotion of these goals, but, if we decide to focus on the sole Italian situation, this country managed to demonstrate some degree of commitment only in part.

With the aim of introducing the main theme of this thesis, it is of remarkable interest to start the analysis on the conclusions highlighted in the 2022 SGD report[1] produced by Istat[2] and, more specifically, to dwell on the chapters concerning "Sustainable growth", "Industry" and "Innovation". Such contents, central to this thesis, are included in the chapters dedicated to the eighth and ninth goal (Istat, 2022b):

More specifically, SDG № 8 concerns two major issues, such as "Decent work" and "Sustained growth". The purpose of monitoring the long-term evolution of such variables is to obtain information about the promotion of sustained, inclusive and sustainable economic growth, productive employment and decent working conditions for Italian citizens (Istat, 2022b). In order to measure the degree of the accomplishments relating to this eighth strategic objective, Istat developed 28 statistical measures. Results show that, since 2012, Italy has recorded improvements just for less than half (46%) of these indicators

[1] The original name of this document is "Rapporto SDGs 2022".
[2] The Italian National Institute of Statistics.

(Istat, 2022b). Similar conclusions also concern SDG № 9, formally dedicated to “Industry, Innovation and Infrastructures”. In this case, Istat produced 27 measures in order to estimate how the Italian economy has enhanced the establishment of resilient infrastructure, promoted inclusive and sustainable industrialisation and fostered innovation throughout its economic mechanism. Even though only two indicators accounted for a certain deterioration, only half of the 27 measures recorded an improvement within the last decade (Istat, 2022b). On the basis of the mentioned data, at a first glance, it is immediately possible to perceive how the overall Italian production system struggled to achieve both acceptable sustained growth and economic development through the last ten years.

If the analysis is extended to the last three decades, also within this timeframe Italy has demonstrated to been unable to exploit its growth potentials, due to some chronic inefficiencies. Several economic studies have concurred to confirm that Italian productivity growth has suffered from a long-lasting stagnation since the second half of the 1990s, especially if compared to the main European economies (Hall et al., 2008; Bugamelli et al., 2018). Productivity, sustainable growth and development are three interconnected themes and, as evidenced by Calligaris et al. (2016), efficiency dynamics have a relevant and direct impact both on the long-term growth of a country and on its productive apparatus. Moreover, aggregate productive efficiency represents one of the main drivers of sustainable development (Sapir et al., 2003). In addition, the establishment of a growth process that is based on the improvements and the exploitation of the way production factors are used, results to be considerably more sustainable than the mere accumulation of primary inputs (Sapir et al., 2003). Essentially, for a nation, being characterised by the presence of efficient industries is a fundamental prerequisite for achieving economic development in the long term.

Taking into account the Italian historical standards, the lack of productivity improvements (characterising the last thirty years) has led this country to its worst performances since the 1970s (Banca d’Italia, 2016). In the same period, Italy has experienced a significant deviation from the efficiency standards of the main euro-area economies (Banca d’Italia, 2016).

The progressive deterioration of the Italian productive system is a topic as relevant as it is complex to deal with: the elevated complexity of this subject is given by the fact that it is influenced by both exogenous and endogenous factors, such as international economic shocks, State failures, regulatory reforms and technological changes. The kind of effects that are generated by such factors are considerably complicated to evaluate. For this reason, it is preferable to focus on the sole structural elements that characterise the Italian productive fabric.

Therefore, the approach of this thesis is based on two levels: a prior observation of the phenomena that occur at the macroeconomic level, and a subsequent attempt to understand the causes that lead Italian companies to adopt certain decisions, which necessarily impact the economy on a larger scale. Through this perspective, the interpretation of aggregate productivity trends can serve as a starting point for acquiring awareness of the Italian entrepreneurial dynamics.

Considering the relevance and the intricacy of the presented subject, the purpose of this thesis is to investigate what are the variables that contributed to the flattening of Italian productivity growth during the last decades and to provide some policy solutions to this issue.

The opportunity to examine the relationship between productivity and the aforementioned explanatory variables results to be engaging and formative, as it allows to comprehend and prove once again how decisions of single and isolated agents contribute to the creation of aggregate phenomena which deeply affect socio-economic development.

1.2 Structure of the Thesis

The remainder of this first introductive Section is dedicated to a presentation concerning the main productivity indicator that has been chosen as a reference point throughout the thesis. Later on, in Subsection 1.4 it is presented which timeframe is taken into consideration through the statistical regression analyses that are carried out in the following Sections[3]. The rest of the thesis is organised as follows: in Section 2 it is presented a Literature Review concerning the relationship between productivity, innovation and firm characteristics, together with a subsequent comparison between productivity trends in Italy and other European countries. Through this second Section it is also investigated the connection between western countries' aggregate productivity and their relative propensity to innovate and invest in research. Therefore, it is verified whether empirical data confirm the intuition according to which the more an economy is characterised by an innovative production system and large-sized companies, the more it is able to generate efficiency improvements and competitive advantages for its enterprises. Finally, Subsection 2 presents two linear regression analyses, whose aim is individuating the most significant productivity drivers among six European economies and verifying whether country-specific aggregate productivity varies as the share of a given category[4] of enterprises changes.

As the previous one, also Section 3 includes two different OLS multiple linear regression models: the first one investigates the relationship between the sole Italian productivity drivers, through an analysis on ten different economic sectors. On the other hand, the second model of this Section is dedicated to a study on productivity dynamics within the sole Italian manufacturing sector. Even within this third Subsection, it is verified whether innovation intensity and business dimension are significant productivity predictors.

In Section 4, it is analysed the nexus between companies' efficiency and their propensity to establish network contracts. Through this fourth Section, the aim of the analysis is dual:

[3] See Subsection 2.7, 2.8, 3.2 and 3.3.

[4] Through the whole thesis, firms are categorised in four different groups: micro-enterprises (those business which employ less than 10 people), small firms (which employ 10 to 49 people), medium-sized firms (which employ 50 to 249 people) and large enterprises (which employ more than 250 people).

on the one hand, it is observed whether sectoral innovation and efficiency are positively associated with the presence of network contracts[5] within a given industry. On the other hand, it is questioned what role the Italian Government played in the promotion of this instrument. In particular, Subsection 4.2 examines the normative actions of the legislator in support of business networks since 2010[6] and the subsequent distribution of such contractual form. In addition, Subsection 4.3 investigates whether networks' distribution within the Italian territories/industries is heterogeneous or if, on the contrary, the location of the networking contracts presents concentrations in specific economic areas. Finally, the last Subsections[7] of Section 4 are dedicated to a qualitative-quantitative analysis which aims at demonstrating how collaboration and cooperation mechanisms among companies can be crucial in order to overcome economic difficulties, to establish innovative virtuous circles and to promote responsible and sustainable production techniques.

Finally, Section 5 is the conclusive segment of this thesis, as it summarises the main findings obtained in the previous analyses. It also contains some suggestions for future studies and provides some policy implications.

[5] This contractual form, which allows businesses to formalise their horizontal integration, was introduced in the Italian legal system in 2009 and is known as "Contratti di rete".
[6] 2010 is the year in which network contracts officially entered into force.
[7] See Subsection 4.4, 4.5, 4.6 and 4.7.

1.3 Productivity Indicator

Before analysing the drivers of productivity and its eventual explicative variables, it is necessary to disclose which kind of productivity indicator has been chosen as a reference point throughout this thesis:

The overall economic academic literature has produced a multitude of statistical measures, both to calculate the efficiency of a production process, and to estimate the level of proficiency in the exploitation of single primary inputs (Schreyer P., 2001). On the one hand, economists generally agree on the common notion of productivity, defined as a ratio between a volume measure of output and a volume measure of input. On the other hand, it has been deeply debated about what is the general purpose of a productivity index and what is its adequate unit of measure (Schreyer P., 2001). The generated indicators differ from each other due to their measurement purpose, since some provide information about the technical change, while others are more focused on real cost savings, rather than living standards.

Given the wide range of choices, the main reference indicator that has been chosen for this work is "Capital-Labour Total Factor Productivity based on value-added". This measure, also known as Total Factor Productivity[8], embodies an interesting tool to make use of, in order to operate comparisons among different national accounts, industries and historical series (Schreyer P., 2001). It estimates the overall efficiency through which the primary inputs are employed in a production system and shows the ability of economic sectors to contribute to the economy-wide variation of income per unit of input.

Capital-Labour Total Factor Productivity based on value-added significantly differs from KLEMS Multifactor Productivity, since the first one does not include intermediate goods[9] in the components of input measures (Schreyer P., 2001; Istat, 2011). This characteristic allows TFP to only incorporate both capital and labour's conjoint effect on the variation of

[8] From now on the terms "Total Factor Productivity", "TFP", "Multi Factor Productivity", "MFP" and "Efficiency" are used as synonyms.

[9] Such as energy, materials and services.

value-added in a specified economic sector/territory/country (Schreyer P., 2001; Istat, 2011).

TFP is generally expressed as a ratio, in which the aggregate value-added represents the numerator, while the denominator is a combination of capital and labour indexes. For any economy, aggregate TFP is obtained as a weighted average of each firm's TFP that is located within its national boundaries (Istat, 2011; Schreyer P., 2001). Aggregate TFP depends on the behaviours of individual companies in a certain territory along two dimensions: on the one hand, national TFP grows when individual firms innovate and develop new ways to perform business practices in a more efficient way. Therefore, if corporations are unable to take advantage of technological opportunities, the whole economy's productive apparatus is destined to be exposed to obsolescence and senescence, with a consequent negative impact on aggregate productivity (Calligaris et al.,2016). On the other hand, every time economic or financial frictions affect the markets of productive factors, national TFP relies on the way those factors are allocated across firms. The relationship between aggregate TFP and misallocation of productive factors is clearly negative, as the latter phenomenon pushes the flow of productive factors from competitive firms towards less efficient ones. (Istat, 2011; Calligaris et al.,2016; Schreyer P.,2001).

The Italian Total Factor Productivity measures are annually presented by Istat, as a performance indicator of the national economy. Specifically, "Istat Productivity Reports" and "Istat National Accounts" exhibit the general trend in the efficiency of the productive system "As a whole" and, more in detail, quantify the relative TFP of each industry that falls into the "Ateco a due cifre" categorisation. In summary, two of the main advantages of this indicator are both its ease of aggregation and de-aggregation among different sectors, as well as the production of a simple conceptual link of industry-level TFP and aggregate TFP growth (Istat, 2011).

1.4 Adopted Timeframe

A further and dutiful anticipation to be made, regards the time horizon that has been chosen in order to run the quantitative analyses contained in Section 2 and 3:

One of the most relevant concerns of this thesis was trying to isolate the composition of the variables under study from the macroeconomic distortions created after 2020. It seems almost redundant to underline how the global value chains have been influenced in the first place by COVID-19 pandemic, and then by both the inflationary spiral and the outbreak of the war in Ukraine. Evidently, these macroeconomic shocks involved and are still affecting the majority of the developed economies. For this reason, the quantitative analyses of this study do not go beyond 2019 and exclude all the data related to the 2020-2023 period.

Unfortunately, this choice precludes the possibility to study extremely updated datasets. Anyways, the adopted time horizon represents a quite fair compromise between the willingness to make use of novel data and the need to rely on less biassed information. Certainly, in the coming years it is going to be crucial to study the impact of the aforementioned macroeconomic shocks on the aggregate productivity, and, more generally, on the performance of European companies. Unfortunately, that is not the aim of this study, especially if we consider the fact that the long-term effects of the pandemic and the war in Eastern Europe have not yet finished impacting the Italian, as well as the global economic system.

The only derogation to the aforementioned decision is represented by the Counterfactual Analysis included in Subsection 4.7. In fact, the main objective of this Subsection is quantifying how the use of a specific contractual tool (the network contract) has helped Italian companies to overcome the negative impacts of the pandemic during 2020 and, subsequently, how this tool has been useful for accelerating the economic recovery of the same organisations during 2021. Therefore, in order to achieve this preset objective, the information inevitably influenced by the macroeconomic dynamics listed above are deliberately used within the sole Subsection 4.7.

Section 2

2.1 Historical Inefficiencies in the Italian Context

As demonstrated by Bugemelli et al. (2018), since 1995 the Italian economy has been affected by slow growth, stagnant efficiency levels and poor improvements in terms of labour productivity. Obviously, the aggregate productivity decline is not an issue that has only concerned Italy, but has spread throughout Europe. However, it is of considerable importance to underline that such negative trend has not affect the European continent in a homogeneous way[10]. Instead, the Italian situation considerably differs from the other major European economies, such as France, Germany and the United Kingdom. As a matter of fact, differently from the aforesaid countries, Italian aggregate TFP did not give any contribution to the national economic development, while labour productivity had an even negative impact on GDP growth. Basically, the structural economic underdevelopment characterising Italy has been merely sustained by the expansion of employment, buoyed by the immigration, which more than offset the ageing of the population (Banca d'Italia, 2016; Bugamelli et al., 2018). Moreover, the technological improvements and efficiency improvements in Italy are still unable to represent a significant driver for GDP growth due to their reduced volume.

In addition to the aforementioned criticalities, since the second half of the 1990s Italy has suffered from an evident productivity gap compared to the other European economies. Such a discrepancy has concerned both the period before and the one following the 2008 financial crisis (Bugamelli et al., 2018). Even from this point of view, the negative performance of Italy represents an exception in the European context, as in the same period, the other major European economies successfully managed to maintain a constant level of TFP growth (in the case of Germany) or limit its slowdown (in the case of France) (Accetturo et al., 2013, Accetturo et al., 2022, Bobbio, 2016 and Calligaris et al., 2016). As it can be noticed in **Figure 1**, from 1995 to 2019 Italy has recorded the worst performance in terms of average annual TFP variation among the most relevant and developed

[10] With regards to the different European performances in terms of Total Factor Productivity growth, **Figure 1** provides a very clear representation on the different European trends.

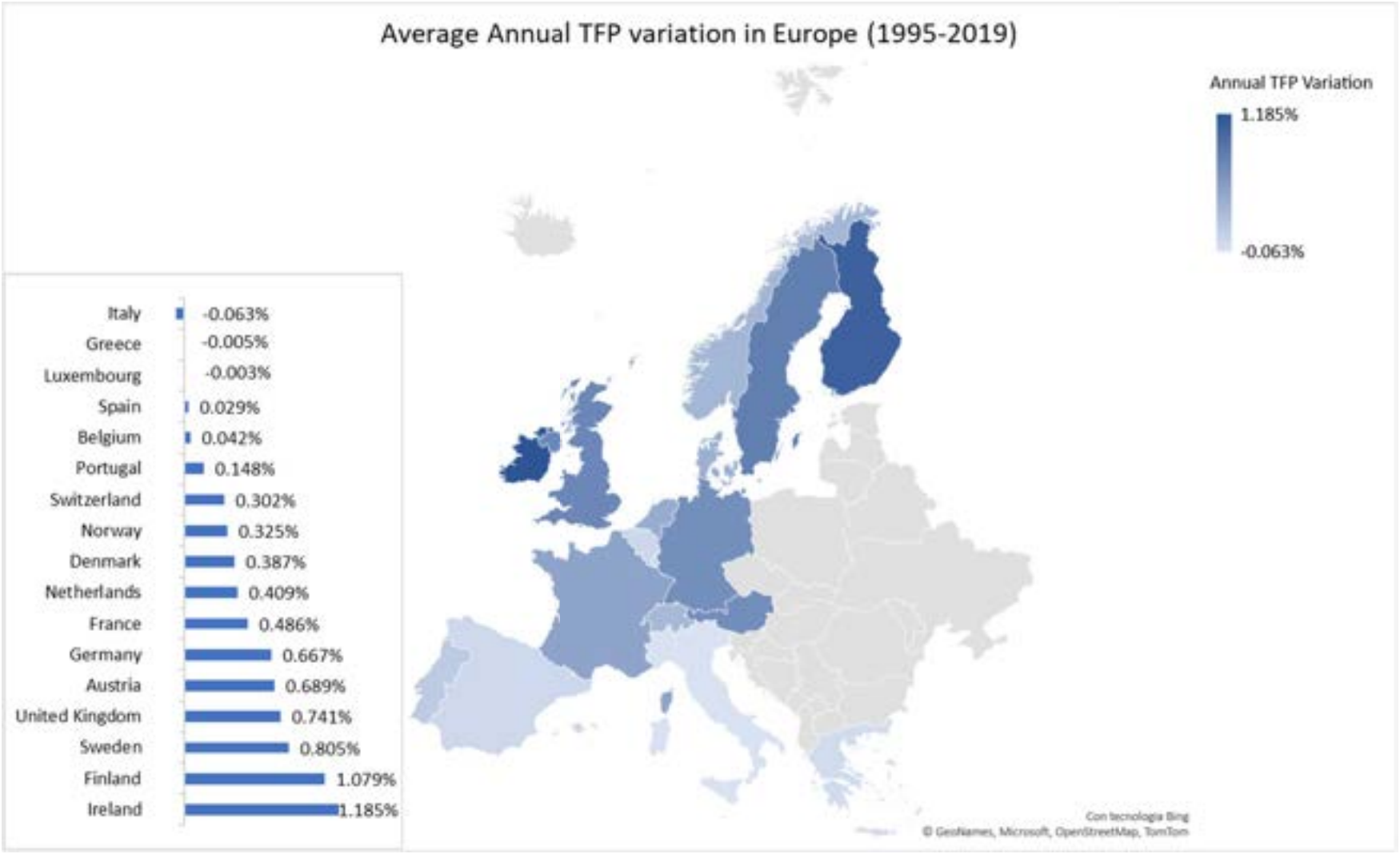
economies within Europe. In particular, during this timeframe, Italy[11], Greece[12] and Luxembourg[13] have been the only economies to report a yearly productivity deterioration. The seriousness of the Italian problem emerges vehemently, especially if these negative performances are compared with TFP growth rates of the Republic of Ireland (+1.185%), Finland (+1.079%), Sweden (+0.805%), the United Kingdom (+0.741%) and Germany (+0.667%).

Proceeding with this productivity review, also from a labour productivity perspective, Italy has been characterised by relatively poor performances. As a matter of fact, since 1995 both French and German labour productivity has recorded growth rates three times higher than the ones of Italy. In general, it seems quite evident that the Italian trajectory deeply diverges from the overall European growth path. In fact, since 1995 the EU27 has registered a +1.5% increase in terms of labour productivity variations, while the Italian progresses have been almost four times lower[14] (Istat, 2022a).

In conclusion, the Italian efficiency gap can be alternatively observed in terms of value-added growth. Even by adopting this perspective, the Italian situation is characterised by remarkable criticalities. In fact, from 1995 to 2021, the average annual growth of Italian value-added has been about +0.6%, a remarkably lower figure than the average +1.7% increase registered by the totality of all 27 European economies (Istat, 2022a).

[11] With an average variation equal to -0.063%.
[12] With an average variation equal to -0.005%.
[13] With an average variation of -0.003%.
[14] During the 1995-2021 period, aggregate labour productivity in Italy only increased by +0.4% (Istat, 2022b).

Figure 1) Total Factor Productivity in Europe



Source: Author's elaboration of OECD data

2.2 Literature Review: Productivity and Business Dimension

Bugamelli et al. (2018) and Calvino et al. (2022), hypothesise that the historical productivity lag which has prevented Italy from keeping-up with the major European economies, is actually originated by a deep fragmentation of the Italian productive system. In particular, the presence of averagely unproductive microenterprises[15] and the simultaneous absence of an adequate number of medium-large efficient firms is one of the main drivers of the TFP slowdown affecting the Italian economy (Banca d'Italia, 2016; Bugamelli et al., 2018; Calvino et al., 2022). Microenterprises represent about 95% of the overall active firms within the Italian territory, while the aggregate value-added generated by these entities is 29% of the total (Bugamelli et al., 2018). As demonstrated by Calvino et al. (2022), Italian microenterprises exhibit lower efficiency standards than their European counterparts. At the same time, highly productive medium-large companies in Italy are less present and exhibit a more reduced size than the frontier firms located in developed European economies (Calvino et al., 2022). Moreover, Calligaris et al. (2016), through an analysis on the performance of Italian companies between 1995 and 2011, confirm that small-sized companies exhibit a clear correlation with productive inefficiencies in both manufacturing and non-manufacturing sectors, whereas big companies are characterised by a positive performance regardless of the sector they are specialised in.

On the basis of the evidence provided within the works just cited, two remarkable stylised facts emerge: the first one concerns the existence of a positive relationship between a company's productivity level and the number of its employees. On the other hand, the second stylised fact indicates that the efficiency lag of Italy can be explained by the fact that its productive fabric, compared to the major European economies, is affected by a more widespread presence of unproductive microenterprises. In order to better clarify the first conclusion, it must be necessarily emphasised that the positive relationship between

[15] Throughout this whole thesis, the term "Microenterprises" refers to those companies whose number of employees oscillates between 1 and 9. At the same time, "Small-sized" businesses are those formed by 10-49 employees, "Medium-sized" firms are those employing 50-249 people and "Large-sized" companies are those with more than 250 employees.

business size and productivity is not a rule that only applies to Italian enterprises. Instead, as reported in the following lines, it is generally valid for any developed economic system.

Corroborating what was just mentioned, Bartelsman et al. (2013) provide a study on the productive apparatus of the United States, the United Kingdom, France, Germany, Romania, Slovenia, Netherlands and Hungary, and find that the highly-productive firms in such territories are more likely to be larger than the less efficient ones. Moreover, Guner et al. (2008) suggest that firm-level policies aimed at increasing business dimension, can be considerably advantageous. In fact, such economic measures can generate positive spill-over effects for the whole economy, as they can both impact the aggregate economic output's growth and enhance positive variations of the long-term TFP. However, the effects of the described policies remain contradictory in case they are applied to developing economies (Guner et al., 2008). In addition, Barba Navaretti et al. (2010), after performing a productivity decomposition analysis, conclude that the discrepancy in the aggregate efficiency levels and export performances between German and Italian enterprises can be explained by their different average size, alluding to the fact that the German production chain is characterised by a lower share of microenterprises and by a more pervasive presence of larger firms with respect to the Italian one. Furthermore, according to Cardinali et al. (2016), business dimension represents a proxy for the volume of resources which a company is capable of investing with the objective to innovate, to adopt new technologies and to improve its efficiency standards. In this sense, a limited volume of available human capital prevents businesses from the achievement of sustained growth. Finally, Bugamelli et al. (2018) show that the difference between the Italian and German efficiency standards can be explained by the fact that, within Italy the productivity level in large firms more than doubles the one of microenterprises. On the other hand, the productivity gap between small and large firms in Germany is just 48%. This implies that, for a simple composition effect, the aggregate Italian productivity growth is hampered by the predominance of microenterprises.

In a complementary way, Bripi et al. (2022) underline that the productivity differences between Italy and the major European economies can be attributed to the territorial/sectoral heterogeneity within the Italian productive apparatus. The cited

economic paper concludes that the Italian efficiency stagnation is originated by a growing gap[16] between the TFP growth rates in Southern and Centre-North regions. Moreover, through the last two decades, Southern regions have been affected by a pronounced deindustrialisation, a pervasive reallocation of human resources towards less knowledge-intensive industries (also demonstrated by Accetturo et al., 2022), and a collapse in the quantity of structural investments. Simultaneously, Central and Northern regions have been less affected by such trends and managed to redirect the employment growth towards knowledge-intensive sectors and larger firms, allowing businesses to recover their international competitiveness (Accetturo, 2022; Bripi et al., 2022). The aforementioned dynamics have ended up accentuating the differences among regions and created a separation of the Italian productive system into two very different realities: Northern and Central regions are able to benefit from economic and productivity improvements, while Southern territories continue to experience a long-lasting efficiency deterioration (Bripi et al., 2022; Calligaris et al., 2016). In conclusion, the fragmentation of the Italian productive system and the excessive presence of unproductive microenterprises, seem to prevent the country from a uniform and sustainable development path.

[16] The highlighted discrepancy between Centre-North and Southern regions has been even accentuated by the 2008 financial crisis (Bripi et al., 2022).

2.3 Literature Review: Innovation and Productivity

Before proceeding with the Literature Review, it must be emphasised that business size is not the only driver of productivity. Actually, the efficiency deterioration within Italy can be explained by many other indicators. One of these potential explanatory variables are innovation intensity, Research and Development expenditures[17] and, in general, innovative activities. Therefore, through the following lines, it is presented a considerable number of economic papers which emphasise the influence of innovative activities on productivity growth:

In this regard, Lichtenberg and Siegel (1991) individuate a significant positive correlation between R&D expenditures and productivity improvements through an analysis on firms located in the United States. Similarly, Harhoff D. (1998) and Bönte W. (2003) observe a positive relationship between R&D intensity and the efficiency level of German companies. In the case of France, Hall and Mairesse (1995) highlight the same kind of relationship among manufacturing firms in the 1980s. In addition, Parisi et al. (2006) conclude that, also in Italy, non-innovating enterprises exhibit relatively lower improvements in terms of TFP growth, especially if compared to innovative firms. More recently, Accetturo et al. (2013) and Banca d'Italia (2016) find a positive correlation between R&D expenditures and productivity in Italy. Similar results are obtained by Guellec and Van Pottelsberghe de la Potterie (2001) who base their analysis on OECD data, while Klette and Johansen (1996) show the presence of a positive relationship between productivity and innovation.

Anyways, it must not be omitted the existence of some researches which are partially in contrast with the aforementioned results. In fact, Klette and Kortum (2004), though evidencing a positive relationship between R&D expenditures and firm-level productivity, also discover that R&D investments are characterised by decreasing returns. Under a different perspective Bugamelli et al. (2012), Crèpon et al. (1998), Hall et al. (2009) and Kleinknecht A. (1987) find that R&D expenditures are not a good proxy for measuring the

[17] From now on "Research and Development expenditures/activities/investments" are referred to as "R&D expenditures/activities/investments".

overall innovative efforts of small and medium enterprises[18]. In particular, these last four studies conclude that SMEs' innovation intensity cannot be entirely captured by R&D investments, since, on average, small firms make great use of informal channels for obtaining technological and organisational development. Such alternative channels involve collaborations with external entities, knowledge management activities and exploitation of positive externalities originated by the external environment. Essentially, the use of R&D expenditures as an indicator of the innovating capacity of SMEs may lead to an underestimation of the innovative effort in official statistics, especially in those sectors that are dominated by the presence of micro, small and medium-sized enterprises (Bugamelli et al., 2012, Crèpon et al., 1998, Hall et al., 2009 and Kleinknecht A., 1987).

However, there is an elevated level of unanimity regarding the impact of R&D activities on internally-produced innovation outputs and external technologies adoption (Accetturo et al., 2013; Griffith et al., 2004; Parisi et al., 2006). In this regard, firm-level investments in research activities have a beneficial impact towards the "Absorptive capacity" of enterprises. In fact, it is proven that the more a company performs R&D investments, the more it is able to adopt, metabolise and integrate the innovations originated by its competitors/suppliers. This way, in the event that the internally-performed R&D activities may not lead to an actual product/process innovation, the innovation effort is not vain anyway, as it can ultimately help the company to better adapt to the external environment (Parisi et al., 2006). Furthermore, concerning the impact of both product and process innovations on TFP, both Hall et al. (2008) and Parisi et al. (2008) find that process innovation is more beneficial than product innovation for firm-level productivity improvements.

As can be deduced from the cited literature, R&D activities and innovation dynamics have a remarkable impact on business efficiency. Given the previous sentence for granted, it becomes interesting to clarify what is the average level of innovation in Italy, in order to

[18] From now on this business category is referred to as "SMEs", indicating all businesses with 10 to 250 employees.

understand whether the Italian productivity lag can be explained by some technological/innovation gaps, especially if compared to other developed economies.

In this regard, Calvino et al. (2022) observe a considerable gap in the adoption of digital technologies by Italian firms, especially when compared with similar OECD counterparts. Such technological and innovative delay has generated during the last 25 years and has led Italy performances to be positioned below the average OECD digital transformation standards. Surprisingly, the reluctance towards the adoption of new sophisticated technologies in Italy is mainly driven by the behaviour of small and young firms, as these companies exhibit lower technology adoption rates than their OECD counterparts (Calvino et al., 2022). In this regard, also Accetturo et al. (2013) underline that, in terms of innovating intensity, Italy records evidently negative performances with respect to the average OECD standards.

Moreover, Bugamelli et al. (2018) describe Italy as a "Moderate innovator" in the EU, highlighting that such a mediocre performance must be ascribed to the fact that Italy is composed of a small number of highly innovating firms belonging to the productivity frontier, while the rest of the business sector plods along. This situation results in a significant lack of economic growth (Bugamelli et al., 2018) and in a context in which TFP growth is stagnant (Calvino et al., 2022). To confirm this thesis, Calvino et al. (2022) conclude that Italian firms are less prone to invest in intangible assets (organisational capital and R&D) and that the described behaviour prevents those businesses from generating patents, adopting more advanced technologies and expanding their market extension.

From a sectorial point of view, Bugamelli et al. (2012) hypothesise that the Italian innovative lag is originated by an unbalanced specialisation of manufacturing firms towards the traditional sector, historically characterised by low technology adoption rates, whereas French and German economies are less affected by the just-described disequilibrium.

Furthermore, Mohnen et al. (2006) through a comparison among Belgium, Denmark, Ireland, Germany, the Netherlands, Norway, and Italy, demonstrate that the latter country is the worst innovator both in high-tech and low-tech business segments. Lotti and

Santarelli (2001) studied the differences between German and Italian firms in the ability to convert innovation efforts into efficiency improvements and, through this study, it is finally evidenced that Italy performs worse than Germany, as the price of R&D activities is lower in the latter country. This price discrepancy pushes Italian companies to direct their efforts towards informal innovation channels. Such a conclusion appears to sustain the already cited thesis of Bugamelli et al. (2012), Crèpon et al. (1998), Hall et al. (2009) and Kleinknecht A. (1987), concerning the unsuitableness of R&D expenditures for measuring innovative efforts.

In conclusion, both Bugamelli et al. (2012) and Cardinali et al. (2016) underline that Italian innovating companies are more prone to develop an incremental change, rather than a radical change. Incremental changes require a fewer amount of endeavour, financial and human resources, but at the same time it enhances less improvements. In particular, Cardinali et al. (2016) observe that among the potential innovative activities within SMEs, product innovation is the one which is on average more likely to be affected by incremental changes, rather than radical ones.

2.4 Literature Review: Innovation and Business Dimension

As can be deduced from the economic papers previously illustrated, it is quite clear that business dimension, efficiency and innovation are three highly interconnected themes, which contribute to influence each other. The objective of this fourth Subsection is to report some evidence about the last of the three relationships which has yet to be addressed: the one related to innovation and business dimension.

Concerning what just mentioned, Pagano and Schivardi (2001), through a study on Germany, France, United Kingdom, Italy, Spain, Finland, Denmark and Sweden, manage to determine that business dimension is positively correlated with both productivity and propensity to innovate, highlighting that firm size enhances productivity through its influence on the innovating propensity of a company. In addition, Bugamelli et al. (2012) observe that, at the European level, the probability to individuate an innovating firm is positively associated with the dimension of the company. Simultaneously, for a company, the probability to obtain concrete and useful innovation outputs (i.e., the generation of a patent) is positively correlated with business dimension as well. The same typology of relationship is also found by Accetturo et al. (2013), with regards to both innovation efforts and outputs.

Not surprisingly, Parisi et al. (2006) conclude that, on average, the share of those firms which either perform R&D activities or introduce a certain process innovation, monotonically increases with the number of employees. Interestingly, in the case of product innovation, the relationship between R&D and size can be represented as an inverted u-shaped curve, as it reaches its maximum in the presence of medium-large enterprises (Parisi et al., 2006).

In order to provide a broad and complete Literature Review, it must not be omitted the presence of some economic studies which are either partially or more deeply in contrast with the aforementioned works. In fact, both Klette and Kortum (2004) and Crèpon et al. (1998) demonstrate that R&D intensity (expressed as the ratio between R&D expenditures and sales) is statistically independent on the number of employees. Contrariwise, Crèpon et al. (1998) discover that R&D intensity is positively associated with market share,

diversification and technology-push indicators, while business dimension and innovative efforts are not significantly correlated.

An intermediate position between the two different schools of thoughts is represented by the work of Acs and Audretsch (1988): through this study, empirical evidence is found on the positive relationship between business size and innovation, exclusively for companies with more than 250 employees. Finally, it is concluded that the larger the firms in an industry, the higher the innovative activity will tend to be originated by small firms rather than larger ones. Probably, this discovery indicates that within industries characterised by a predominance of large enterprises, small firms need to increase their innovation intensity in order to compete and not exit the market, creating positive externalities for the whole economy (Acs and Audretsch, 1988).

2.5 Literature Review: Additional Drivers of Productivity

Undoubtedly the efficiency of a generic productive system does not depend only on the size or the propensity for innovation of the firms that are part of it[19]. Instead, there are multiple additional factors which can contribute to the shaping of firm- and country-level productivity, through both direct and indirect channels.

In this regard, according to Accetturo et al. (2013), Banca d'Italia (2016), Bloom (2007) and Bugamelli et al. (2018), one of the potential drivers of company-level productivity is the presence of "Excessive familism" within the management. More specifically, for a given enterprise, if the board of directors consists of members from the same family, this represents a good predictor of worsening managerial practices, risk aversion, low efficiency, lack of investments and low propensity to innovate. Moreover, Bugamelli et al. (2012) find that highly concentrated management is more present within family businesses, and that such feature is averagely associated with the absence of performance incentives for the managers. Concerning what was just mentioned, Bandiera et al. (2015) demonstrate that the lack of performance incentives (usually originated by the existence of familiar relationships within an organisation) is likely to lead companies towards inefficiency and unprofitability.

Furthermore, Bugamelli et al. (2012) prove that the pervasive presence of family businesses does not represent a negative element per se. Actually, on the one hand empirical evidence is found on the fact that family businesses are averagely less prone to innovate due to their higher risk aversion (especially when compared with companies whose management is less family-concentrated). On the other hand, the lack of innovation proneness represents a relevant disadvantage only in case the overall productive system is affected by external shocks and it is required a strong competitive effort in order to survive (Bugamelli et al., 2012).

According to Lippi and Schivardi (2014), excessive familism negatively affects productivity, as it does not allow organisations to judge and evaluate their own human resources on the

[19] See Subsection 2.2, 2.3 and 2.4.

basis of their ability. Instead, excessive familism generates business dynamics which are aimed at preserving personal relationships, without objectively analysing the actual employees' performances. In this regard, Pellegrino and Zingales (2017) reach similar conclusions, highlighting that whenever firms are more likely to select their management by only focusing on its competences and merits, then firm-level TFP is positively impacted.

Even though the nature of the bonds established within a family business can positively impact both the reduction of information asymmetries (between owners and managers) and the possibility to reach faster conflict resolutions, there is a quite wide consensus regarding the fact that excessive familism represents a constraint for firm growth (Banca d'Italia, 2016; Bloom and Van Reenen, 2007).

Even in this scenario, by looking at the "European Firms in Global Economy" research project, it emerges that Italy has some peculiar characteristics, quite different from the main developed economies in Europe. In fact, within a sample of manufacturing companies with more than ten employees, the share of Italian family-owned companies is 86%, a figure higher than the one recorded in Spain (83%), United Kingdom (81%) and France (80%), though lower than Germany (90%). Interestingly, the Italian anomaly becomes more evident if it is only considered the share of family businesses in which the management is entirely represented by members from the same family. Under this assumption, the percentage accounts for 66% in Italy, 33% in Spain, about 25% in France and Germany and only 10% in the United Kingdom. In the case of Italy, the described phenomenon is mainly present in agriculture, traditional manufacturing, retail businesses and, more generally, in Southern[20] regions.

To conclude the review referring to the main drivers of efficiency, in addition to what already reported, it must be underlined that productivity and innovation improvements are usually associated with good levels of competition (Aghion et al., 2009), propensity to internationalise (Barba Navaretti et al., 2010), lack of financial constraints (Alm et al., 2019), better access to credit markets (Bonaccorsi di Patti and Finaldi Russo, 2017), presence of

[20] According to the Istat classification, the Southern macro-area of Italy includes 8 regions: Abruzzo, Campania, Molise, Basilicata, Puglia, Calabria, Sicily and Sardinia.

agglomerations (Accetturo et al., 2022), low misallocation (Bugamelli et al., 2018; Calligaris et al., 2016) and absence of illegal behaviours, as corruption and fiscal evasion (Banca d'Italia, 2016; Bobbio, 2016).

2.6 Empirical Evidence from European Economies

In order to fully understand those efficiency dynamics characterising developed economies, it is fundamental to quantify the relationship between productivity and its potential explanatory variables through an empirical approach. To achieve such objective, Subsections 2.7 and 2.8 are respectively dedicated to two OLS multiple linear regression models and two multivariate time-series analyses, which can help to better define and characterise TFP trends within the European context. According to the results of the proposed statistical tools, it is possible to confirm or to question the conclusions highlighted throughout the previously-illustrated Literature Reviews. For this reason, the following studies are based on a series of data which are closely related to those topics[21] which constitute the main object of the economic studies contained in previous Subsections[22].

The analyses contained in this second Section make use of reliable information (collected from the OECD database) and refer to a timeframe set between 2009 and 2019. In addition, as shown in Appendix I and II, these data are not affected by the presence of significant outliers. In order to quantify the relationships between aggregate productivity, business dimension and country-level innovation, I built two OLS multiple linear regression models, named "*Model-1*" and "*Model-2*" and two vector autoregressive models, named "*VAR Model-1*" and "*VAR Model-2*". The first regression model, included in Subsection 2.7, makes use of data relating to a sample of six major European economies[23], while the second regression analysis concerns the sole Italian and German production systems. This second study, contained in Subsection 2.8, is constructed in such a way as to allow a comparison between Italy and a point of reference at the European level, both for its productivity growth rates and for its simultaneous innovative propensity. With regards to the two multivariate time-series analyses contained in both Subsection 2.7 and 2.8, *VAR Model-1* is

[21] Such as Productivity, R&D activities, innovation propensity and business dimension.
[22] See Subsection 2.2, 2.3 and 2.4.
[23] The sample is composed of data concerning Denmark, Germany, Italy, Netherlands, Spain and the United Kingdom (member of the European Union until 31/1/2020). The analysed data were collected from the OECD database.

based on an analysis of panel data referring to ten European countries[24] and identifies a medium-term relationship between country-level propensity for innovation and the presence of large enterprises. On the other hand, the second vector autoregressive analysis (*VAR Model-2*), verifies whether the divergent productivity growth rates characterising Italy and Germany, can be explained by the different production system' s composition of the two economies.

As anticipated through Subsection 1.4, since the most recently collected data refer to the 2019 period, any conclusion reported in the following lines is not subject to biases originated by the consistent macroeconomic distortions that have started affecting Europe since the first trimester of 2020.

Throughout the following OLS multiple linear regression models, the indicator named "TFP_variation"[25] represents the dependent variable and, as previously mentioned, in both Subsection 2.7 and 2.8 it is addressed the relationships between TFP and three macro-categories of explanatory variables, which can be summarised as follows:

- Independent variables expressing the dimension of businesses within a certain territory;
- Independent variables indicating the innovative effort carried out within a given economy;
- Independent variables concerning the human capital dedicated to innovative activities.

In conclusion, within the following regression analyses, two additional regressors (also called "Control variables") are finally inserted. Typically, this kind of indicator is extremely influential on the dependent variable and, therefore, the inclusion of such measures is useful for verifying whether their predominance can be tolerated by the rest of the regressors. Consequently, in the event that their inclusion does not lead to

[24] The sample is composed of data concerning Denmark, Finland, France, Germany, Italy, Netherlands, Norway, Portugal, Spain and United Kingdom. The analysed data were collected from the OECD database.
[25] The values assumed by this indicator express the yearly percentage variation in the level of Total Factor Productivity for each country from 2009 to 2019.

significant distortions in the conclusions reached thanks to the "Original" model, then the analysis is to be considered reliable.

2.7 Analysis on Productivity Dynamics in Europe

The first multiple linear regression model proposed in this Section has the function to determine, among a pool of selected indicators, what are those predictors which present a significant impact on six[26] European countries' productivity growth rates, over an eleven-year reference period, set between 2009 and 2019.

Model-1 represents the first attempt of this thesis to determine whether either business dimension or aggregate innovation propensity have a significant impact on the response variable ("TFP_variation"[27]) at a European level. For this reason, the presented study has the following form[28]:

$$TFP\_variation = \beta_0 + \beta_1\ National\_R\&D + \beta_2\ R\&D\_employees + \beta_3\ Firms\_R\&D\_effort + \beta_4\ Micro\_firms + \beta_5\ Small\_firms + \beta_6\ Medium\_firms + \beta_7\ Large\_firms + \varepsilon_i$$

In order to fully understand the meaning of the proposed variables, the next lines are useful for illustrating what is the actual role of each indicator:

The first explanatory variable, named "National_R&D", expresses the ratio between the Research and Development expenditures in a given country (carried out by public and private organisations, NGOs and universities) and its relative GDP. This indicator can be considered as a proxy for the overall innovative effort characterising an economic system. On the other hand, "R&D_employees" expresses, for each country, what is the number of workers dedicated to R&D activities for every 100 employees. As the previous one, also this predictor can be used as a proxy for representing the general innovative effort carried out within a given territory. Moreover, "Firms_R&D_effort" measures the volume of R&D expenditures (carried out by sole private firms) for every 100 people employed in the private sector. Differently from the first two variables, this one only incarnates the

[26] The sampled countries are Denmark, Germany, Italy, Netherlands, Spain and the United Kingdom.
[27] It expresses the annual logarithmic variation in the level of the Total Factor Productivity in the six sampled countries from 2009 to 2019.
[28] Each β_i represents a regression coefficient associated with a specific independent variable, while ε_i is the error term.

innovative effort of private businesses, excluding the investments of universities, Public Administrations and NGOs. The remaining predictors ("Micro_firms", "Small_firms", "Medium_firms" and "Large_firms") do not concern the innovative level of an economy. Instead, they respectively express the variation in the population of micro, small, medium and large firms within the sampled nations. As it can be observed in **Table 1**, even though *Model-1* is characterised by a medium-low goodness of fit[29], on the other hand it leads to some interesting conclusions, as it presents three significant[30] coefficients. In particular, according to *Model-1*, the variation in the population of small, medium and large companies has a significant impact on country-level aggregate TFP growth.

Table 1

	(*Model-1*)
VARIABLES	TFP_variation
National_R&D	0.640
	(0.268)
R&D_employees	0.568
	(0.432)
Firms_R&D_effort	-0.005
	(0.480)
Micro_firms	0.520
	(0.470)
Small_firms	0.176**
	(0.029)
Medium_firms	-0.161***
	(0.006)
Large_firms	0.154***
	(0.003)
Constant	-0.011*
	(0.061)
Observations	65
R-squared	0.310
Adjusted R-squared	0.225
F-test (7, 57)	3.65***

p-values in parentheses (*** p<0.01, ** p<0.05, * p<0.1)

[29] The R^2 index indicates that this model explains about 31% of the variability of "TFP_variation" (the dependent variable).

[30] The coefficient associated with the variable "Small_firms" presents a p-value inferior to 0.05. This implies that its significance level is higher than 95%. On the other hand, the regressors associated with both "Medium_firms" and "Large_firms" present even lower p-values (inferior to 0.01), implying that their respective significance level is higher than 99%.

It must be underlined that the three significant regressors in question are not characterised by equal signs, suggesting that aggregate the impact of small, medium and large companies' growth is divergent. As a matter of fact, on the basis of the obtained results, a +1% increase in the population of large firms enhances a +0.15% TFP improvement, whereas a +1% growth in the total amount of medium-sized enterprises generates a -0.16% TFP variation. Moreover, a +1% increase in the variable "Small_firms" seems to produce a +0.17% improvement of the response variable. Unfortunately, the lack of significance of the regressor associated with "Micro_firms" does not allow a complete comparison among the four business categories. Anyways, the results contained in **Table 1** give a first indication concerning the beneficial impact of large enterprises on the aggregate European productivity level. Unfortunately, on the basis of this analysis, public and private R&D investments, as well as the human capital dedicated to innovative activities, do not seem to have a significant impact on aggregate productivity.

With the objective to test the reliability of the presented analysis, two control variables are included within *Model-1*: the selected indicators are "GDP_per_hour_worked"[31] and "Value_added"[32] and, as illustrated in **Table 2**, both control variables have a positive and non-negligible correlation with TFP. For this reason, their inclusion within *Model-1* is supposed to evidence any presence of weakly-significant relationships between the dependent variable and its predictors.

Table 2

	TFP_variation	GDP_per_hour_worked	Value_added
TFP_variation	1		
GDP_per_hour_worked	0.595***	1	
Value_added	0.459***	0.112	1
N	65		

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

[31] This control variable is an efficiency measure which can be used as a proxy for labour productivity, as it indicates the amount of GDP generated for every working hour within a given economy.

[32] This control variable is another productivity measure which is often associated with labour productivity and TFP, as it indicates the overall value-added created for every 100 employees operating in a given production system.

In addition to that, the linear regression study contained in **Table 3** confirms the positive and remarkable influence of the two control variables towards aggregate productivity. In particular, "GDP_per_hour_worked" and "Value_added" explain about 51% of the dependent variable's variance[33] and exhibit significant coefficients. On the basis of such considerations, the inclusion of these indicators is expected to properly certify (or deny) the reliability of the "Original" *Model-1*.

Table 3

VARIABLES	(Impact of control variables on TFP) TFP_variation
GDP_per_hour_worked	0.386***
	(0.000)
Value_added	0.089***
	(0.000)
Constant	-0.010***
	(0.000)
Observations	65
R-squared	0.510
Adjusted R-squared	0.494
F-test (2, 62)	32.23***

p-value in parentheses (*** p<0.01, ** p<0.05, * p<0.1)

Results concerning the inclusion of the presented measures within *Model-1* are reported in **Table 4** and, as it can be observed, this new analysis (named "*Model-1.2*") presents four significant coefficients. As expected, both control variables are associated with low p-values and show positive signs. Interestingly, their inclusion does not "Dominate" the predictors "Medium_firms" and "Large_firms", as their coefficients retain their significance. On the other hand, the variable "Small_firms" does not behave the same way. In fact, this last predictor seems to undergo the predominance of both control variables, ending up losing any significance (the p-value of "Small_firms" is now equal to 0.295).

Through this analysis it is possible to notice that a +1% increase in the share of large enterprises generates a positive (+0.10%) increase of country-level efficiency growth, whereas a similar increase in the population of medium enterprises produces a -0.12%

[33] The two control variables manage to explain almost 20% more of the variance explained in *Model-1*.

deterioration of the dependent variable[34]. Unfortunately, the inclusion of two control variables does not help reveal other potential relationships. Finally, it must be underlined that *Model-1.2* is characterised by a higher goodness of fit[35] than Model-1, confirming the beneficial impact of the two control indicators in the explanation of the response variable.

Table 4

VARIABLES	(*Model-1.2*) TFP_variation
National_R&D	0.638
	(0.154)
R&D_employees	0.024
	(0.965)
Firms_R&D_effort	-0.004
	(0.385)
Micro_firms	-0.157
	(0.779)
Small_firms	0.067
	(0.295)
Medium_firms	-0.123***
	(0.008)
Large_firms	0.100**
	(0.012)
Control Variables	
GDP_per_hour_worked	0.313***
	(0.000)
Value_added	0.082***
	(0.000)
Constant	-0.015***
	(0.002)
Observations	65
R-squared	0.611
Adjusted R-squared	0.547
F-test (9, 55)	9.61***

p-value in parentheses (*** p<0.01, ** p<0.05, * p<0.1)

To conclude this first study, an analysis concerning the relationship between business dimension and innovation at the European level is finally proposed. More precisely,

[34] These results are in line with the ones highlighted in **Table 1**, in which the coefficients associated with "Large_firms" and "Medium_firms" are respectively equal to (+0.154) and (-0.161).

[35] By looking at the R^2, it can be deduced that the inclusion of "GDP_per_hour_worked" and "Value_added" generated a +30% increase in the share of explained variance with respect to the "Original" *Model-1*.

through the following lines it is presented a vector autoregressive model, which makes use of data from ten European countries[36] and identifies a clear connection between the presence of large companies and private spending on R&D activities. This multivariate time-series analysis (*VAR Model-1*) is composed of 2 variables: specifically, "National_BERD" represents the variation in the volume of private organisations' R&D activities expenses, divided by the GDP of the country in which such entities operate. On the other hand, "Share_of_large_firms", measures the variation in the ratio between active large firms and active microenterprises operating in each of the sampled countries. The model in question makes use of one-, two- and three-year lags and, therefore, it allows to identify the "Medium-term" effects of a pervasive presence of large companies towards the aggregate innovative proneness within a given production system. Results are shown in **Table 5**.

Table 5

(*VAR Model-1*) VARIABLES	National_BERD	Share_of_large_firms
L1. National_BERD	-1.153***	1.088***
	(0.000)	(0.000)
L2. National_BERD	-0.315***	-0.092***
	(0.000)	(0.000)
L3. National_BERD	-0.326***	-0.031***
	(0.000)	(0.000)
L1. Share_of_large_firms	1.515***	-0.488***
	(0.000)	(0.000)
L2. Share_of_large_firms	4.039***	-1.370***
	(0.000)	(0.000)
L3. Share_of_large_firms	3.809***	-3.027***
	(0.000)	(0.000)
Constant	-0.000***	-0.000***
	(0.000)	(0.000)
Observations	7	7
Log likelihood	590.4233	
AIC	-164.6924	

p-value in parentheses (*** p<0.01, ** p<0.05, * p<0.1)

As it can be observed, the more a European economy is affected by an elevated ratio of

[36] This ten-countries sample includes data stemming from Denmark, Finland, France, Germany, Italy, Netherlands, Norway, Portugal, Spain and the United Kingdom in a period set between 2009 and 2019.

large firms to microenterprises, the more the private sector is likely to invest funds on innovating activities. Moreover, the positive effect of large enterprises is even more accentuated when a medium-term perspective is adopted, exhibiting higher coefficients when 2- and 3-year lags are adopted.

In conclusion, on the basis of the results obtained through *Model-1* (furtherly confirmed in *Model-1.2*, thanks to the inclusion of two control variables), it emerges that large enterprises have a significantly positive impact on aggregate productivity at a European level, while medium-sized companies seem to be characterised by an opposite relationship. By analysing the vector autoregressive model contained in **Table 5** (*VAR Model-1*), it is finally possible to observe how the presence of large firms generates benefits also in terms of aggregate innovation propensity among developed European economies, whereas microenterprises act as a barrier to R&D investments.

Robustness checks concerning *Model-1.2* and *VAR Model-1* are contained in Appendix I. In particular, as shown in **Exhibit 1** and **4**, *Model-1.2* is neither affected by heteroskedasticity nor multicollinearity. Moreover, the analysis on *Model-1.2* residuals, contained in **Exhibit 2**, demonstrates that the error terms of the multiple linear regression model in question are normally distributed. With regards to the multivariate time-series analysis presented in this Subsection, as shown in **Exhibit 5** and **6**, *VAR Model-1* does not present stationarity. Unfortunately, this first vector autoregressive study does not satisfy the eigenvalue stability condition, while, on the other hand, its residuals have an expected value which is significantly close to zero. Finally, by looking at **Exhibit 9**, it can be observed that, according to Akaike's information criterion (AIC), Hannan–Quinn information criterion (HQIC) and Schwarz information criterion (SBIC), the choice of applying a 3-year lag to the overall time-series analysis is the optimal one.

2.8 Analysis on Productivity Dynamics in Germany and Italy

In order to identify further empirical evidence concerning the relationship between productivity and its drivers, I decided to dedicate this Subsection to *Model-2*: an analysis on German and Italian economies. As in the previous one, also in this Subsection I make use of an OLS multiple linear regression analysis, whose results help to illustrate the reason why Italy and Germany have been affected by remarkably divergent paths in terms of productivity growth. Even within this second study, "TFP_variation" is the dependent variable, while the overall model makes use of eight explicative indicators, six of which (included the two control variables) are the same presented in *Model-1.2*[37]:

$$TFP\_variation = \beta_0 + \beta_1\ Micro\_firms + \beta_2\ Small\_firms + \beta_3\ Medium\_firms + \beta_4\ Large\_firms + \beta_5\ Share\_of\_small\_firms + \beta_6\ Share\_of\_mediumlarge\_firms + \beta_7\ GDP\_per\_hour\_worked + \beta_8\ Value\_added + \varepsilon_i$$

By comparing the structure of *Model-1.2* and *Model-2*, the only two novel indicators included in this new study are "Share_of_small_firms" and "Share_of_mediumlarge_firms". These two variables are useful for estimating the weight on the overall economy of different business size categories, as they respectively measure the number of firms with 10-to-50 employees for each microenterprise and the number of firms with 50-to-250 employees for each microenterprise in Germany and Italy. On the other hand, the previously-adopted indicators used for expressing the overall innovative effort of a given nation ("National_R&D", "R&D_employees" and "Firms_R&D_effort"), are initially excluded from this second research.

The results of *Model-2*, contained in **Table 6**, provide some interesting insights about the drivers of productivity among the analysed couple of countries. In fact, this study presents four significant coefficients (two of which are characterised by a barely acceptable p-value). In addition, by looking at the R^2 index, it can be deduced that *Model-2* contributes to

[37] See Subsection 2.7.

explain almost 89% of the total variance. Evidently, such a notable goodness of fit can be attributed to the elevated number of included predictors. Anyways, the fact that the adjusted-R^2 is equal to 82.6% confirms the overall elevated reliability of the analysis[38].

Table 6

VARIABLES	(*Model-2*) TFP_variation
Micro_firms	-0.670
	(0.319)
Small_firms	-0.075
	(0.550)
Medium_firms	-0.149
	(0.100)
Large_firms	0.134**
	(0.033)
Share_of_mediumlarge_firms	3.181*
	(0.080)
Share_of_small_firms	-0.673*
	(0.095)
Control Variables	
GDP_per_hour_worked	0.161
	(0.122)
Value_added	0.338***
	(0.000)
Constant	0.005
	(0.561)
Observations	22
R-squared	0.892
Adjusted R-squared	0.826
F-test (8, 13)	13.42***

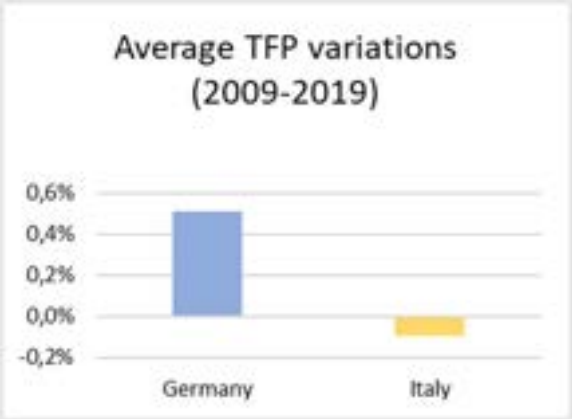
p-value in parentheses (*** p<0.01, ** p<0.05, * p<0.1)

By Observing **Table 6**, the conclusions concerning the positive relationship between the population of large firms' growth and TFP improvements (already obtained through *Model-1.2*) are once again confirmed.

[38] The Adjusted-R^2 is a more accurate measure of the actual goodness of fit of a linear regression model, as it inserts a "penalty" based on the number of predictors included in the study.

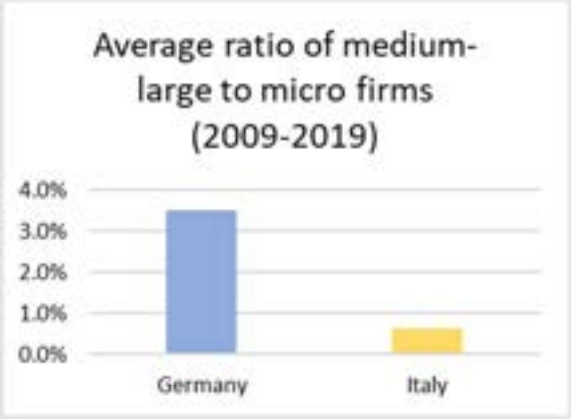
Interestingly, the "Novel" variables included in *Model-2* are barely significant, as the coefficients associated with "Share_of_mediumlarge_firms" and "Share_of_small_firms" present a p-value between 0.05 and 0.1. Given this borderline situation, both values and signs of such coefficients deserve an in-depth analysis, since their interpretation may lead to very important conclusions. In fact, the regressor associated with "Share_of_mediumlarge_firms" suggests that, on average, the higher is the ratio of medium-large companies to microenterprises, the higher is the probability for a nation to improve its aggregate efficiency level. In particular, a +1% increase of the described ratio generates a +3.18% TFP change. Even though these conclusions must be handled carefully, it must be anyways highlighted that they find a quite remarkable empirical confirmation:

Figure 2) TFP growth comparison



Source: Author's elaboration of OECD data

Figure 3) Business population composition



Source: Author's elaboration of OECD data

Evidently, **Figure 3** shows that there exist non-negligible differences in the intrinsic nature of the productive apparatus of Germany and Italy, as the first is characterised by a higher medium-large to microenterprises ratio. Consequently, this discrepancy seems to produce a significant impact on the divergent productivity growth path of both countries. In this regard, **Figure 2** shows that German productivity exhibited averagely positive variations from 2009 to 2019, while, on the other hand, Italy has been affected by even negative TFP changes within the same timeframe.

In addition to what was just mentioned, the last barely-significant coefficient to interpret is the one associated with "Share_of_small_firms". The negative sign of such regressor provides interesting information regarding the negative effect of small-sized enterprises on

aggregate efficiency, though in absolute terms this impact is less relevant than the one stemming from medium-large firms.

In summary, *Model-2* shows that, within German and Italian economies, TFP growth is favoured by positive variations in the number of large firms. In any case, this second regression analysis also demonstrates that, on average, when an economic system is affected by a higher ratio of medium-large firms to microenterprises, then aggregate productivity is more likely to grow. Finally, there is also evidence that an excessive presence of small firms, when compared to microenterprises, has an even worse impact on country-level productivity. Anyways, the lack of elevated significance associated with both variables "Share_of_small_firms" and "Share_of_mediumlarge_firms" suggests that the last two conclusions should be taken with a grain of salt.

Therefore, with the objective to better analyse the relationship between TFP and business dimension, the last segment of this Subsection is dedicated to a vector autoregressive model. In particular, drawing from the previously-used data in "*Model-2*", two indicators are extrapolated: "Diff_TFP" and "Diff_Share_of_mediumlarge_firms". The first variable measures the annual differences in TFP growth between Germany and Italy, while the second measures the differences in the ratio between medium-large and micro enterprises between the two countries in the same timeframe. Results are shown in **Table 7**.

Table 7

(*VAR Model-2*)		
VARIABLES	Diff_TFP	Diff_Share_of_mediumlarge_firms
L1. Diff_TFP	-0.042**	0.309
	(0.040)	(0.300)
L1. Diff_Share_of_mediumlarge_firms	0.417**	-0.314
	(0.039)	(0.286)
Constant	-0.002	-0.002
	(0.186)	(0.404)
Observations	8	8
Log likelihood	57.71126	
AIC	-12.92782	

p-value in parentheses (*** p<0.01, ** p<0.05, * p<0.1)

The purpose of this analysis, therefore, is to verify whether the different production system's composition of the two countries can significantly explain their relative divergent performances in terms of productivity. Within *VAR Model-2*, as can be seen from **Table 7**, a one-year lag is applied.

As it can be noticed, results of *VAR Model-2* confirm the previously-highlighted intuitions, according to which, during the last decade, Germany has been able to improve its aggregate efficiency level thanks to the intrinsic composition of its production system, affected by a more pervasive presence of medium and large companies. For the same reason, the poor performances of Italy can be attributed to a more extensive presence of microenterprises. In particular, **Table 7** shows that from 2012 until 2019, every time the German economy managed to increase the share of medium-large firms by one percentage point more than in Italy, this produced an increase of +1.892% of the productivity gap between the two countries (in favour of Germany).

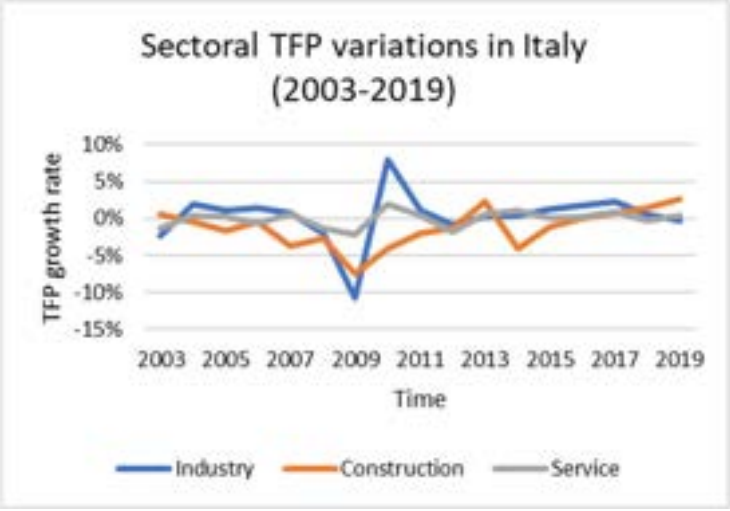
Robustness checks concerning *Model-2* and *VAR Model-2* are contained in Appendix II. As reported in **Exhibit 10** and **11**, the Breusch-Pagan and Jarque-Bera tests indicate that *Model-2* presents significant homoskedasticity and normality of the residuals. In confirmation of the robustness of the *Model-2*, as shown in **Exhibit 12**, the expected value of *Model-2* error terms does not significantly differ from zero. The only problematic indicator which may partially compromise the goodness of *Model-2* is represented by the VIF index. Actually, the fact that this measure far exceeds the threshold value (equal to 5) demonstrates that a high degree of multicollinearity is present within the model. More specifically, **Exhibit 13** shows that the two predictors "Share_of_mediumlarge_firms" and "Share_of_small_firms" should be discarded from the model. Finally, **Exhibit 14**, **15** and **16** show that *VAR Model-2* is not stationary and satisfies the eigenvalue stability condition. At the same time, **Exhibit 17** provides relevant information concerning the residuals' expected value, showing that their mean is significantly close to zero.

Section 3

3.1 Productivity Heterogeneity in Italy

The purpose of Section 3 is to explain productivity dynamics characterising the sole Italian territory. Therefore, from now on the cross-country comparison approach which characterised both Subsection 2.7 and 2.8 is abandoned. Differently from the previous approaches, the new adopted one has the objective to identify which variables have significant effects on the sole Italian aggregate efficiency (from both a sectoral and a regional perspective) and to quantify their actual impact. Therefore, the following analyses try to provide some explanations about the intra-sectoral and intraregional TFP differences within the Italian economy. In this regard, **Figure 4** helps to describe quite clearly the aforementioned intra-sectoral differences, by illustrating the average TFP growth rates characterising the Service, the Construction and the Industry[39] business sectors during the last two decades[40]. By looking at **Figure 4**, the presence of notable discrepancies in terms of productivity improvements among these three macro-sectors is quite evident. Such differences can be better clarified through a detailed analysis of the proposed graph:

Figure 4) Productivity intra-sectoral differences in Italy



Source: Author's elaboration of Istat data

[39] According to Istat definition, this macro-sector includes four typologies of economic activities: "Mining of minerals from quarries and mines", "Manufacturing activities", "Supply of electricity, gas, steam and air conditioning" and "Supply of water, sewerage, waste management activities and rehabilitation".

[40] Excluding agricultural activities, the aggregate Service, Construction and Industry economic areas represent the entire production system of Italian private companies and contribute to employing almost seventeen million regular workers.

Starting the analysis from Construction, this economic segment has been affected by average negative TFP growth throughout the adopted timeframe, recording few positive improvements in just six years[41] out of seventeen. In general, the average Construction's TFP variation recorded an average -1.271% efficiency deterioration each year. Proceeding the analysis with the Service sector, **Figure 4** shows that only on two occasions[42] this business area recorded positive growth rates exceeding +1%, while it maintained substantial stagnation for the rest of the period. As in the previous one, also in the case of the Service sector, aggregate TFP has recorded slightly negative variations (-0.049%), though recording better performances than the ones associated with Construction. Unlike the just-described economic segments, Industry is the only one which experienced little improvements, as it managed to express a positive annual growth from 2003 until the end of the analysed period (+0.246%)[43]. On the basis of the highlighted data, it appears that, on average, Service and (especially) Construction activities contributed to the deterioration of Italian TFP, whereas the aggregate Industry system, though experiencing some improvements, did not manage to completely counterbalance the negative performances of the two aforementioned sectors, leading Italy to a substantial productivity stagnation.

Also from a regional perspective, the Italian production system has recorded heterogeneous performances, depending on the geographical location. Obviously, this fragmentation represents a burden for the whole economy, as it contributes to generate inequalities throughout the country. In this regard, **Figure 5** provides a graphic representation about the average productivity growth characterising the four macro-

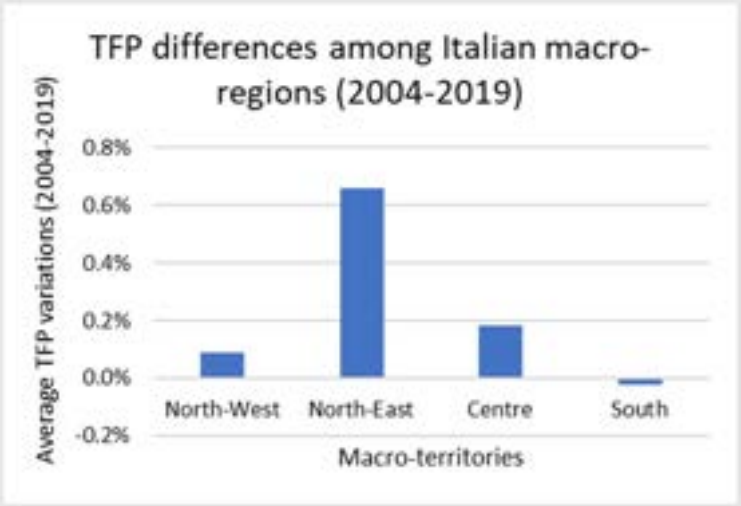
[41] In particular, the Construction sector reported a 2.337% TFP growth during 2013, a quite moderate growth during 2018 (+1.343%) and a +2.538% increase in 2019. More exiguous growth rates characterised 2003 (+0.481%), 2016 (+0.294%) and 2017 (+0.835%).

[42] In particular, the aggregate Service sector recorded an increase of +1.872% and +1.033% respectively in 2010 and 2014.

[43] Since 2003, on 8 occasions Industry reported TFP growth rates higher than both Service and Construction.

regions (North-West[44], North-East[45], Centre[46] and South[47]) composing the overall Italian territory.

Figure 5) Regional productivity discrepancies within Italy



Source: Author's elaboration of Istat data

As it can be noticed, from 2004 to 2019 the aggregate Southern macro-region has been the only one to express an average TFP deterioration, whereas the North-East has been associated with the highest average growth. Surprisingly, between North-Western and North-Eastern regions there exists remarkable differences (of 0.569 percentage points). This element is particularly coherent with the conclusions highlighted by Calligaris et al. (2016), concerning the accentuating misallocation and the diminishing efficiency affecting the North-West of Italy.

On the basis of the presented empirical observations and with the objective to find some explanation concerning the emphasised sectoral and geographical discrepancies, I decided to make use of three separate OLS multiple linear regression models. Unfortunately, as it can be deduced by looking at **Exhibit 18** (presented in Appendix III), the "*Regional Regression Model*", dedicated to a territorial-level analysis on productivity dynamics, does

[44] According to the Istat classification of macro-areas, the North-Western area includes Valle d'Aosta, Piedmont, Liguria and Lombardy.
[45] According to the Istat classification of macro-areas, the North-Eastern area includes Trentino Alto Adige, Friuli-Venezia Giulia, Veneto and Emilia Romagna.
[46]According to the Istat classification of macro-areas, the Central area includes Tuscany, Marche, Umbria and Lazio.
[47] According to the Istat classification of macro-areas, the Southern area includes Abruzzo, Campania, Molise, Basilicata, Puglia, Calabria, Sicily and Sardinia.

not produce any reliable result, as all the considered regressors are characterised by too elevated p-values. The objective of this model was to determine whether regional TFP variations can be explained either by business dimension or R&D investments/human capital dedicated to innovative activities, but the lack of significant coefficients suggests that neither one of the proposed variables is able to predict the variability of regional productivity dynamics.

However, if we abandon a territorial perspective, the sectoral analyses which are presented through the following Subsections[48] make it possible to achieve clearer and more significant results concerning the role of private investments, business dimension and propensity to illegal behaviours at an industry-level.

The following OLS linear regression models make full use of information provided by the Istat database and refer to a seven-year timeframe, set between 2013 and 2019. The decision to exclude information referring to a period before 2013 is based on the desire to adopt only complete data. In addition, as emphasised through the previous Sections[49], all the indicators concerning the 2020-2023 period are not taken into consideration, in order to isolate the study from the potential distortions originated by Covid-19 and by the inflationary repercussions on Italian companies started in 2021. In this regard, as it can be noticed by looking at Appendix IV and V, all the variables included within the multiple linear regression analyses of Subsection 3.2 and 3.3 are not characterised by the presence of significant outliers.

[48] See Subsection 3.2 and Subsection 3.3.
[49] See Subsection 1.4.

3.2 Analysis on Intra-Sector Productivity Dynamics in Italy

As already mentioned, *Model-3* makes use of panel data referring to ten different business sectors which, in terms of employment, make up 70% of the Italian productive apparatus. In order to categorise these miscellaneous industries, I took into consideration the "Ateco 2007" classification. On the basis of such categorisation, the analysed industries included within *Model-3* are the followings: Manufacturing (sector C), Construction (sector F), Wholesale and Retail Trade, Repair of motor vehicles and motorcycles (sector G), Transport and Storage services, Accommodation and Catering (sector H and I)[50], Information and Communication services (sector J), Financial and Insurance activities (sector K), Professional, Scientific and Technical activities (sector M), Health and Other services dedicated to households and businesses (sector Q and S)[51]. In order to eliminate outliers and to rely on exclusively complete data, this regression analysis does not take into consideration the other eleven industries[52] which compose the rest of the Italian economic system.

As for the previous OLS linear regression analyses contained in Section 2, also for *Model-3* the response variable is represented by "TFP_variations", expressing the yearly logarithmic productivity variation recorded in each of the considered industries from 2013 to 2019.

On the other hand, this third statistical analysis includes seven independent variables, which can be grouped into four general categories:

[50] These two sectors are merged, due to the lack of disaggregated data.
[51] These two industries are merged, due to the lack of disaggregated data.
[52] The excluded industries are: sector A (Agriculture, forestry and fishing), sector D (Supply of electricity, gas, steam and air conditioning), sector E (Water supply; sewerage, waste management and remediation activities), sector L (Real estate activities), sector N (Rental, travel agencies, business support services), sector O (Public administration and defence; compulsory social insurance), sector P (Education), sector R (Artistic, sports and entertainment and activities), sector T (Activities of families and cohabitants as employers for domestic personnel; production of undifferentiated goods and services for own use by families and cohabitants) and sector U (Extraterritorial organisations and bodies).
Differently from the just-cited industries, sector B (Extraction of minerals from quarries and mines) is not included into *Model-3* as its TFP variations represent an outlier. As a matter of fact, while the average variation (in absolute terms) related to the ten sectors included in the model is 0.9425%, the one associated with sector B is more than four times higher (4.3899%).

The first category is made up of two predictors which express the innovative efforts carried out in a given business sector. The first indicator[53] measures the ratio of sectoral R&D expenditures for every 100 employees, while the second one[54] indicates the volume of R&D expenditures carried out exclusively by private companies for every 100 employees.

The second category is composed of two variables which identify the share of human capital dedicated to innovation activities. In fact, the variable named "Researchers" identifies the number of researchers for every 100 employees in a given industry. On the other hand, the variable "R&D_employees" expresses the number of individuals operating R&D activities for every 100 employees within a given economic sector.

Furthermore, the third category focuses on quantifying the propensity of each sector to engage in opportunistic and illegal behaviours through the use of irregular workers. In particular, the variable "Irregular_employees" measures the number of irregular employees for every 100 employees. The inclusion of this variable is an attempt to identify the relationship between tax-evasion propensity and the general efficiency level within a certain economic field.

Finally, the residual category concerns two control variables. Specifically, the predictors in question are "Labour_Productivity_variation" and "Value_added", and, as highlighted by the R-squared index reported in **Table 8**, both indicators manage to explain 63.6% of the total response variable's variability. In addition, the sign and the p-values associated with the coefficients, demonstrate that the selected control variables have a positive and significant impact on sectoral TFP growth within Italy.

As for *Model-1.2* and *Model-2*, the inclusion of these two indicators (which are ex-ante known for being significantly influential) is useful for confirming the reliability of the overall analysis.

[53] The variable is named "Public_and_private_R&D_effort" and it constitutes a useful tool for expressing the general innovation effort carried out in each sector. The R&D expenses which represent the numerator of this indicator comprehend five funding sources: Enterprises, Public Administrations, Universities (public and private ones), Private non-profit organisations and Investments from the rest of the world.
[54] The variable in question is named "Firms_R&D_effort", as it indicates the ratio of the sole private businesses' R&D investments to the overall human capital employed in a given industry.

Table 8

	(Influence of control variables on TFP)
VARIABLES	TFP_variation
Labour_Productivity_variation	0.813***
	(0.000)
Value_added	0.181**
	(0.035)
Constant	-0.002
	(0.296)
Observations	56
R-squared	0.636
Adjusted R-squared	0.623
F-test (2, 53)	46.39***

p-values in parentheses (*** p<0.01, ** p<0.05, * p<0.1)

With regards to the impact of the aforementioned explanatory variables on TFP, **Table 9** shows *Model-3* results. As it can be noticed, the explained variance of the proposed model is 78.8% (Adjusted R^2 is equal to 75.7%). In addition, results show that among the seven independent variables, five of them have a significant coefficient at the 99% level (two of which are control variables), while the coefficient associated with "Firms_R&D_effort" is significant at the 95% level. The only variable which presents a weak significance level is "Irregular_employees", with a p-value between 0.05 and 0.1. This element suggests carefully handling any interpretation of the respective coefficient.

As it can be observed, if we compare *Model-3* with the other OLS linear regression analyses contained in Section 2, this third study is the first one which manages to identify a significant relationship between productivity and innovative efforts. In this regard, **Table 9** shows that private organisations' R&D investments seem to have a beneficial impact on sectoral efficiency (+0.038). On the other hand, this beneficial effect appears to be in contrast with the coefficient associated with "Public_and_private_R&D_effort". In particular, this predictor is characterised by a significant and opposite coefficient, equal to -0.045.

On the basis of these results, one could conclude that, within the Italian production system, R&D investments have an ambiguous impact on productivity. This reflection is certainly true, but in my opinion, it is important to go into even more detail of this analysis and try

to find an accurate explanation for what has been just described.

Table 9

VARIABLES	(*Model-3*) TFP_variation
Public_and_private_R&D_effort	-0.045***
	(0.005)
Firms_R&D_effort	0.038**
	(0.031)
Researchers	4.031***
	(0.006)
R&D_employees	-1.013***
	(0.010)
Irregular_employees	0.067*
	(0.060)
Control Variables	
Labour_Productivity_variation	0.849***
	(0.000)
Value_added	0.238***
	(0.002)
Constant	-0.004
	(0.259)
Observations	56
R-squared	0.788
Adjusted R-squared	0.757
F-test (7, 48)	25.49***

p-values in parentheses (*** p<0.01, ** p<0.05, * p<0.1)

Specifically, results demonstrate that whenever R&D activities are exclusively performed by private entities, then the effect on aggregate productivity is averagely positive. On the contrary, when R&D investments are carried out by multiple parties, then the outcome is basically opposite. Such a result may appear surprising, but it actually embodies a good level of logic, as it represents the difficulty of Italian firms to develop an adequate level of absorptive capacity[55].

In particular, the fact that Italian sectoral productivity benefits in a practically opposite way from the innovative effort (in one case, produced exclusively by private businesses and, in the other, generated by the total economy), helps to demonstrate that Italian private

[55] The concept of absorptive capacity is discussed in Subsection 2.3, with regards to the conclusions reached by Accetturo et al. (2013), Griffith et al. (2004) and Parisi et al. (2006).

organisations manage to efficiently metabolise intra-mural innovations, whereas they seem unable to reap the potential benefits generated by extra-territorial or university research activities.

Moreover, interesting conclusions stemming from *Model-3* can be obtained by looking at the different values of the coefficients associated with the human capital dedicated to innovation activities[56]. In particular, **Table 9** shows that those economic sectors characterised by a more pervasive presence of sole researchers are those who report averagely higher TFP growth rates, whereas the overall impact of the broad category of workers dedicated to R&D activities has a negative effect. A possible explanation of this dynamic can be attributed to the fact that deep specialisation in a certain economic sector (represented by the variable "Researchers") is considerably more beneficial than those innovation activities carried out by a multitude of employees, including non-experts.

Finally, the barely significant coefficient associated with variable "Irregular_employees" indicates that Italian enterprises seem to take advantage of illegal behaviours, such as irregular employment. According to **Table 9**, in fact, a +1% increase in the volume of Irregular workers generates a +0.67% TFP improvement within a given Italian industry. Anyways, this last conclusion needs to be taken with a grain of salt.

In summary, *Model-3* demonstrates that innovation efforts have a positive impact on productivity, but only in the event that R&D activities are carried out exclusively by private companies. On the other hand, Italian firms seem to be averagely unable to benefit from those innovation outputs produced by universities/public organisations/investments from outside the country. In addition, this regression analysis demonstrates the importance of sectoral specialisation, since **Table 9** shows that the more a sector's workforce is composed of researchers, the higher are the benefits in terms of TFP growth. Differently, when innovation activities are not carried exclusively by researchers, then the benefits translate to disadvantages for the aggregate sectoral economy.

Finally, *Model-3* proves that an extensive growth in the share of irregular employees has an aggregate positive impact on sectoral productivity. Anyways, this relationship appears to be characterised by a weak significance level.

[56] The coefficients in question are "Researchers" and "R&D_employees".

Robustness checks concerning *Model-3* are contained in Appendix IV. As reported in **Exhibit 19**, *Model-3* presents non-significant homoskedasticity. In addition, the Jarque-Bera test, contained in **Exhibit 20**, indicates that the residuals of *Model-3 do not* distribute normally. Anyways, the expected value of *Model-3* error terms appears to be significantly close to zero. Finally, **Exhibit 22** shows that *Model-3* is affected by multicollinearity. In any case, this latter aspect was largely predictable, given the conspicuous number of logically interconnected variables referring to the innovative intensity of Italian industries.

3.3 Analysis on Inter-Sector Productivity Dynamics in Italy

As already mentioned in Section 3.1, the objective of *Model-4* is to analyse productivity dynamics within the sole manufacturing sector from 2013 to 2019. Therefore, this fourth OLS linear regression differentiates from the previous one as it does not take into consideration the information referring to sector F, G, H, I, J, K, M, Q and S. Instead, it concerns 20 (of the total 24) sub-sectors which are part of sector C (the overall Manufacturing industry). Due to the lack of disaggregate information, the sampled sub-industries have been re-merged into the following categorisation:

- Food, Beverage and Tobacco industries (C.10, C.11 and C.12);
- Textile industries, Manufacture of clothing and Manufacture of leather goods and similar (C.13, C.14 and C.15);
- Wood, Paper and Publishing industries (C.16, C.17 and C.18);
- Manufacture of chemicals (C.20);
- Manufacture of rubber and plastic products and Other non-metallic mineral products (C.22 and C.23);
- Metallurgical activities and Manufacture of metal products, excluding machinery and equipment (C.24 and C.25);
- Manufacture of computer, electronic and optical products (C.26);
- Manufacture of electrical equipment and non-electric household devices (C.27);
- Manufacture of machinery and equipment not coded elsewhere (C.28);
- Furniture manufacturing, Other manufacturing industries, Repair and installation of machinery and equipment (C.31, C.32 and C.33);

In order to remove outliers and to preserve a high degree of completeness of information, sub-sectors C.19[57], C.21[58] C.29[59] and C.30[60] are excluded from *Model-4*.

[57] Manufacture of coke and products derived from oil refining.
[58] Manufacture of basic pharmaceutical products and pharmaceutical preparations.
[59] Manufacture of motor vehicles, trailers and semi-trailers.
[60] Manufacture of other means of transport.

As reported in **Table 10**, *Model-4* includes the same variables contained in *Model-3*[61], plus seven additional indicators: "Irregular_selfemployed_workers" (measuring the number of self-employed workers for every 100 employees), "Share_of_large_firms" (indicating the volume of large firms for every 100 microenterprises), "Share_of_mediumlarge_firms" (expressing the number of medium-large firms for every 100 microenterprises), "Share_of_small_firms" (showing the number of small firms for every 100 microenterprises), "Micro_firms", "Small_firms", "Medium_firms" and "Large_firms".

By looking at the results in **Table 10**, *Model-4* shows an excellent goodness of fit (R^2=96.4% and Adjusted-R^2=95.4%), three significant variables at the 99% level, five significant predictors at the 95% level and one barely significant regressor (this coefficient presents a p-value between 0.05 and 0.1 and, therefore, any conclusion originated by its interpretation must be handled cautiously).

It is interesting to note that even within this study it emerges that those manufacturing sub-sectors that are most affected by opportunistic behaviours (such as irregular work) are those that at the same time are more likely to record positive changes in their TFP[62]. However, this conclusion seems to be valid only with regards to irregular self-employment. Probably, the amount of taxes evaded through these opportunistic behaviours acts like a sort of "Reserve tank" for those manufacturing entrepreneurs who decide to adopt such illegal techniques, ending up creating an unfair and not-negligible competitive advantage.

Furthermore, **Table 10** shows how Italian manufacturing companies find it difficult to develop an adequate absorptive capacity. In particular, the negative sign of the coefficient associated with "Public_and_private_R&D_effort" proves that, in the short term, manufacturers' efficiency is not enhanced by R&D activities conjointly carried out by public and private organisations.

In addition, *Model-4* results show that, within the manufacturing environment, the more a given sub-sector is characterised by an elevated large-to-microenterprises ratio, the better

[61] See Subsection 3.2.

[62] The coefficient associated with "Irregular_selfemployed_workers" demonstrates that a +1% increase in the share of irregular self-employed workers can generate a +0.10% productivity improvement within a given manufacturing sub-industry.

it is in terms of efficiency improvements.

Table 10

VARIABLES	(*Model-4*) TFP_variation
Researchers	1.127***
	(0.010)
R&D_employees	0.091
	(0.417)
Irregular_employees	-0.166
	(0.141)
Irregular_selfemployed_workers	0.102**
	(0.024)
Public_and_private_R&D_effort	-1.075***
	(0.004)
Firms_R&D_effort	0.367
	(0.247)
Share_of_largefirms	2.058**
	(0.031)
Share_of_mediumlarge_firms	-0.460**
	(0.018)
Share_of_small_firms	0.030
	(0.287)
Micro_firms	0.165
	(0.555)
Small_firms	0.134*
	(0.061)
Medium_firms	-0.070**
	(0.023)
Large_firms	-0.020
	(0.327)
Control Variables	
Labour_Productivity_variation	0.874***
	(0.000)
Value_added	0.090**
	(0.015)
Constant	0.001
	(0.950)
Observations	70
R-squared	0.964
Adjusted R-squared	0.954
F-test (15, 54)	96.51

p-values in parentheses (*** p<0.01, ** p<0.05, * p<0.1)

On the other hand, the sign of the regressor associated with "Share_of_mediumlarge_firms" indicates that medium-sized companies have a completely opposite effect, which is capable of breaking down the advantages connected with exclusively large businesses' proliferation.

In summary, *Model-4* provides empirical evidence regarding the "Boosting" impact of irregular self-employment on productivity within the manufacturing sector. In addition, this study confirms how Italian companies struggle to translate their innovation efforts into a competitive advantage, due to the lack of an appropriate absorptive capacity. Finally, *Model-4* allows to demonstrate the beneficial role of large enterprises within the Italian context (especially if compared with the one of medium and micro firms).

Robustness checks concerning *Model-4* are contained in Appendix V. As reported in **Exhibit 23**, *Model-4* does not resist the robustness tests of Breusch-Pagan, showing significant heteroskedasticity. On the other hand, the Jarque-Bera test, contained in **Exhibit 24**, and the residuals' mean estimation, contained in **Exhibit 25**, demonstrate that the error terms of *Model-4* distribute normally, with an expected value significantly close to zero. Finally, **Exhibit 26** proves that *Model-4* is affected by multicollinearity. In any case, this latter aspect was largely predictable, given the conspicuous number of logically interconnected variables included in this study.

Section 4

4.1 A Potential Solution for Italian Inefficiencies

On the basis of the empirical evidence provided in Section 2 and 3, it emerges that the lack of aggregate efficiency and the absence of economic development in Italy can be traced back to the average incapacity of the Italian productive apparatus to innovate and encourage small businesses to expand their dimension. Of course, innovation and business size are not the only predictors of economic growth, as many other variables concur to influence the general efficiency of either a given country or a business sector[63]. However, in order to identify a potential solution to the productivity stagnation characterising Italy, it may be convenient to narrow the field of study and concentrate the analysis on the two aforementioned issues.

The convenience of focusing the study on innovation intensity and business dimension lies in the fact that any attempt to measure these two indicators is much more easily achievable[64], as they incorporate the remarkable advantage of being both frequently and efficiently quantifiable[65]. The quantifiability of such measures is a fundamental aspect to take into consideration, not only because it facilitates a more precise and rapid detection of the two aforementioned variables, but also because it can favour both frequent monitoring and accurate in-depth evaluations of eventual policies aimed at increasing the size of Italian enterprises, as well as encouraging their propensity for innovation.

In this regard, during 2008 the European Union designed and presented the "Small Business Act"[66]. This document included a communication (from the European Commission towards the other European Institutions[67]), which was initially meant to encourage Member States and Public Organisations to foster the growth of European SMEs. As a matter of fact, the

[63] See Subsection 2.5.
[64] Especially if compared to calculating other predictors, such as the quality of human capital used or the type of governance of a firm.
[65] Unlike other factors influencing the economic development of a country.
[66] From now on, the "Small Business Act" is referred to as "SBA".
[67] The Council, the European Parliament, the European Economic and Social Committee and the Committee of the Regions.

whole document is based on the promotion of the "Think Small First" principle. The general assumption at the basis of the SBA was that the future and the development of Europe could be possible as long as any country would implement policies intended for creating an economic environment in which smaller and younger businesses could prosper and expand their dimension (European Commission, 2008). As expected, immediately after the beginning of the 2008 financial crisis, it was already clear that innovation and national-level economic development are closely linked to the enlargement of the average size of firms.

For this reason, the SBA comprehended the following ten principles, aimed at guiding an efficient implementation of policies which could ultimately favour the growth of SMEs throughout the European Union:

- Give birth to an environment in which enterprises and family businesses could prosper and entrepreneurship is rewarded.
- Make sure that those honest business-owners who faced bankruptcy could rapidly obtain a second chance.
- Put the "Think Small First principle" at the basis of new rules' design.
- Enable Public Administrations to be responsive to the needs of SMEs.
- Adapt public policy tools to SMEs' needs: facilitate SMEs' participation in public procurement procedures and efficiently use State grants for sustaining SMEs' growth.
- Facilitate SMEs' access to financial resources and develop a supportive environment to timely payments in commercial transactions.
- Allow SMEs to benefit more from the advantages offered by the "Single Market".
- Encourage the evolution of skills and all forms of innovation in SMEs.
- Enable SMEs to transform environmental challenges into opportunities.
- Support SMEs to benefit from the growth of markets.

Interestingly, within the whole document, among the various provided guidelines referring to the implementation of the "Think Small First" principle, the one relating to the promotion of formal cooperation between companies stands out. As a matter of fact, throughout the SBA, business networking is identified as a very useful tool for the

enhancement of profitability growth within SMEs. In addition, according to the European Commission, networking activities are strongly advantageous, as they allow small businesses to exploit their true potential through the sharing of knowledge, information and resources (European Commission, 2008). It is no secret, in fact, that one of the main obstacles to growth and development of European and (especially) Italian SMEs is the incapacity to create economies of scale[68]. The reason behind the need to promote network contracts, therefore, lies in the fact that cooperation among companies allows them to reduce their operational costs through the common use of resources, patents, skills and capabilities.

On the basis of the highlighted motivations, since 2008, European institutions and Member States have been encouraged to promote the diffusion of intense coordination mechanisms among companies (even from different countries) through the adoption of networking activities (European Commission, 2008).

From a theoretical point of view, in much of the economic literature published during the last decades, it is actually confirmed that business networks provide several advantages to firms (especially to SMEs) and that such positive externalities manifest themselves through disparate forms. First of all, when networks involve the presence of well-known companies with a popular and trusted brand, this creates an endorsement effect in favour of smaller and younger participants. In this sense, for an undersized company, being a member of a network generates indirect advantages in terms of status improvement, better customer recognition and positive perceptions by the markets (Gulati and Higgins, 2003). Similarly, Lechner et al (2006) find a positive relationship between "Reputational Networks Affiliation"[69] and the reduction in the time necessary for young networking companies to break-even. In this regard, it seems that networks have an enzymatic effect on firm-level efficiency, as they accelerate the growth process of smaller participants, allowing them to become profitable in a shorter term than it would be normally required in absence of

[68] Within this discussion, economies of scale are represented by all those factors that allow companies to reduce their average costs, increase profits and have more manoeuvring space to devote to innovative activities.

[69] Aggregations which include the presence of a market-leader or, anyways, a company in its maturity stage, which controls a non-negligible share of the market, has a good reputation and a trusted brand.

business affiliation (Gulati and Higgins, 2003; Lechner et al., 2006). In some cases, therefore, networks provide the possibility to mitigate some of the risks affecting younger and smaller enterprises and, at the same time, they shorten the duration of young firms' relative "Liability of newness"[70].

Interestingly, Schoonjans et al. (2013) highlight a positive correlation between participation in a network and the possibility for a firm to expand its size, showing that networking allows firms to increase their dimension, also in terms of net assets and added value creation. On the other hand, both Bell and Zaheer (2005)[71] and Lin and Lin (2016)[72] notice that network participation improves firm-level performances. This conclusion is particularly valid in the case of affiliated firms which operate at the innovation frontier[73]. Similar results are also obtained by Stuart T. (2000), who concludes that American semiconductor producers' innovation and expansion dynamics are positively influenced by the existence of highly-innovative alliance partners[74].

In addition, Li et al. (2015) prove that performance improvements within affiliated firms positively depend on the intensity of resource transfers among partners, thus confirming that high levels of integration between companies allow for efficiency improvements. Moreover, the results obtained by Khanna and Rivkin (2001) show that business aggregations have a deeply beneficial impact on average members' profitability. Lastly, Havnes and Senneseth (2001) do not find empirical evidence regarding a short-term positive impact of networking[75]. Instead, the results of the latter study on 1700 European SMEs suggest that business networks are positively associated with an enlargement in the

[70] The concept of "Liability of newness" was first introduced in 1965 by the American sociologist, Arthur L. Stinchcombe. Essentially, the aforementioned concept indicates the state of vulnerability that, on average, young companies have to face during the first years after their foundation.
[71] Through a study on Canadian mutual funds.
[72] Through an analysis focused on Taiwanese manufacturing firms.
[73] This conclusion confirms the importance of the absorptive capacity for a company. More precisely, on average, the more a firm is embedded into an innovating environment, the more it is able to take advantage of the innovations/know-how/expertise/other material and immaterial resources stemming from external organisations. Obviously, the ability to metabolise these resources has evident and positive effects on firms' performance.
[74] As they do not fully appropriate the fruits of their innovation, though allowing to some extent their partners to enjoy them in turn.
[75] Such a conclusion is in partial contrast to what highlighted in both Gulati and Higgins (2003) and Lechner et al. (2006).

geographic extension of members' markets, implying that such alliances are useful for achieving exclusively long-term objectives.

Evidently, networking improves firm performances through multiple direct and indirect channels. Among them, one of the most relevant means through which businesses manage to increase their efficiency is R&D cooperation. In this regard, Gronum et al. (2012) notice that partnerships enhance performance improvements, but they also highlight that this causal nexus is mediated by innovation. Therefore, in order to increase their chances of being successful, firms are supposed to establish strong and heterogeneous relationships with the ultimate objective to benefit from all those innovative externalities generated by their partners. In addition, while Marinucci M. (2012) highlights that, in general terms, R&D cooperation improves both private companies and overall communities' welfare, on the other hand Schøtt and Jensen (2016) show that networking fosters both process and product innovation. Similarly, through a study on pharmaceutical firms from all over the globe, Mazzola et al. (2016) conclude that being part of a network increases firms' chances of developing product innovations. Finally, Koput et al. (2016) highlight that whenever an industry is characterised by high complexity, elevated expansion rates and low concentration of expertise, then the locus of innovation is more likely to be found within networks rather than individual firms.

By looking at the consensus shared by several economists[76] concerning the multiple advantages deriving from business networks, it is not difficult to hypothesise that both an implementation and a widespread adoption of this tool could be extremely useful for Italian entrepreneurs, especially if we take into consideration networks' capacity to both improve the performance of private organisations and stimulate firm-level innovative cooperation. On the basis of both the just-described advantages and the European Commission's guidelines, one year after the publication of the SBA, in 2009, the Italian legislator introduced the regulation of the network contract into the legal system[77]. The

[76] Verifiable from the works cited above.

[77] Specifically, network contracts in Italy (known as "Contratti di Rete") are governed by the *Decree-Law of 10 February 2009 № 5*, converted with amendments into Law the 9th April of the same year. Officially, the networks' regulation came into force in 2010, the year in which the first "Contratti di Rete" began to be used by Italian entrepreneurs.

decision[78] to formalise the regulation around such contracts was generated both by the desire to create ad hoc incentives for networks, and by the need to recognise a new form of coordination that would guarantee greater flexibility than traditional ones.

As highlighted in Subsection 4.2, after an initial moment of "Mistrust", this contractual tool has been increasingly recognised by Italian entrepreneurs as a remunerative support for meeting their needs, thus exhibiting adoption rates in constant growth every year in year. Anyways, as highlighted in Subsection 4.3 and 4.5, during the last thirteen years the geographical distribution of network contracts has not remained uniform neither within the Italian territory nor within the various Italian industries.

As regards the actual impact of networks on Italian businesses, Subsection 4.5 reports two studies which contribute to describe the most promising results obtained by the regulation of business networks during the first 5 years after their official recognition.

Furthermore, while Subsection 4.4 is dedicated to a study on the relationship between sectoral innovation and the presence of entrepreneurial coordination forms (which are alternative to the network contract), on the other hand Subsection 4.6 presents an original microeconomic analysis on the tangible effects of network contracts in Lombardy and Piedmont regions within a period between 2019 and 2021.

Finally, Subsection 4.7 focuses on a review of the economic literature concerning the relationship between networks and sustainability.

[78] This choice makes Italy one of the few European countries to expressly recognise business networks within its legal system.

4.2 Network Contracts Legislation

As previously anticipated[79], through the *Decree-Law of 10 February 2009 № 5*, the Italian legislator opted to recognise and formalise network contracts, with the ultimate objective to stimulate SMEs dimensional growth and increase competition among firms.

In this regard, the aforementioned Decree-Law defines a "Contratto di Rete" as an agreement through which at least two enterprises adopt a joint program in order to increase their competitiveness and innovating capacity. Therefore, each contracting party is supposed to collaborate, share information or exchange services of commercial and technical nature. In terms of intensity, the legislator does not impose any form of mandatory coordination, since any network can range from a mere agreement for the exchange of information, to the complete exercise of a conjoint economic activity. From a functional point of view, contracting parties can either achieve vertical integration objectives or horizontal cooperation, also through a strengthening of the ties already in place (Bentivogli et al., 2013). As it can be noticed, the coordination spectrum of networking companies is extremely broad and leaves enormous freedom to any economic operator.

In general, the decision to create a network can be caused by a multitude of business needs, such as the expansion of customer portfolio, the reduction of costs, the creation of economies of scale, the possibility to penetrate new markets (both national and international), the expansion of the catalogue of goods and services to be supplied, the implementation of innovation processes and the sharing of both know-how and commercial information. Another criterion for evaluating the usefulness of the network contract is represented by its role in facilitating the access to credit, through the reduction of transaction costs for the affiliated companies.

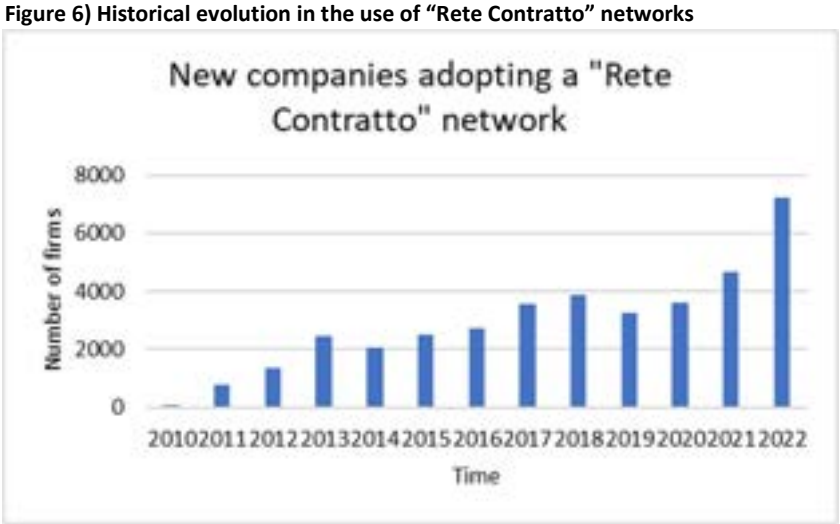
From a merely formal perspective, contractual networks must be drawn up in one of the following formats: Public Document, Authenticated Private Document and Digital Signed Document. Regardless of the chosen format, these contracts must compulsorily indicate

[79] See Subsection 4.1.

the name of the participating companies (by original or subsequent subscription), the strategic objectives of the participants (as well as the methods agreed between them to measure progress towards these objectives), the network program (with an indication of the rights and duties assumed by each participant), the contractual duration, the procedure to include new potential partners and the decision-making rules concerning any issue or aspect of common interest.

In addition, since 2011 the Italian legislation has allowed companies to choose between two different categories of formal networks: the so-called "Reti Contratto" and "Reti Soggetto"[80]. The first category enables firms to establish a network without necessarily giving birth to an autonomous legal entity (completely distinct from the contracting companies). Anyways, companies adopting this type of contract are still free to decide whether to have a common patrimonial fund and a common body. The second category, on the other hand, refers to an agreement stipulated between companies, which requires the establishment of a patrimonial fund and a common entity that acquire autonomous legal subjectivity as soon as they are registered in the national companies' register. Evidently, this second category requires greater integration and much more binding cooperation relationships. Since 2011, the "Reti Soggetto" type of contract has been generally less considered by firms which aimed at establishing a network. **Figure 6** and **7** provide some interesting insights about the trends in the usage rate of the two

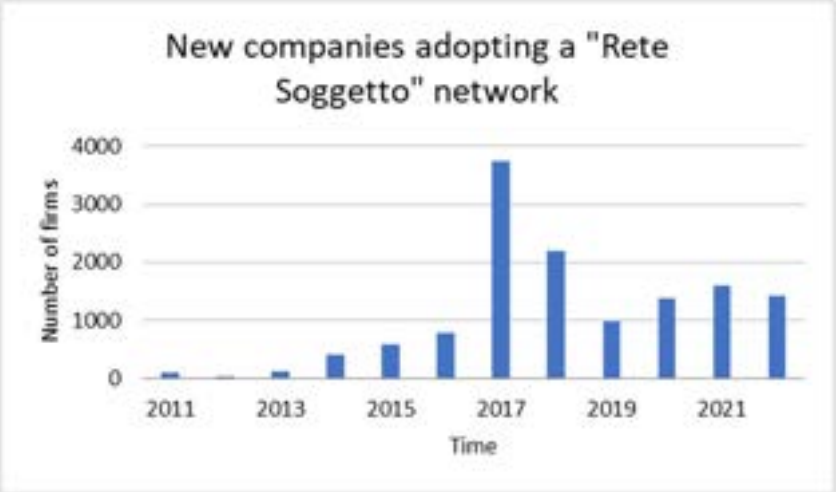
Figure 6) Historical evolution in the use of "Rete Contratto" networks



Source: Author's elaboration of data provided by Infocamere

[80] This second category is the one which has been integrated within the Italian legislation in 2011.

Figure 7) Historical evolution in the use of "Rete Soggetto" networks



Source: Author's elaboration of data provided by Infocamere

different categories, thus showing that during the last twelve years "Reti Contratto" have expressed a quite regular growth in terms of their popularity, whereas "Reti Soggetto" have recorded relatively lower and more oscillating adoption rates.

On the basis of the data provided by Infocamere, it is quite evident that that the majority of Italian networking companies have preferred and still prefer the first contractual category[81]. In addition, **Figure 7** shows that during the first years after the establishment of the "Rete Soggetto", this category struggled enough to be accepted by Italian entrepreneurs. Only in 2017 it started to experience a profound growth, eventually fluctuating between 2018 and 2022.

About the overall the usage rate of networks, regardless of the distinction between the two contractual typologies, according to Bentivogli et al. (2013), since the entrance into force of *Decree-Law of 10 February 2009 № 5*, for several months the only remarkable effect of such Decree-Law has been the formalisation of pre-existing partnerships. As a matter of fact, the majority of early-registered contracts only concerned those informal networks which already existed before 2009. On the other hand, since 2012 this novel contractual form has begun to favour the creation of unprecedented affiliations between companies,

[81] From 2010 to 2022, about 38691 Italian firms have decided to create a "Rete Contratto" network, whereas from 2011 to 2022, about 13282 companies have entered a "Rete Soggetto" network.

above all due to Italy's decision to create a series of ad hoc economic incentives linked to the official establishment of formal long-term alliances.

The first attempt of the Italian legislator to encourage the adoption of network contracts is contained within *art. 3 of Decree-Law of 10 February 2009 № 5*. The first step of the legislator, through this article, was to make the network contract equal to other forms of entrepreneurial coordination (already present in Italy), such as consortia. In fact, within this article, financial facilitations[82] regarding the access to credit have been extended also in favour of networking participants.

Another extremely useful incentive aimed at promoting the adoption of networking alliances is contained in *art. 42 of Decree-Law of 31 May 2010 № 78*. This regulatory act provided for a tax suspension regime in favour of network contractors for the years 2011, 2012 and 2013. In particular, the foreseen incentive was intended for all those networks of companies which decided to allocate their profits[83] towards a common reserve, with the ultimate aim of using it as a financing source[84] for the realisation of investment projects indicated in the contractual program. The ultimate goal of this regulation was, in essence, to encourage the commitment of each partner, ensure the effective implementation of the program and facilitate investments.

Furthermore, *art. 42 of Decree-Law of 22 June 2012 № 83* provided considerable facilitations for all those consortia which, making use of a network contract, decided to start investment projects aimed at fostering their own internationalisation process. In particular, the recipients of these provisions were granted contributions aimed at covering a maximum of 50% of the expenses incurred for the execution of the "Internationalisation projects", to be implemented even through the establishment of network contracts involving SMEs that were not necessarily part of any beneficiary consortium. Through this article, the goal of the Italian legislator was twofold: on the one hand, the direct effect of this kind of incentive was to increase the number of networking SMEs. On the other hand,

[82] Such facilitations were already contained in *art. 1 paragraph 368 of Law of 23 December 2005 № 266*.
[83] The maximum number of allocable profits identified by the legislator is equal to one million euros.
[84] According to *art. 42 of the Decree-Law of 31 May 2010 № 78*, the tax suspension regime was intended for all those investments realised in the year immediately after the allocation of the profits towards the common reserve.

the provided contributions were meant to stimulate the growth of businesses, even encouraging SMEs to reach an international dimension.

An ulterior example demonstrating how the Italian legislator promoted network contracts' adoption, is contained in *art. 6bis of Decree-Law of 24 June 2014 № 91*. The whole normative act is generally dedicated to the protection of Italian brands, whereas *art. 6bis* specifically foresees that agricultural, forestry and agri-food companies participating in a network contract can benefit from subsidised financing from the Government. At the same time, this Decree-Law allowed networking firms to gain a certain "Priority" in accessing the funding provided by the measures of the regional and national rural development programs.

Finally, the last incentive of the Italian Government aimed at encouraging networking activities is represented by *art. 1 of the 2015 Stability Law*. Specifically, the sixth paragraph of *art. 1* established a support fund[85] for the years 2014 and 2015, which was dedicated to all those companies with more than fifteen employees that decided to implement innovative/research activities within a network contract. Even in this case, the goal of the Italian legislator was twofold: on the one hand it aimed at increasing the share of SMEs. On the other hand, the allocated funds were supposed to stimulate R&D cooperation and innovative activities.

In conclusion, by looking at **Figure 6** and **7** it can be noticed that, especially in the case of "Reti Contratto", the presented incentives have achieved the goal of bringing entrepreneurs even closer to the world of partnerships. But above all, the most successful impact of the illustrated facilitations is represented by the fact that they have not had significant distorting effects on the market. In particular, where some of these measures have not been renewed[86], there has nevertheless been a growth in the adoption rates by businesses. All this clearly demonstrates that after needing to be "Pushed" to create network contracts, nowadays Italian companies already recognise networks as an extremely useful and beneficial tool for achieving growth, regardless of the existence of

[85] Of five to ten million euros.
[86] As in the case of the concessions provided for by *art. 6bis of Decree-Law of 14 June 2014 № 91* and by the first article of the *2015 Stability Law*.

huge State subsidies. This latter conclusion is also confirmed by Costa et al. (2017): in fact, within this research, conjointly carried out by Istat and Confindustria[87], through an analysis of 211 thousand Italian companies it is evidenced that, on the one hand, those networking companies which took advantage of a tax bonus, have also achieved better performances than they would have achieved without being affiliated. On the other hand, the study shows that the beneficial effect of the aforementioned subsidies seems to vanish in the long run, ending up not significantly affecting the differences in terms of performance between subsidised and non-subsidised companies. For this reason, over a fairly extended time horizon, it is difficult to hypothesise that State tax and non-tax benefits still represent one of the most significant drivers which encourage companies to join a network.

[87] The main representative organisation of Italian manufacturing and service companies.

4.3 Geographical Distribution of Networks

As highlighted through the previous Subsection[88], network contracts have enjoyed and are continuing to enjoy moderate success among Italian businesses[89], especially if we consider their growth rates in terms of businesses that chose to adopt this tool for the first time. However, a more in-depth analysis on this topic requires verifying whether the adoption of such contracts has remained uniform also at the territorial level.

In this regard, already in 2013, Bentivogli et al. (2013) noticed that the phenomenon of network contracts, despite being present in almost all Italian regions[90], still presented an unequal distribution, with a rather accentuated disproportion towards the Central and North-Eastern territories. At the same time, Southern territories appeared to be less interested in this new coordination mechanism. The same kind of conclusions are also highlighted in Costa et al. (2017)[91], through which the distribution of Italian networks in a period set between 2010 and 2015 is addressed.

Unfortunately, almost fourteen years after the inclusion of the network contract within the Italian legal system, it seems that the disproportionate distribution of the usage rate of such tool has been even accentuated. In order to have a clearer idea about the current situation on the Italian territory, it can be useful to look at **Figure 8** and **9**.

In particular, **Figure 8** reports the aggregate number of enterprises which decided to issue a "Reti Contratto" network contract from 2010 to 2022 and, as it can be noticed, Southern regions show a relatively lower reliance on this kind of contractual instrument. In this scenario, Campania and Puglia represent a sort of exception, as the number of networking businesses within these two regions is essentially similar with the one of Northern and Central territories. With regards to the aforementioned studies of Bentivogli et al. (2013) and Costa et al. (2017), **Figure 8** shows that during the last 7 years there has been a certain

[88] See Subsection 4.2.
[89] In particular, the adoption of "Reti Contratto" type of networks has recorded a constant and positive growth since its introduction in the legal system.
[90] Before 2013, network contracts had been issued in nineteen of the twenty Italian regions.
[91] Through this study it emerges that especially the enterprises based in Tuscany and Lombardy were strongly attracted by the advantages offered by network contracts.

reduction in the differences among North-Eastern and North-Western regions, while the aggregate gap among Northern and Central regions is more accentuated with respect to the past.

On the other hand, **Figure 9** reports very interesting insights concerning the geographic distribution of "Reti Soggetto" contracts. This second map presents more remarkable differences with respect to the previous one. In particular, **Figure 9** shows that almost 40%[92] of "Reti Soggetto" networks, between 2011 and 2022, have been registered by companies located in Lazio region[93].

A possible explanation for the remarkable concentration of networks within Lazio region can be attributed to the fact that during the last 7 years, the Government of the region in question has been strongly committed towards the promotion of such coordination tool, regardless of the adopted contractual category[94]. In particular, in 2016 the regional Government of Lazio set up a tender worth ten million euros (with a maximum funding of 100 thousand euros per network), dedicated exclusively to the birth, the development and the sustainability of business networks made up of at least 30 units. In addition to that, through *Regional Law of 6 November 2019 № 5*, the regional Government of Lazio has allocated approximately 6.6 million euros for the two-year period 2020-2021 in order to finance programs to support the development of network contracts (Regione Lazio, 2019).

Returning to a broader discussion, **Figure 9** essentially shows that, excluding the outlier represented by Lazio region, there are not major discrepancies among Northern, Central and Southern regions, in terms of "Reti Soggetto" territorial distribution, since all of these three macro-areas show relatively low adoption rates.

As for the case of "Reti Contratto", also with regards to the adoption rates of "Reti Soggetto" among Southern regions it must be highlighted that Campania and Puglia exhibit

[92] Since 2011, 5289 contracts (of the total 13254).
[93] If we consider Lazio, Lombardy and Tuscany, about 55% of the Italian networks have been registered in these sole three regions.
[94] In fact, by looking at **Figure 8** and **9** it can be noticed that Lazio is the region which records the highest number of both "Reti Contratto" and "Reti Soggetto" networks.

significantly better performances. In particular, these two territories account for about 56% of total Southern networks.

Finally, **Figure 9** shows that the adoption of “Reti Soggetto” is not characterised by significant disproportionate distributions among North-Western and North-Eastern regions.

Figure 8) "Reti Contratto" distribution within the Italian territory

Source: Author's elaboration of data provided by Infocamere

Figure 9) "Reti Soggetto" distribution within the Italian territory

Source: Author's elaboration of data provided by Infocamere

4.4 Other Coordination Mechanisms adopted by Italian Enterprises

Since 2009, the general role of network contracts was to flank, in a complementary way, with other mechanisms of aggregation among companies, such as plurilateral contracts[95] (i.e., consortia[96] and temporary associations of companies, also known as "ATI"[97]) or bilateral contracts (i.e., franchising, trademarks and licensing contracts) (Bentivogli et al., 2013). In fact, the most widespread coordination tool for Italian enterprises is that of the "Consortium with external activities" or of the "Consortium with mutualistic purposes", through which affiliated firms take advantage of the economies of scale deriving from the shared management of resources for the production of goods and services of common interest (Bentivogli et al., 2013). Another advantage stemming from this particular associative form is that consortia allow small businesses to overcome some of the disadvantages related to their size, as they enhance participation in procurement tenders for which small firms and microenterprises would not possess adequate size requirements. However, consortia remain slightly different from network contracts, as they do not incorporate some of the beneficial coordination mechanisms that characterise the contractual tool introduced in 2009 (Bentivogli et al., 2013). As a matter of fact, the mutualistic nature[98] of consortia makes sure that affiliated companies mainly focus on the coordination of singular phases of their production processes, rather than reorganising into a more profit-oriented and integrated production of goods and services. In essence, although the consortium is a useful tool for aggregation and coordination among firms, the network contract still provides for greater flexibility and even more efficient coordination (Bentivogli et al., 2013).

Moreover, alongside consortia, an alternative coordination instrument which appears quite adequate for Italian entrepreneurs is represented by the establishment of Limited Liability Companies[99]. This type of company combines high asset/service transferability and

[95] This tool is mainly used for the coordination of companies in an equal position.
[96] In Italy, consortia usually have mutualistic purposes.
[97] Such a tool differentiates from contractual networks because of its temporary nature. In fact, the specific purpose of this instrument is to allow the parties to participate in a procurement procedure, without creating a stable and long-lasting coordination mechanism.
[98] Essentially based on cost reduction.
[99] From now on Limited Liability Companies are referred to as "LLCs".

large margins of flexibility in the regulation of the management process, also with regards to the administration of the relations among partners[100] (Bentivogli et al., 2013). However, LLCs present some limitations both with reference to the possibility of establishing additional obligations for given shareholders and to the possibility to derogate from the principle of proportionality between rights and shares owned. For this reason, even when compared with LLCs' coordination mechanisms, business networks appear to be slightly more flexible (Bentivogli et al., 2013).

Despite the highlighted differences that distinguish network contracts from consortia and LLCs, it is nonetheless important to analyse the relationship that the latter two have with respect to the innovation propensity of affiliated companies. As seen in previous chapters, the more companies have a high propensity to associate, form partnerships and establish coordination mechanisms, the more likely they are to increase their innovation rates. Consequently, such firm-level improvements can generate positive externalities throughout the industries in which cooperating businesses are located, ultimately ending up increasing the overall sectoral innovation intensity.

In order to empirically verify this latter assumption, I have collected some data that indicate the level of innovative effort carried out within ten different Italian industries[101]. In particular, I decided to analyse the relationship between the variable "Firms_R&D_effort"[102] and the presence of consortia/LLCs/Stock companies within a given economic sector. The decision to include Stock companies in this analysis is justified by the willingness to compare how different types of companies/groups of firms have divergent impacts on the aggregate innovation intensity of Italian sectors.

[100] In fact, LLCs' statutes can enhance particular rights to specific shareholders, with reference to the appointment of directors, the possibility of vetoing certain operations, and the possibility to exclude partners because of the lack of certain requisites/breach of the contract.

[101] As for *Model-3*, the sectors under analysis are the following: Manufacturing (sector C), Construction (sector F), Wholesale and Retail Trade, Repair of motor vehicles and motorcycles (sector G), Transport and Storage services, Accommodation and Catering (Sector H and I), Information and Communication services (sector J), Financial and Insurance activities (sector K), Professional, Scientific and Technical activities (sector M), Health and Other services dedicated to households and businesses (sector Q and S).

[102] Essentially, this indicator expresses the volume of R&D investments for every 100 employees in a given industry. This measure is a proxy for representing the propensity to implement product/process innovations within Italian business sectors.

As it can be noticed through the matrix presented in **Table 11**, I first opted to verify what is the correlation between merely private innovation proneness and the presence of Consortia, Limited Liability Companies and Stock Companies, respectively expressed by the variables “Consortia”, “LLCs” and “Stock_companies”.

The results of the matrix contained in **Table 11** seem to confirm the positive correlation between the presence of both Consortia/LLCs and medium-high innovation propensity in a given industry. In fact, while the presence of stock companies is basically uncorrelated with sectoral innovative effort[103], on the other hand “Consortia” and “LLCs” express a positive and significant relationship with “Firms_R&D_effort”.

Table 11

	Firms_R&D_effort	Consortia	Stock_companies	LLCs
Firms_R&D_effort	1			
Consortia	0.420**	1		
Stock_companies	0.0508	0.0933	1	
LLCs	0.520***	0.461***	0.298*	1
N	56			

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

With the intention of analysing the relationship between the reported variables in an even more in-depth way, I opted for the creation of a linear regression model (named “*Model-5*”)[104]. Essentially, *Model-5* treats " Firms_R&D_effort " as the dependent variable, while “Consortia”, “LLCs” and “Stock_companies” are the predictors. Furthermore, in order to test the overall reliability of *Model-5* the control variable named "R&D_employees"[105] has been finally included within this fifth OLS multiple linear regression analysis.

[103] The coefficient aimed at measuring the correlation between “Stock_companies” and “Firms_R&D_effort” is not significant. In any case, even without taking into consideration the level of significance, the expressed value is very close to zero, indicating once again the absence of correlation between the two variables.

[104] See **Table 12**.

[105] As indicated through the previous Subsections, this variable expresses the share of employees dedicated to R&D activities over the total workforce operating in a given economic sector.

As it can be observed through **Table 12**, the overall study is characterised by a medium-high goodness of fit[106] and all the analysed coefficients present an elevated level of significance[107], with the exception of the constant term.

Table 12

VARIABLES	(*Model-5*) Firms_R&D_effort
Consortia	1.598***
	(0.000)
LLCs	-0.027***
	(0.001)
Stock_companies	-0.147***
	(0.009)
Control Variable	
R&D_employees	33.342***
	(0.000)
Constant	-0.145
	(0.270)
Observations	56
R-squared	0.763
Adjusted R-squared	0.745
F-test (4, 51)	41.15***

p-values in parentheses (*** p<0.01, ** p<0.05, * p<0.1)

Interestingly, the results contained in **Table 12** show that the presence of consortia predicts a positive increase in the innovating propensity of a certain economic sector. In particular, a +1% increase in the volume of consortia (for every 100 private companies) generates a more than proportional increase[108] in the volume of R&D investments for every 100 employees. In essence, this analysis helps to demonstrate the positive impact that forms of association such as consortia have towards innovation. On the other hand, *Model-5* allows to highlight how the impact of stock companies on sectoral innovation intensity seems slightly negative, while that of LLCs is practically nil. In general, this analysis partially confirms that associative forms have a positive impact on the development of new products/production techniques. In particular, the consortium association (among the

[106] The R^2 index shows that *Model-5* is able to explain about 76% of the variability of the dependent variable.
[107] The p-values associated with each regressor are lower than 0.01.
[108] Of +1.598%.

various alternatives to network contracts) represents the most useful tool for favouring an increase in the aggregate innovative intensity of ten sampled industries, which employ about 70% of the Italian workforce.

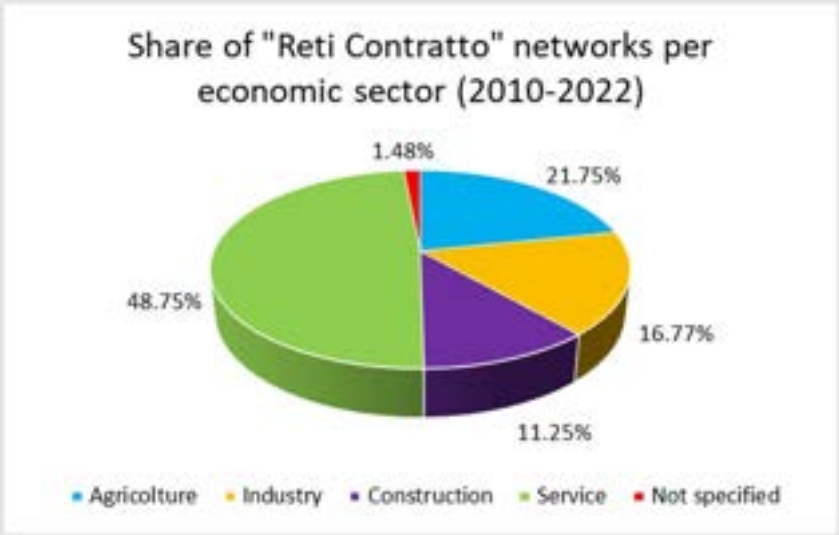
Robustness checks concerning *Model-5* are contained in Appendix VI. As reported in **Exhibit 27**, *Model-5* does not resist the robustness tests of Breusch-Pagan, showing significant heteroskedasticity. On the other hand, the Jarque-Bera test, contained in **Exhibit 28**, demonstrates that the residuals of *Model-5* distribute normally. Finally, **Exhibit 29** indicates that *Model-5* is not affected by significant multicollinearity.

4.5 The Impact of Networks on Italy

Starting from 2010, year in which the first network contracts have begun to be formally registered and adopted by Italian companies, this tool has been used in a heterogeneous way, not only in terms of geographical location[109], but also in terms of sectoral distribution of the affiliated companies.

As a matter of fact, by looking at the data provided by Infocamere[110] it is possible to observe how network contracts[111] tend to be more adopted by firms operating in the Service macro-sector[112]. By comparing **Figure 10** and **11** it can be also deduced that the aforementioned sectoral concentration (in favour of the Service business) is even more accentuated in the case of “Reti Soggetto" type of networks[113].

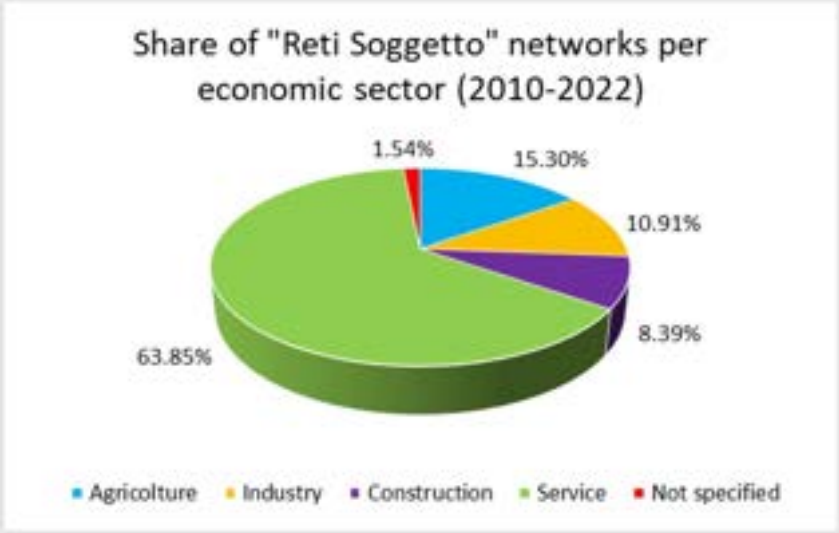
Figure 10) Sectoral distribution of “Reti Contratto” networks



Source: Author’s elaboration of Infocamere data

[109] See Subsection 4.3.
[110] The IT company of the Italian Chambers of Commerce.
[111] Both in the case of those that give life to a patrimonial fund with legal subjectivity, and in the opposite case.
[112] Considering the data provided by Infocamere, the majority of network contracts signed by service companies, belong to sector G (Wholesale and Retail Trade, Repair of motor vehicles and motorcycles), sector H (Transport and Storage services), sector I (Accommodation and Catering) and sector M (Professional, Scientific and Technical activities).
[113] In fact, the share of networking companies operating in the Service macro-sector is almost fifteen percentage points higher for “Reti Soggetto” (63.85%) than for “Reti Contratto” contracts (48.75%).

Figure 11) Sectoral distribution of "Reti Soggetto" networks



Source: Author's elaboration of Infocamere data

On the basis of the presented graphs, it seems evident that a certain tendency has developed among Italian companies to adopt network contracts, especially in those businesses affected by a declining aggregate productivity[114]. Considering such empirical evidence, it can be hypothesised that those companies which belong to less productive sectors, recognise the network contract as a useful instrument for supporting their efficiency level, mitigating the systemic unproductiveness of the environment in which they are embedded and gaining competitive advantages. For these motivations, it is not a case that the most "Binding" typology of network[115] enjoys considerable success among those firms which belong to Service and Construction macro-sectors[116].

A similar conclusion is also reached by Costa et al. (2017), who, through an analysis on the 2011-2015 period, emphasise how network contracts have recorded a positive and significant impact on the performance of Italian firms, allowing them to maintain their

[114] With this regard, in Subsection 3.1 it is shown that from 2003 to 2019 both the Construction and the Service macro-sectors have been affected by average negative TFP growth rates. More precisely, firms operating in the Service sector have recorded a yearly aggregate productivity slowdown equal to -0.049%. On the other hand, the aggregate performance of Construction businesses has been even worse, as they reported a yearly -1.271% reduction in their aggregate TFP.

[115] The one which requires contracting companies to set up a common patrimonial fund.

[116] Around 70% of "Reti Soggetto" network contracts, in fact, involve companies operating in these two averagely inefficient business fields (see Subsection 3.1).

growth standards even in a period characterised by a severe global recession, such as the one that occurred in connection with the 2010s sovereign debt crisis.

More Specifically, in Costa et al. (2017) it is applied a "Counterfactual test" with the objective to estimate the effects of the introduction of the network contracts on company-level performances. Through this test, a category of firms is identified (the so-called "Control group") which do not participate in any network, though possessing significantly analogous characteristics[117] with respect to networking companies. Through this type of analysis, Costa et al. (2017) managed to compare the performances of two categories of similar companies that only differed for the fact that one decided to join a network whereas the other one did otherwise. The cited study, in essence, obtains two remarkable goals:

- Isolating the impact of business networks from a range of multiple potential explanatory variables that inevitably affect networks' success.
- Explaining which have been the tangible benefits enhanced by contractual networks in Italy after the global recession started in 2008, which evidently affected the whole European economic environment.

In particular, on the basis of the analysis provided by Costa et al. (2017), the average difference in terms of employment growth between networking and non-networking firms in Italy, has been equal to +5.2% in 2012, +8.1% in 2013 and +11.2 in 2014%[118] in favour of the first business category. Moreover, the turnover growth differences between the two samples are even more significant: +7.4% in 2012 and +14.4% in 2014 in favour of networking firms. Essentially, since their introduction within the legal system, network contracts have consistently contributed to defend both firm-level competitivity and employment growth during an economic crisis of exceptional duration and intensity[119] (Costa et al., 2017).

[117] In terms of employees, turnover, business sector, technologies adopted, type of governance and geographic location.
[118] It should be noted that the beneficial impact of the networks has followed a growing trend from year to year.
[119] In the period considered, the average decrease in turnover and number of employees was much more accentuated in non-networking companies (Costa et al., 2017).

In order to proceed with the qualitative analysis concerning the impact of business networks it is useful to remind that in Subsection 4.1, through the description of the European Small Business Act, one of the document's most remarkable indications referred to the beneficial role of networks, especially for SMEs. In fact, through the SBA it emerges that the EU considers networks as a fundamental tool for protecting smaller companies and allowing them to improve their size and productivity standards (European Commission, 2008). In this regard, Costa et al. (2017) find empirical evidence about the beneficial spillovers of networks in Italy, especially for micro and small enterprises[120], while medium-sized businesses seem to be less responsive to the advantages linked with business affiliation.

An ulteriorly interesting conclusion reached by Costa et al. (2017) concerns the economic impact of contractual networks towards aggregate sectoral performances. In particular, the presented research shows that, between 2011 and 2015, business aggregations have generated positive effects for all the main Italian sectors, with the exception of the Construction macro-sector. Specifically, for those companies operating in the Manufacturing and the Service sectors, Costa et al. (2017) show that, three years after the adoption of a network contract, firms exhibit a turnover growth which is 15% higher than the one related to non-networking companies.

With regards to the relationship between geographic location and the benefits enhanced by networks, their effects seem to remark once again the discrepancies in the productive system of Southern regions and the rest of Italy. In particular, Costa et al. (2017) point out that, from 2011 until 2015, while networks have allowed for average improvements of +23.2% (in terms of turnover) and +13.7% (in terms of employment) in the regions of Northern and Central Italy, at the same time the effects on Southern territories seem to be much more discouraging (with a -30% drop in turnover and a -14% drop in employment). Therefore, by taking into consideration this empirical evidence, the role of network contracts remains somewhat ambiguous, as it is ascertained that their effectiveness

[120] Micro- and small-sized enterprises exhibit a doubling in terms of revenues between the first (+12.6%) and third year (+24.7%) after the adoption of a network contract. Similar results are also obtained by large organisations.

depends very much on the productive apparatus in which they are applied, and that, evidently, the advantages deriving from their insertion does not apply in any context.

As in the case of Costa et al. (2017), also Cisi et al. (2020) come to the conclusion that the impact of networks strongly depends on the geographical location in which this tool is used. In any case, while Costa et al. (2017) demonstrate that the Central-Northern regions are more capable of exploiting the benefits deriving from networks, on the other hand Cisi et al. (2020) reaches diametrically opposite conclusions. In fact, Cisi et al. (2020) highlight how network contracts bring particular benefits in less developed geographical areas, characterised by less efficient infrastructures and high propensity to base the economy on more traditional sectors. More precisely, Cisi et al. (2020) demonstrate that belonging to a network allows contractors in the most underdeveloped areas to increase both their value added (per units of revenues) and their export share to a higher extent than that of companies located in Northern Italy[121].

In general, the analysis provided by Cisi et al. (2020) is based on a study on those Italian SMEs which have decided to be part of a network contract from 2010 to 2014. As in the case of Costa et al. (2017), a counterfactual test is also carried out with the aim of quantifying the real economic advantage that networks bring (Cisi et al., 2020). The final results of this research show that, on average, networks allow contracting SMEs to increase their value added per units of revenues and, at the same time, to foster their international presence[122]. Finally, according to the presented research, membership in a network does not have a significant impact on profit growth. This latter conclusion is to be considered reasonable and acceptable since, as highlighted by Costa et al. (2017), the 2010-2014

[121] In Southern and Central Italy, after entering a network, the value added per unit of revenues records an increase of +1% (while the whole sample exhibits an average +0.5% growth). At the same time, the export share of networking SMEs located in underdeveloped areas also increases by +8% (as compared to +0.6% for the whole sample). For this reason, according to Cisi et al. (2020), formal networks are more beneficial in less developed areas, where the sharing of resources, information and expertise is a solution to compensate for the absence of infrastructures and services.

[122] This conclusion is particularly significant, as it demonstrates how networks act as a "Stepping stone" for SMEs, allowing them to diversify their markets, to be less affected by the policies and economic shocks of Italy and to increase their business dimension.

period was characterised by a severe global recession, which has necessarily influenced the reduction of European firms' profits.

In conclusion, on the basis of the literature presented, it can be deduced that the impact of business networks, although still very limited to a small share of the Italian entrepreneurial population, has rapidly brought its benefits towards Italian businesses. On average, belonging to a network has allowed Italian SMEs to resist macroeconomic shocks (stemming from the external environment) through an increase in their own efficiency. On the other hand, it is still difficult to understand whether networks are more advantageous for those enterprises already inserted in a more prosperous geographical context or if, on the contrary, they do have more significant effects on the enterprises of Southern Italy. In any case, formal firm-level cooperation has already started to produce interesting results as regards the dimensional growth of Italian SMEs and the consequent improvement in their production efficiency, through the creation of larger economies of scale.

4.6 Counterfactual Analysis on Networks' Effects

After having observed how, according to the economic literature provided within the previous Subsection[123], networks have generally managed to bring some significant advantages to affiliated companies in Italy, all that remains is to scrutinise these conclusions also from an updated empirical point of view. To differentiate the content of this Subsection from the models presented by Cisi et al. (2020) and Costa et al. (2017)[124] I decided to focus my analysis on a slightly more recent period of time, set between 2019 and 2021. In fact, the researches of Cisi et al. (2020) and Costa et al. (2017), while being extremely useful, precise and explanatory, do not have the advantage of being particularly novel and, above all, they only concerned those "First" network contracts adopted by a small share of Italian companies, which, at that time, were not yet supposedly used to integrate this coordination mechanism into their operational scheme. Consequently, with the aim of producing a more updated analysis that no longer assumes the network contract as a "Novelty in the Italian productive system", the following lines propose a study concerning the economic performance of 80 Italian firms which issued a network contract in 2019. Obviously, as for the previously-presented literature, the final objective of this analysis is to verify what have been (if any) the effects of networks on a portion of the Italian productive system during a three-year period characterised by the outbreak of the Covid-19 pandemic and by a subsequent economic recovery, started in 2021.

It is also important to underline that this Subsection, thanks to the use of the "Infocamere" database and the financial statements[125] of Italian joint-stock companies, is the only one within this thesis that makes use of disaggregated microdata for the quantification of networks' impact on single companies. More in detail, the Infocamere database provides information related to every Italian enterprise which has decided to enter a network since 2010. The information contained in this database includes the name of every networking company, the location of its physical headquarters (region, province and municipality to which it belongs), the name of the other contractual parties, the year in which the company

[123] See Subsection 4.5.
[124] Both studies focus on approximately the same time period, between 2010 and 2014.
[125] The selected financial statements are provided by the CompanyReports database.

joined the network, the economic sector in which it operates (coherently with the "Ateco a due cifre" classification) and its relative tax code[126] (which serves as an identification code). The integration of these data with the information relating to the turnover and the operating result of all the Italian joint-stock companies[127], therefore, serves as the basis on which the analysis of this Subsection is built.

Once the sources of this empirical study have been identified, it is good to dwell on what type of analysis is contained within this Subsection: in general, a common mistake that occurs when judging the impact of a given economic policy is to base such judgement on a comparison of the situation "Before" and the one "After" the implementation of that specific policy. This approach is somewhat incorrect, as it does not take into account all the other variables which inevitably affect those indicators monitored for the assessment of the policy in question. With reference to the intention of this Subsection, it is therefore useless to quantify the impact of business networks simply by comparing the economic results of companies before and after their participation in a network, since these results are evidently influenced by relevant macroeconomic dynamics, such as inflation, presence of conflicts in a given region, global recessions and employment dynamics.

Therefore, with reference to the concrete analysis contained in this Subsection, an interesting and accurate method for measuring the impact of networks is that of quantifying the entrepreneurial performance of networking companies over a certain period and, at the same time, estimating what their performance would have been in the event that they had not joined a network in the same timeframe. Obviously, the estimate of this second element is particularly delicate, as it requires the establishment of a control group[128] of non-networking companies which possess extremely similar characteristics to those of the sampled networking firms. Having such similarities in terms of type of enterprise, size, geographical location and belonging industry, the performance of the control group can be consequently considered as an approximation of what would have

[126] Through the tax code, it was possible to integrate the data provided by Infocamere and the ones provided by CompanyReports, ending up with the creation of a sample that contains both the economic result and the turnover of the networking companies considered.
[127] Both typologies of data are contained in the CompanyReports database.
[128] The concept of control groups is illustrated in Subsection 4.5.

been the average economic accomplishment of the networking enterprises in case they did not decide to affiliate.

Therefore, within this study, in order to quantify the impact of network contracts, 91 small-sized joint-stock companies[129] located in Lombardy and Piedmont have been selected. These companies are also united by two stylised facts: they operate in the construction and manufacturing sectors and all of them entered a network in 2019. Of these companies, both their turnover and their operating results for 2019, 2020 and 2021 are analysed. On the basis of these characteristics, the control group was analogously constructed. This second group is composed of 304 randomly selected enterprises and, as mentioned before, it serves as a sort of benchmark for the performance of affiliated firms.

Finally, it must be highlighted that all those companies with particularly "Extreme" economic results were eliminated from the analysis. In particular, all the entities which recorded a year-over-year change in turnover or a year-over-year change in EBIT with a z-score above (below) +3 (-3), were treated as outliers and finally excluded from this research. As a result, the final sample of networking firms ends up with 80 observations, while the control group is composed of 282 enterprises.

The quantification of the impact of the networks in the following lines is based on 2 comparisons:

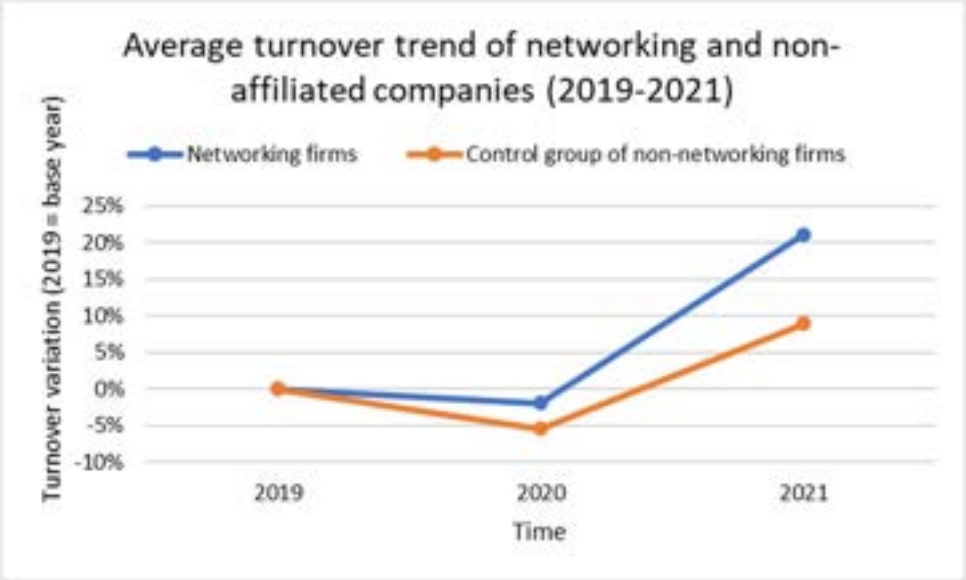
The first analysis investigates the variation in the turnover of the two sampled groups between 2019, 2020 and 2021. The objective, in this case, is twofold: in fact, this study is used for verifying whether networks averagely encouraged affiliated firms to improve their economic performance more than they would have done otherwise, but it also serves for estimating how group-affiliation allowed companies to recover from the damage caused by the global pandemic started in 2020.

In this regard, **Figure 12** shows quite exhaustively how, in 2020, the 80 sampled networking companies, averagely managed to limit their turnover[130] decline in a more effective way

[129] Micro-enterprises and small enterprises, with a maximum number of employees lower than 50.
[130] For each sampled company, its relative turnover is deflated for the annual sectoral inflation rate, calculated by Istat.

than the control group did, whereas in 2021 (two years after their entry in the network), the average turnover variation recorded by networking firms appeared to be almost twelve percentage points higher than that of the control group. On the basis of this empirical evidence, it has to be emphasised the "Parachute" role that the networks have played during the first months of Covid-19 pandemic and, at the same time, it should be noticed how formal cooperation among companies has allowed them to rapidly restore their economic activities, creating a sort of “Boosting effect” in 2021.

Figure 12) Impact of networks on turnover growth of firms from Lombardy and Piedmont



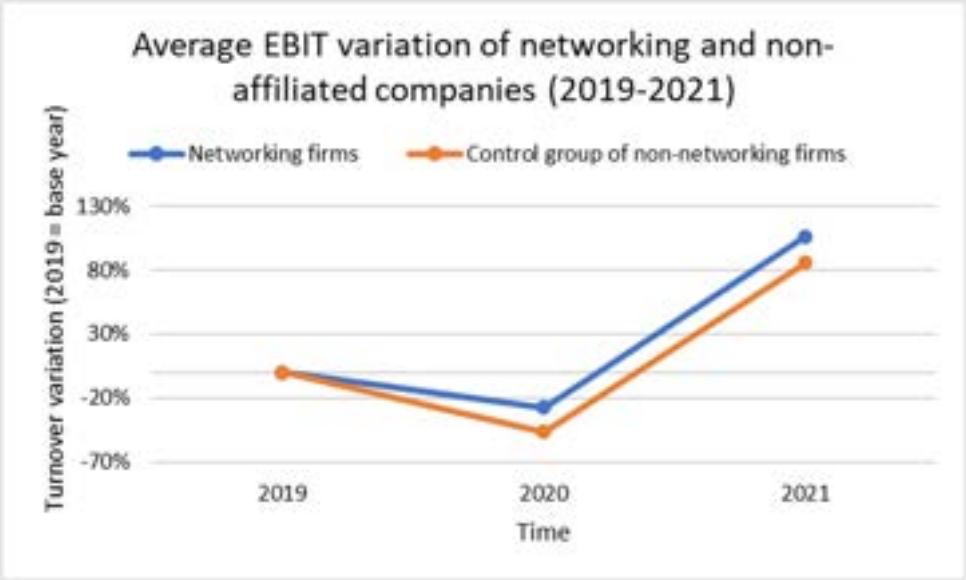
Source: Author’s elaboration of CompanyReports, Infocamere and Istat data

Similar conclusions can be also reached by looking at **Figure 13**. Through this second analysis it is compared the average operating result of the two samples. Even in this case, data evidently show that those companies which entered a network in 2019 benefited from a mitigation of the pandemic’s impact. As a matter of fact, while affiliated firms reported average losses equal to 27.5% in 2020, at the same time the control group exhibited an average loss higher than 46.5%.

Finally, during 2021, the year in which a good economic recovery began to affect Italy, a significant reversal in the economic trend of those companies that had performed worse in 2020 could have been expected. Surprisingly, despite this reversal actually took place, the

group of companies that exhibited a more significant recovery was the least penalised one during 2020. As it can be observed, with respect to 2019, networking enterprises recorded an average increase in their earnings equal to 106.5%, whereas non-networking firms, though starting from a more negative economic condition, only improved their earnings of 85.9%.

Figure 13) Impact of networks on EBIT growth of firms from Lombardy and Piedmont



Source: Author's elaboration of CompanyReports, Infocamere and Istat data

In conclusion, it can be stated that, on the basis of the collected data referring to the 2019-2021 period, the intuition contained in Cisi et al. (2020) and Costa et al. (2017), which implies that network participation helps to improve the performance of member companies, is empirically confirmed. Moreover, the presence of a strong macroeconomic shock within the analysed timeframe proves that network affiliation has effectively allowed affiliated firms to mitigate Covid-19 economic damages and to amplify the intensity of the recovery phase during 2021. In this sense, comparing the performance of networking and non-networking businesses between 2020 and 2021 contributes to demonstrate that the use of "Contratti di rete" in Italy is already remarkable and could be even more decisive for the growth of micro and small businesses, even in times of great economic uncertainty.

4.7 Sustainable Development within Business Networks

A final element to be evaluated when analysing the contribution of networks to the Italian production system, concerns the relationship between firm-level cooperation and sustainability. As highlighted in Subsection 1.1, it should be noted that Italy and the whole European Union have strongly manifested their commitment towards the achievement of the seventeen Sustainable Development Goals set by the UN 2030 Agenda, among which, for example, we find the promotion of more environmentally oriented production techniques as well as the strong encouragement towards a more inclusive and sustainable innovation path. For this reason, by focusing on the sole Italian context, it is important to verify how the network contract tool has played and can still play a non-negligible contribution to the achievement of the aforementioned sustainability objectives. Consequently, the following lines are dedicated to a brief Literature Review, made up of a good number of researches which emphasise the channels through which networks around the world encourage greater attention by companies towards socio-environmental issues, an intense dissemination of information related to CSR performances and more frequent application of increasingly efficient and sustainable production techniques.

In this regard, Chun et al. (2014) demonstrate that business networks have an indirect impact on the ability of SMEs to develop and embrace more sustainable production processes, aimed at protecting the environment. More specifically, Chun et al. (2014) notice that cooperation among firms allows each partner to improve its own innovative performance (i.e., increase the number of both product and process innovations). Consequently, the described growth in the innovation intensity within the network ends up generating positive externalities in terms of environmental protection, through the development of new efficient production techniques and the improvement of labour productivity.

The existence of a positive relationship between business networks and innovative performance of affiliated firms is also shown in Stuart T. (2000), Örntqvist and Parida (2015) and Gronum et al. (2012). These studies analyse three different business categories, as they

respectively make use of a sample of manufacturing firms[131] from Europe, USA, Japan and South-East Asia, a sample of small Swedish companies and a sample of Australian enterprises[132] employing less than 200 people. In particular, Stuart T. (2000) finds that those networks composed of large and innovative organisations, allow partners to generate better innovation rates than those of comparable non-affiliated firms. The findings of Stuart T. (2000) also demonstrate that young and small firms benefit more from large and innovative strategic alliance partners than do old and large organisations. Similarly, Örntqvist and Parida (2015) show that the innovative performance of Swedish technology-based companies is positively influenced by their ability to develop networking skills. Furthermore, Gronum et al. (2012) emphasise that higher innovation rates are enhanced by strong and heterogeneous network interactions and that, consequently, SMEs are supposed to only concentrate on firm-level cooperation as long as it leads to improvements in their own innovative ability.

From an aggregate perspective, empirical observations on the Italian productive system seem to confirm that the presence of network contracts is positively correlated with sectoral propensity to employ financial and human resources in order to produce innovation outputs. In this regard, the correlation matrix in **Table 13** provides some interesting details.

Table 13

	Researchers	R&D_employees	Firms_R&D_effort	Business_Networks
Researchers	1			
R&D_employees	0.970***	1		
Firms_R&D_effort	0.834***	0.756***	1	
Business_Networks	0.721***	0.818***	0.445***	1
N	56			

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

[131] The collected data belong to the 1985-1991 period.
[132] The analysed data belong to the 2004-2007 period.

More precisely, by analysing aggregate information on ten different Italian economic sectors[133] from 2013 to 2019, it is possible to verify how the presence of business networks within the sampled industries has been highly correlated with an increase in the share of employees dedicated to R&D activities. A similarly elevated correlation is also obtained when studying the relationship between networks and researchers. In addition, **Table 13** shows that at the sectoral level, in Italy the correlation between networks and sectoral innovative effort is moderately positive.

Returning to the economic literature that analyses the relationship between networks and sustainability topics, analogously to what is highlighted by Chun et al. (2014), also Choi et al. (2019) and Choi et al. (2018) notice that networking companies exhibit a more significant commitment in terms of Corporate Social Responsibility performance improvements. In particular, Choi et al. (2019) demonstrate that the efficient allocation of internal resources, enhanced by network participation, has a positive effect on the ability of Korean companies to develop sustainable production techniques. In addition, Choi et al. (2019) emphasise that the more a group of firms presents high intensity in terms of financial cooperation (group-level financial donations), the more the CSR performance within the business group is enhanced. Moreover, Choi et al. (2018), by analysing Korean SMEs, find that group affiliation is associated with higher improvements in terms of both Social[134] and Environmental[135] CSR.

Furthermore, both Choi et al. (2019) and Choi et al. (2018) emphasise that network participation is correlated with higher propensity to disclose information concerning firms' compliance with social and environmental regulations. The latter conclusion is addressed in detail also through the study of Bi et al. (2022). In fact, many companies still consider the disclosure of documents concerning their CSR performance as a relevant risk, which discourages them from sharing this type of sensitive information. In this scenario, the role

[133] The ten industries in question are the following: Manufacturing (sector C), Construction (sector F), Wholesale and Retail Trade, Repair of motor vehicles and motorcycles (sector G), Transport and Storage services, Accommodation and Catering (sector H and I) Information and Communication services (sector J), Financial and Insurance activities (sector K), Professional, Scientific and Technical activities (sector M), Health and Other services dedicated to households and businesses (sector Q and S).
[134] Social CSR addresses issues concerning employees, customers, and local community.
[135] Environmental CSR Includes issues related to interests of global or local community concerns.

of the network is to mitigate[136] the described lack of transparency of members and encourage them to publish information concerning their CSR activities (Bi et al., 2022).

The aforementioned positive relationship between group affiliation and adoption of sustainable production techniques is furtherly highlighted by Collins et al. (2007), through an analysis of 800 New Zealand companies. Within this research it is compared the environmental initiatives' adoption propensity of networking and non-affiliated firms and it is finally shown that business group members are more likely to adopt environmentally oriented production processes. Furthermore, Collins et al. (2007) show that network participants are also more prone to adopt Social CSR initiatives, while they find no significant differences among members and non-members with regards to wasted energy and total waste generated by their daily operations. Moreover, Govindan et al. (2020), Cainelli et al. (2011) and De Stefano and Montes-Sancho (2018) demonstrate that the sharing of knowledge and the overall R&D cooperation within a cluster is a significant predictor for the adoption of both "Green" innovations and environmental production practices throughout members' supply chain. Finally, Choi et al. (2018), Govindan et al. (2020) and Martínez-Ros and Kunapatarawong (2019) find a positive relationship between business size and propensity to adopt environmentally oriented processes.

As regards the interactions between business networks and the communities in which they operate, Besser et al. (2006) underline that the network participants, compared to non-members, provide greater support to the social context in which they are inserted. This support, in particular, takes the form of providing leadership and sustenance for community improvement projects, while there are no significant relationships between the presence of business groups and an increased usage of local suppliers/services.

In summary, by looking at the economic literature provided within this Subsection, it is intuitive to understand that the impact of networks should not be measured only on the basis of the economic benefits incorporated by this tool, but also on the basis of the spillover effect originated by the cooperation between businesses. In particular, networks

[136] Such a mitigation effect is enhanced by the redistribution of risk and the guarantee of significant support among the various networking parties.

prove to be particularly useful when it comes to increasing firms' innovation intensity, as they allow partner companies to broaden their horizons, through the development of economies of scale, cost reduction, risk redistribution and information sharing (Örntqvist and Parida, 2015; Gronum et al., 2012). According to Stuart (2000), the previous conclusion is particularly true for SMEs. For the last step, this innovative acceleration creates indirect advantages towards the environment and the social context in which companies operate, as the innovation outputs end up improving and streamlining production processes, reduce the environmental impact and improve the working conditions of employees (Collins et al., 2007; Chun et al., 2014; Choi et al., 2018; Choi et al., 2019). Finally, belonging to a network helps companies increase their transparency and accountability. Indeed, if it is true that the sharing of sensitive CSR information exposes any company to a certain risk, at the same time this risk is mitigated by the various intra-company relationships that are created (Bi et al., 2022). Therefore, the network acts as a sort of parachute for member firms, since it guarantees a strong financial and commercial support to all parties which, by increasing their transparency, inevitably become more subject to market reactions.

Section 5

5.1 Conclusion

As can be deduced from both the economic literature presented in the course of this thesis and the regression analyses contained in Sections 2, 3 and 4, the study of the dynamics concerning the concept of productivity, whether concentrated on a geographic macro-area, a specific sector or a complex production system, makes it possible to discover how efficiency is strongly influenced by a multitude of factors, sometimes even counterintuitive. In this regard, the Literature Review contained in Section 2 helps to highlight how the size of a company, its innovative capacity and its productivity are three strongly interconnected themes. The first regression model (*Model-1.2*, contained in Subsection 2.7), is the first empirical analysis presented in this thesis, which obtains significant results in explaining the relationship between firm size and productivity. In particular, *Model-1.2* focuses on 6 European economies in a period ranging from 2009 to 2019. In this framework, *Model-1.2* (composed of 7 predictors and 2 control variables) shows that the aggregate TFP of a nation is positively influenced by the existence of large companies, whereas the presence of medium-sized enterprises has an opposite effect. The conclusions to which *Model-1.2* leads are quite remarkable, as they demonstrate that, due to a simple compositional effect, the more a country encourages the development of large enterprises, the more its efficiency is likely to improve. This latter conclusion seems to logically explain that Italian productivity is essentially stagnant due to the country's inability to create an economic environment that favours the growth of SMEs. In addition, the first vector autoregressive analysis, presented in Subsection 2.7, (*VAR Model-1*) highlights that the more a country is able to encourage large firms' proliferation in a given year, the more R&D investments are likely to increase in the medium-term.

As it can be observed in Annex 1, *Model-1.2* does not present heteroskedasticity, the included predictors do not exhibit strong multicollinearity and residuals distribute normally. All in all, despite the interesting results obtained, *Model-1.2* still has a few caveats: in fact, although this research reacts well to the inclusion of two control variables, it is also true that it can still be improved, especially in terms of overall goodness of fit

(R^2=0.611). Furthermore, this first empirical analysis does not incorporate a model which can be easily extended to all European economies, as it focuses on a relatively small sample of countries. Therefore, to have a clearer picture of the production dynamics within the whole European Union, it could be useful to enlarge the number of analysed economies. Finally, a lengthening of the adopted timeframe could enhance greater validity acquisition.

Section 2 also presents a second model (*Model-2*, included in Subsection 2.8), which circumscribes the field of analysis and verifies which are the explanatory variables that significantly explain the differences in German and Italian efficiency growth. In particular, this second analysis assumes that Italy has behaved very differently from Germany in the last thirty years, showing much lower (negative) TFP growth rates, lower labour productivity growth and lower GDP improvements. Just like in the previous case, *Model-2* regards the 2009-2019 period, while the explanatory variables adopted on this occasion are six, plus two control variables. The goodness of fit of this second analysis is quite high (R^2=0.892), while the resulting significant regressors are two. In summary, the results of *Model-2* contribute to reinforce those obtained in the previous analysis. In fact, also in this case it is emphasised how the presence of large firms is particularly significant when it comes to explaining the different level of aggregate efficiency among developed countries. In addition, both *Model-2* and *VAR Model-2* (the second vector autoregressive analysis presented within this thesis) show that the different productivity growths of Italy and Germany can be explained by the fact that one country (Italy) has a low ratio between medium-large firms and microenterprises, while the other (Germany) presents a ratio which is nearly four times higher.

If compared to *Model-1.2*, *Model-2* has a lower volume of caveats. Its goodness of fit is in fact very high, it does not present any heteroskedasticity and the residuals distribute normally. However, this second model is characterised by an expectably strong multicollinearity. It should be also emphasised that the accuracy of *Model-2* is intuitively and logically lower than that of a hypothetical research based on microdata, which would inevitably allow for a more detailed analysis. For this reason, in any future studies, it could be extremely useful to analyse the phenomenon through a more accentuated microeconomic perspective. Instead of studying these dynamics in such an aggregate way,

it could be interesting to compare the productivity of the different size classes of enterprises between Italy and Germany in recent years, observing whether or not there are significant differences in the productivity of micro/large enterprises depending on the country which they are located in.

After having addressed the macroeconomic production dynamics within the 6 sampled European countries in Section 2, the rest of the thesis has been dedicated to an analysis of the Italian economy alone. In particular, Section 3 includes two OLS multiple linear regression models dedicated respectively to the study of industries (*Model-3*) and 20 sub-sectors (*Model-4*). In summary, *Model-3* demonstrates that innovation efforts have a positive impact on productivity, especially when R&D activities are carried out exclusively by private companies. On the other hand, Italian firms appear to be averagely unable to benefit from those innovation outputs that are produced by universities/public companies/foreign investments. In addition, this third regression analysis demonstrates the importance of sectoral specialisation, since data show that the more a sector's workforce is composed of researchers, the higher are the benefits in terms of TFP growth. Differently, when innovation activities are not carried exclusively by researchers, then the benefits translate to disadvantages for the aggregate sectoral economy.

The good accuracy of this third model is confirmed by the R^2 index (equal to 0.788) and by the fact that the presence of two control variables does not totally "Dominate" over the other five regressors. In general, among the presented statistical analyses, *Model-3* seems to be the most problematic, as it presents heteroskedasticity, non-normality of the residuals and accentuated multicollinearity. This last aspect was largely expectable, given the elevated number of predictors concerning the innovative effort of Italian enterprises.

Unlike the just-described study, *Model-4* does not focus on an intra-industry analysis, but on an inter-industry study. More specifically, the fourth linear regression of this thesis is dedicated to an analysis of the sole manufacturing industry, within a period set between 2013 and 2019. The main findings of this research lead to two interesting conclusions. In fact, *Model-4* confirms once again that the more an economic environment is characterised by a high ratio of large-to-microenterprises, the more its aggregate TFP is likely to improve.

The second remarkable stylised fact regards the positive relationship between productivity and the adoption of illegal practices, such as fiscal evasion. In particular, within this model it emerges that those manufacturing sub-sectors which are more affected by opportunistic behaviours (such as irregular employment), are those who are more likely to record positive TFP changes. However, this conclusion seems to be valid only with regards to irregular self-employment. Probably, the amount of taxes evaded through these opportunistic behaviours acts like a sort of "Reserve tank" for those manufacturing companies adopting such illegal techniques, ending up creating an unfair and at the same time not-negligible competitive advantage.

Among the presented regression analyses, this fourth model seems to be the most accurate and detailed one. In fact, the associated R^2 index is equal to 96.4%, the inclusion of two control variables does not have a "Prevarication effect" on the explanatory variables and, in general, it can be said that this study is the least close to a purely macroeconomic dimension, as it does not compare nations/economic macro-sectors, but focuses on a within-industry analysis. With regards to the robustness checks carried out in Annex IV, *Model-4* appears to be significantly affected by heteroskedasticity and multicollinearity, whereas the analysis of the residuals shows that the error terms distribute normally.

Differently from the second and the third ones, Section 4 of this thesis does not focus on highlighting what are the main issues that Italy should resolve in order to equate its standards with those of other Western economies. Instead, Section 4 suggests a tool that could potentially help to solve many of the criticalities emerged from the aforementioned analyses. Specifically, starting from the guidelines provided by the European Commission through the European Small Business Act of 2008, Section 4 takes the opportunity to verify that cooperation among companies, manifested through the establishment of a formal network, can bring economic benefits both at microeconomic and, consequently, on a larger scale.

As a matter of fact, Section 4 provides a first review of the literature concerning the beneficial role that business networks have in the development of partners' efficiency level (especially smaller ones). In this regard, the various studies presented contribute to

emphasise how the positive externalities produced by networks manifest themselves through an impressive variety of channels. The advantages of belonging to a cluster of firms can derive from the "Reputational networks affiliation effect", from the mitigation of commercial risks, from the reduction of financial costs, from the creation of economies of scale and from the sharing of means and knowledge, which can ultimately lead to the creation of product and process innovations. According to many economists, the correlation between networks and innovation deserves particular attention, as research and development activities are the tool through which SMEs can both increase their size and efficiency, and reduce their socio-environmental impact on the context in which they operate. In this sense, the development of innovations favoured by the networks also has the indirect effect of favouring the use of transparent production techniques, more environmentally-oriented operations and a more consistent preservation of social welfare.

On the basis of both European Union's indications and the economic literature in support of formal business networks, in 2009 Italy introduced the "network contract" into its legal system, with the ultimate goal of promoting the growth of SMEs and helping them resist the economic crisis that was beginning to spread throughout the European continent at that time. It took a couple of years for this contractual tool to start enjoying some popularity among Italian entrepreneurs, but as soon as it started to be seen as a significant competitive advantage, many companies started exploiting it. Specifically, as highlighted in Subsection 4.5 and 4.6, the benefits of networking in Italy seem to grow over time and lead companies to increase their size, expand their markets (enhancing their internationalisation), better withstand macroeconomic shocks and improve their general efficiency. Unfortunately, the distribution of this particular type of contract, despite an important series of incentives instituted by the Italian State, appears to be concentrated in specific geographical and economic areas. Moreover, the number of Italian companies officially included in a network contract is still extremely low. These dynamics, in the light of the advantages produced by the networks, appear somewhat counterintuitive, but can be explained by the relative novelty of this coordination mechanism. For these reasons, Italy should promote this instrument in an even more convinced way, expanding the already-existing incentives and restoring those concessions which have already

demonstrated their ability to attract many businesses in the past. In fact, if it is true that Italy should develop policies aimed at fostering SMEs' growth, with the ultimate objective to increase national aggregate efficiency, it is equally true that the network contract tool can be extremely useful (if combined with other initiatives) for achieving the aforementioned goal. Finally, as reported through Subsection 4.7, business networks can play a fundamental role in the achievement of long-term objectives for Italy, such as sustainable growth, innovation, employment and decent working conditions. For this reason, in the near future it could be extremely interesting to investigate about the actual impact of contractual networks within the Italian scenario, showing whether this tool has helped firms to achieve long-term sustainability and to adopt more innovative/sustainable production processes.

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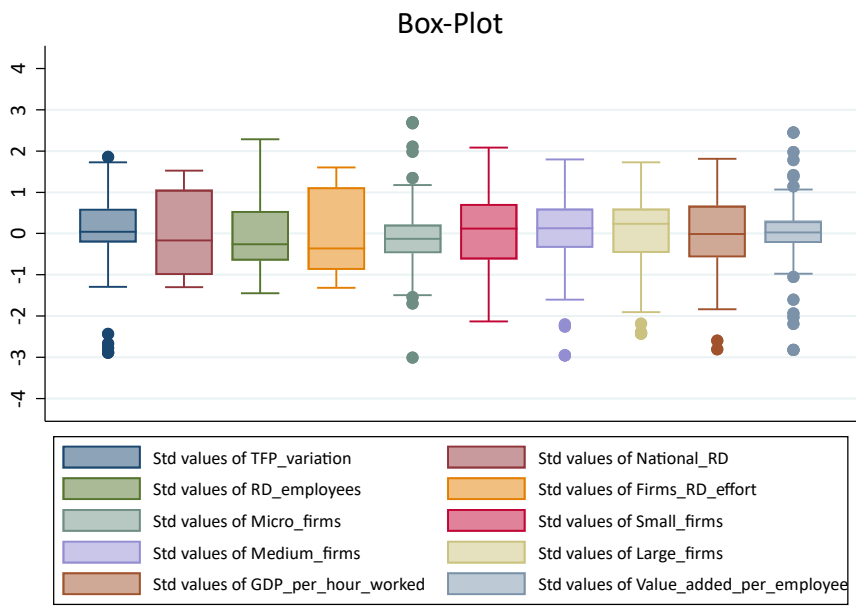
Appendix I: Robustness Checks concerning Subsection 2.7

On the basis of **Figure 14**, *Model-1.2* does not seem to be characterised by the presence of outliers. In this regard, the box-plots shown in **Figure 14** demonstrate that each variable included in this study has a z-score between -3 and +3.

Figure 14



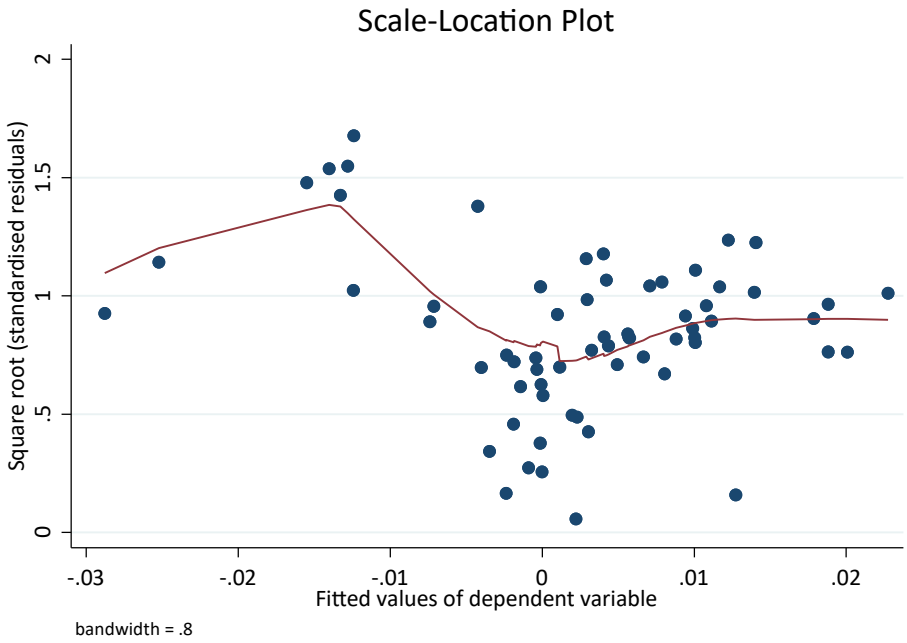
The Breusch-Pagan test for heteroskedasticity, contained in **Exhibit 1**, shows that *Model-1.2* is not affected by significant heteroskedasticity.

Exhibit 1

Assumption: Variable: H_0: chi2(1)	Normal error terms Fitted values of TFP_variation Constant variance 8.66
Prob > chi2	0.0033

The homoskedasticity assumption is confirmed by the Scale-Location plot contained in **Figure 15**, but only in part. In fact, in the ideal case of complete homoskedasticity, the red line crossing the cloud of points should be perfectly horizontal. However, with regards to the concrete scenario depicted by **Figure 15**, this only occurs in the right side of the distribution, while the left side exhibits a more wave-like pattern

Figure 15



However, taking into account both the information provided by the Breusch-Pagan test and by the Scale-Location plot, it can be stated with a high degree of certainty that *Model-1.2* does not exhibit significant heteroskedasticity.

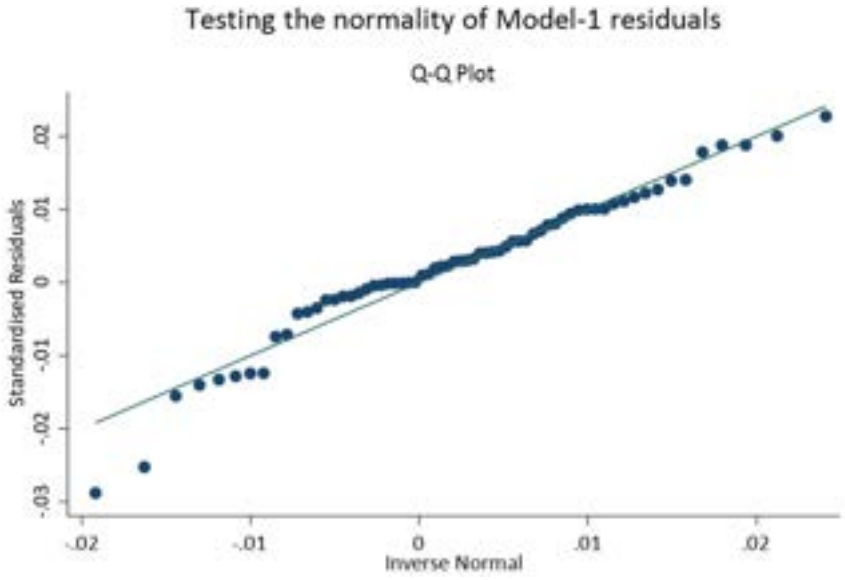
With reference to the analysis of *Model-1.2* residuals, the Jarque-Bera skewness and kurtosis tests for normality, contained in **Exhibit 2**, shows that the error terms of the model present a normal distribution.

Exhibit 2

				----- Joint test -----	
Variable	Observations	Pr(skewness)	Pr(kurtosis)	Adj chi2(2)	Prob>chi2
Residuals	65	0.023	0.084	7.300	0.026

The normal distribution of the residuals is also graphically confirmed by the quantile-quantile plot presented in **Figure 16**. In fact, it can be noticed that the standardised residuals are adjacent to almost the entire bisector (except the most extreme quantiles), and, therefore, tend to assume a distribution which is similar to a theoretical normal random variable.

Figure 16



In addition, the mean estimation of *Model-1.2* residuals shows that, within a 95% confidence interval, the error terms present an expected value significantly close to zero.

Exhibit 3

	Mean	Std.err.	Number of obs = 65 [95% conf. interval]	
Residuals	0.0024575	0.0012397	-0.0000191	0.0049342

Concerning the eventual presence of multicollinearity among the variables included in *Model-1.2*, **Exhibit 4** shows that the study is not characterised by strong correlations among its explanatory variables, since the "Mean VIF" is slightly lower than 5.

Exhibit 4

Variables	VIF	1/VIF
National_R&D	8.140	0.123
Firms_R&D_effort	7.220	0.139
Micro_firms	6.430	0.156
Small_firms	5.190	0.193
Medium_firms	4.600	0.218
R&D_employees	3.550	0.281
Large_firms	3.160	0.316
Value_added	1.260	0.796
GDP_per_hour_worked	1.130	0.889
	Mean VIF 4.520	

With regards to *VAR Model-1*, the Dickey-Fuller unit root tests and the Phillip-Perron unit root tests contained in **Exhibit 5** and **6** show that both variables ("National_BERD" and "Share_of_large_firms") included within the first multivariate time-series analysis of this thesis are not stationary. Therefore, it can be stated that the overall study is not affected by stationary trends.

Exhibit 5

Dickey-Fuller test Variable: National_BERD		Number of obs = 9 Number of lags = 0		
H_0: Random walk without drift, d=0		Dickey-Fuller critical value		
Test Statistic		1%	5%	10%
Z(t)	-4.719	-3.750	-3.000	-2.630
MacKinnon approximate p-value for Z(t) = 0.0001				
Phillip-Perron test Variable: National_BERD		Number of obs = 9 Newey–West lags = 2		
H0: Random walk without drift, d=0		Dickey-Fuller critical value		
Test Statistic		1%	5%	10%
Z(rho)	-13.210	-17.200	-12.500	-10.200
Z(t)	-4.685	-3.750	-3.000	-2.630
MacKinnon approximate p-value for Z(t) = 0.0001				

Exhibit 6

Dickey-Fuller test Variable: Share_of_large_firms		Number of obs = 9 Number of lags = 0		
H_0: Random walk without drift, d=0		Dickey-Fuller critical value		
Test Statistic		1%	5%	10%
Z(t)	-4.388	-3.750	-3.000	-2.630
MacKinnon approximate p-value for Z(t) = 0.0003				
Phillip-Perron test Variable: Share_of_large_firms		Number of obs = 9 Newey–West lags = 2		
H0: Random walk without drift, d=0		Dickey-Fuller critical value		
Test Statistic		1%	5%	10%
Z(rho)	-12.515	-17.200	-12.500	-10.200
Z(t)	-4.289	-3.750	-3.000	-2.630
MacKinnon approximate p-value for Z(t) = 0.0005				

In addition, **Exhibit 7** shows that *VAR Model-1* does not satisfy the stability condition, as at least one |eigenvalue| is higher than 1.00.

Eigenvalue stability condition (*VAR Model-1*):

Exhibit 7

Eigenvalue	Modulus
-1.662308	1.66231
-0.4190153 +0.9839732i	1.06948
-0.4190153 +0.9839732i	1.06948
-0.7137548 +0.7165246i	1.01136
-0.7137548 +0.7165246i	1.01136
-0.5680066	.568007
	At least one eigenvalue is at least 1.0. VAR does not satisfy the stability condition.

On the other hand, the mean estimation of *VAR Model-1* residuals shows that, within a 95% confidence interval, error terms' expected value is significantly close to zero.

Exhibit 8

	Mean	Std.err.	Number of obs = 7 [95% conf. interval]	
Residuals	0.0000864	0.0000551	-0.0002213	0.0000484

Finally, **Exhibit 9** shows that, according to Akaike's information criterion (AIC), Hannan–Quinn information criterion (HQIC) and Schwarz information criterion (SBIC), the choice of applying a 3-year lag to the overall model is the optimal one.

Exhibit 9

Lag-order selection criteria
Sample: 2013 thru 2019 Number of obs. = 7

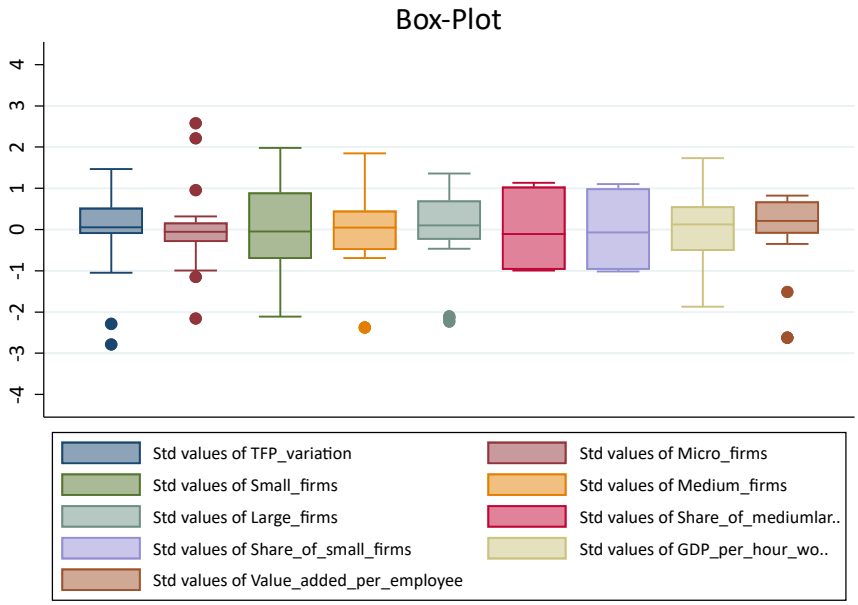
Lag	LL	LR	df	p	FPE	AIC	HQIC	SBIC
0	110.664				1.1e-16*	-31.041	-31.232	-31.0565
1	111.982	2.676	4	0.613	2.7e-16	-30.2804	-30.8535	-30.3268
2	117.783	11.603	4	0.021	3.0e-16	-30.7952	-31.7503	-30.8725
3	590.423	945.28*	4	0.000		-164.692*	-166.029*	164.801*

*Optimal lag
Endogenous: National_BERD, Share_of_large_firms
Exogenous: _cons

Appendix II: Robustness Checks concerning Subsection 2.8

On the basis of **Figure 17**, *Model-2* does not seem to be characterised by the presence of outliers. In this regard, the box-plots contained in **Figure 17** demonstrate that each variable included in this study has a z-score between -3 and +3.

Figure 17



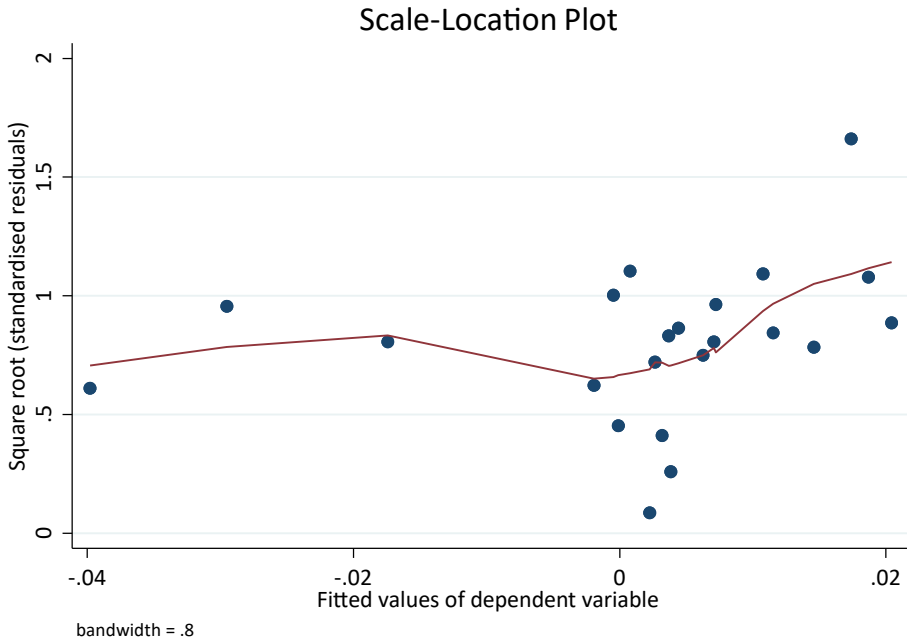
The Breusch-Pagan test for heteroskedasticity shows that, with a 95% significance level, *Model-2* is not affected by heteroskedasticity. Results are reported in **Exhibit 10**.

Exhibit 10

Assumption: Variable: H_0: chi2(1)	Normal error terms Fitted values of TFP_variation Constant variance 4.19
Prob > chi2	0.0406

The homoskedasticity assumption is graphically confirmed by the Scale-Location plot presented in **Figure 18**. In fact, it can be noticed that the red line crossing the graph can be roughly approximated by a horizontal segment. This helps to demonstrate that the distribution of the error terms is equal at all fitted values.

Figure 18



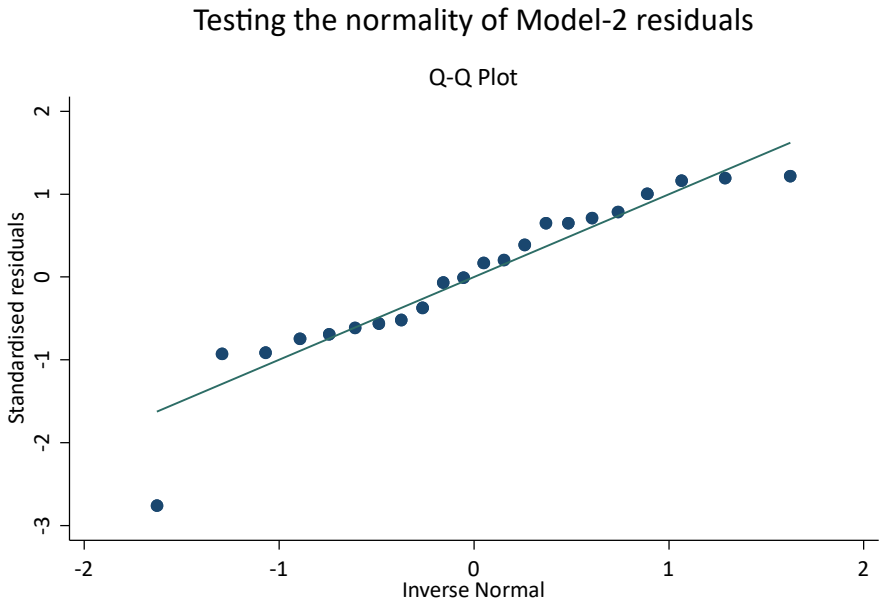
With regards to the analysis of *Model-2* residuals, the Jarque-Bera skewness and kurtosis tests for normality (contained **in Exhibit 11**) shows that, with a 99% significance level, the error terms of the model assume a normal distribution.

Exhibit 11

				----- Joint test -----	
Variable	Observations	Pr(skewness)	Pr(kurtosis)	Adj chi2(2)	Prob>chi2
Residuals	22	0.003	0.026	10.830	0.004

Residuals' normal distribution is also graphically confirmed by the quantile-quantile plot contained in **Figure 19**, as the standardised error terms tend to be distributed in an almost identical way to that of a theoretical normal random variable.

Figure 19



In addition, the mean estimation of *Model-2* error terms shows that the residuals present an expected value which is significantly close to zero.

Exhibit 12

	Mean	Std.err.	Number of obs = 22 [95% conf. interval]	
Residuals	0.0020712	0.0030898	-0.0043544	0.0084968

With regards to the eventual presence of multicollinearity within *Model-2*, **Exhibit 13** shows that the aforementioned analysis is characterised by strong relationships among its regressors, as it records a "Mean VIF" higher than 5.

Exhibit 13

Variable	VIF	1/VIF
Share_of_mediumlarge_firms	312.030	0.003
Share_of_small_firms	309.960	0.003
Small_firms	9.130	0.109
Micro_firms	8.730	0.115
Medium_firms	5500	0.182
Large_firms	3.700	0.270
Value_added	1.860	0.537
GDP_per_hour_worked	1.520	0.656
	Mean VIF 81.550	

With regards to *VAR Model-1*, the Dickey-Fuller unit root tests and the Phillip-Perron unit root tests contained in **Exhibit 14** and **15** show that both variables ("Diff_TFP" and "Diff_Share_of_mediumlarge_firms") included within this multivariate time-series analysis are not stationary. Therefore, the whole study appears to be not characterised by a stationary trend.

Exhibit 14

Dickey-Fuller test		Number of obs = 8		
Variable: Diff_TFP		Number of lags = 0		
H0: Random walk without drift, d=0		Dickey-Fuller critical value		
Test Statistic		1%	5%	10%
Z(t)	-4.778	-3.750	-3.000	-2.630
MacKinnon approximate p-value for Z(t) = 0.0001				
Phillip-Perron test		Number of obs = 8		
Variable: Diff_TFP		Newey–West lags = 2		
H0: Random walk without drift, d=0		Dickey-Fuller critical value		
Test Statistic		1%	5%	10%
Z(rho)	-10.160	-17.200	-12.500	-10.200
Z(t)	-6.078	-3.750	-3.000	-2.630
MacKinnon approximate p-value for Z(t) = 0.0000				

Exhibit 15

Dickey-Fuller test		Number of obs = 8		
Variable: Diff_Share_of_mediumlarge_firms		Number of lags = 0		
H0: Random walk without drift, d=0		Dickey-Fuller critical value		
Test Statistic		1%	5%	10%
Z(t)	-3.594	-3.750	-3.000	-2.630
MacKinnon approximate p-value for Z(t) = 0.0059				
Phillip-Perron test		Number of obs = 8		
Variable: Diff_Share_of_mediumlarge_firms		Newey–West lags = 2		
H0: Random walk without drift, d=0		Dickey-Fuller critical value		
Test Statistic		1%	5%	10%
Z(rho)	-9.634	-17.200	-12.500	-10.200
Z(t)	-3.782	-3.750	-3.000	-2.630
MacKinnon approximate p-value for Z(t) = 0.0031				

In addition, results contained in **Exhibit 16** prove that *VAR Model-2* satisfies the stability condition, as the two |eigenvalues| do not assume values higher than 1.00.

Eigenvalue stability condition (*VAR Model-2*):

Exhibit 16

Eigenvalue	Modulus
-0.731 -0.004	0.731 0.004
	All the eigenvalues lie inside the unit circle. VAR satisfies the stability condition.

Finally, the mean estimation of *VAR Model-2* residuals, presented in **Exhibit 17**, shows that within a 95% confidence interval the error terms have an expected value significantly close to zero.

Exhibit 17

	Mean	Std.err.	Number of obs = 8 [95% conf. interval]	
Residuals	-0.0025733	0.0020827	-0.0074981	0.0023516

Appendix III: Regional Regression Model

As anticipated in Subsection 3.1, the multiple linear regression analysis contained in **Exhibit 18** shows that regional-level TFP variations do not seem to be influenced by business dimension and innovation propensity or, at least, they are not affected by the previously-analysed categories of explanatory variables, which have already demonstrated to be characterised by a significant relationship with the variable "TFP_variation" through Section 2 and 3.

Exhibit 18

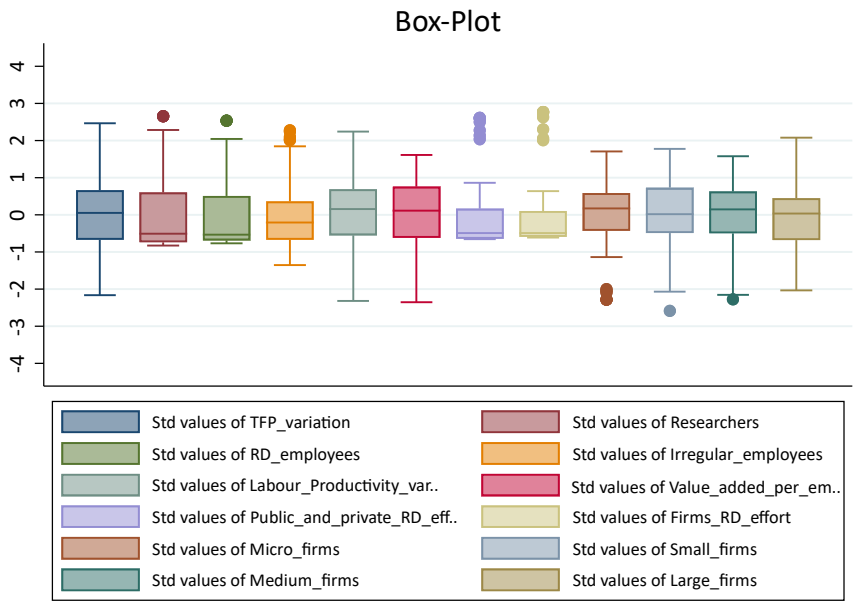
	(*Regional Regression Model*)
VARIABLES	TFP_variation
National_R&D	-8.647
	(0.159)
National_BERD	11.831
	(0.174)
Researchers	-0.187
	(0.857)
R&D_employees	0.089
	(0.842)
Micro_firms	-1.726
	(0.605)
Small_firms	-0.174
	(0.182)
Medium_firms	0.041
	(0.234)
Large_firms	-0.001
	(0.964)
Constant	0.000
	(0.976)
Observations	140
R-squared	0.068
Adjusted R-squared	0.016
F-test (8, 131)	1.20

p-values in parentheses (*** p<0.01, ** p<0.05, * p<0.1)

Appendix IV: Robustness Checks concerning Subsection 3.2

On the basis of **Figure 20**, *Model-3* does not seem to be characterised by the presence of outliers. In this regard, the box-plots shown in **Figure 20** demonstrate that each variable included in this study has a z-score between -3 and +3.

Figure 20



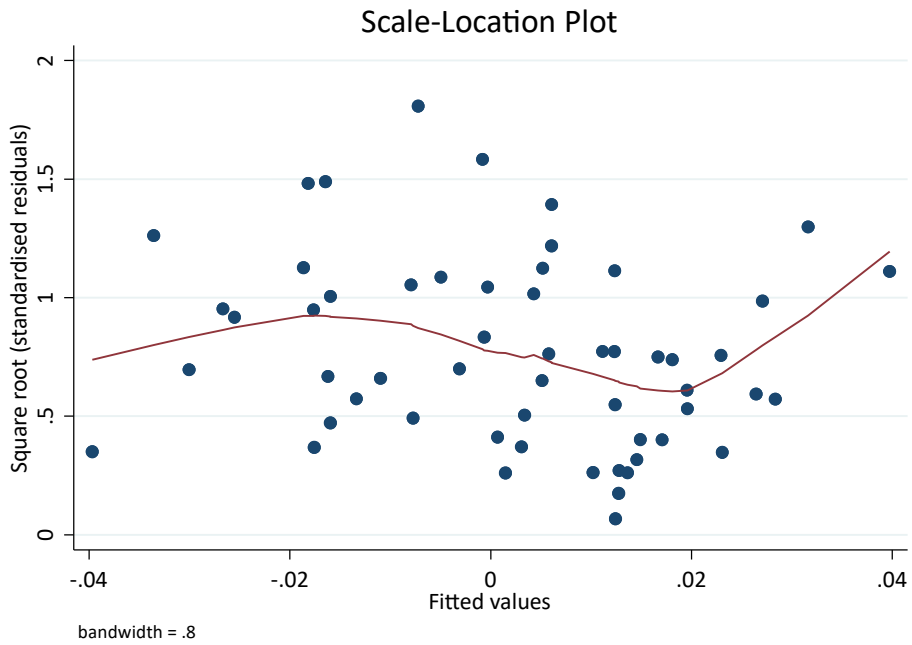
The Breusch-Pagan test shows that homoskedasticity within *Model-3* is not present and, therefore, the whole study must be handled carefully. In fact, through **Exhibit 19** it is possible to observe that the p-value is higher than 0.05.

Exhibit 19

Assumption: Variable: H0: chi2(1)	Normal error terms Fitted values of TFP_variation Constant variance 1.95
Prob > chi2	0.1629

The absence of homoskedasticity within *Model-3* can be graphically confirmed by the Scale-Location plot contained in **Figure 21.** As a matter of fact, the red line crossing the graph cannot be roughly approximated by a horizontal segment.

Figure 21



With regards to the analysis of *Model-3* residuals, the Jarque-Bera skewness and kurtosis tests for normality shows that the error terms of the study do not present a normal distribution.

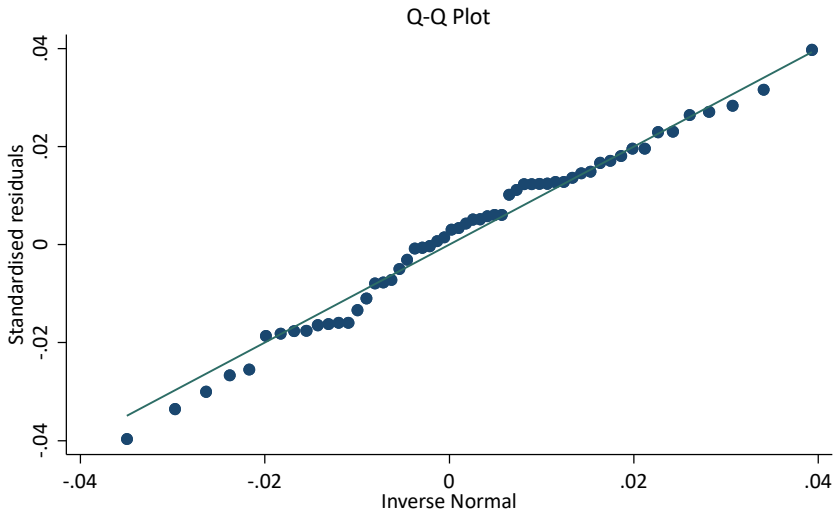
Exhibit 20

				----- Joint test -----	
Variable	Observations	Pr(skewness)	Pr(kurtosis)	Adj chi2(2)	Prob>chi2
Residuals	56	0.3382	0.5325	1.36	0.5064

The non-normal distribution of the residuals can be graphically confirmed by the quantile-quantile plot contained in **Figure 22**, through which it can be noticed that the standardised error terms deviate from the bisector, especially in the central area of the graph, while they tend to assume the theoretical distribution of a normal random variable in correspondence with the more extreme tails.

Figure 22

Testing the normality of Model-3 residuals



However, the mean estimation of residuals shows that, within a 95% confidence interval, the error terms of *Model-3* present an expected value significantly close to zero:

Exhibit 21

	Mean	Std.err.	Number of obs = 56 [95% conf. interval]	
Residuals	0.0021712	0.0023544	-0.0025471	0.0068894

With regards to the eventual presence of multicollinearity among the predictors included within *Model-3*, **Exhibit 22** demonstrates that the analysis is affected by strong correlations among the independent variables, as "Mean VIF" presents a value remarkably higher than 5. In particular, those indicators which are used for expressing the overall innovative effort of Italian enterprises exhibit elevated multicollinearity, which was anyways expectable.

Exhibit 22

Variables	VIF	1/VIF
Public_and_private_R&D_effort	101.57	0.009
Firms_R&D_effort	85.69	0.011
Researchers	51.91	0.019
R&D_employees	37.07	0.026
Irregular_employees	1.33	0.749
Value_added	1.15	0.867
Labour_Productivity_variation	1.10	0.913
	Mean VIF 39.98	

Appendix V: Robustness Checks concerning Subsection 3.3

On the basis of **Figure 23** and **24**, *Model-4* does not seem to be characterised by the presence of outliers. In this regard, the box-plots shown in **Figure 23** and **24** demonstrate that each variable included in this study has a z-score between -3 and +3.

Figure 23

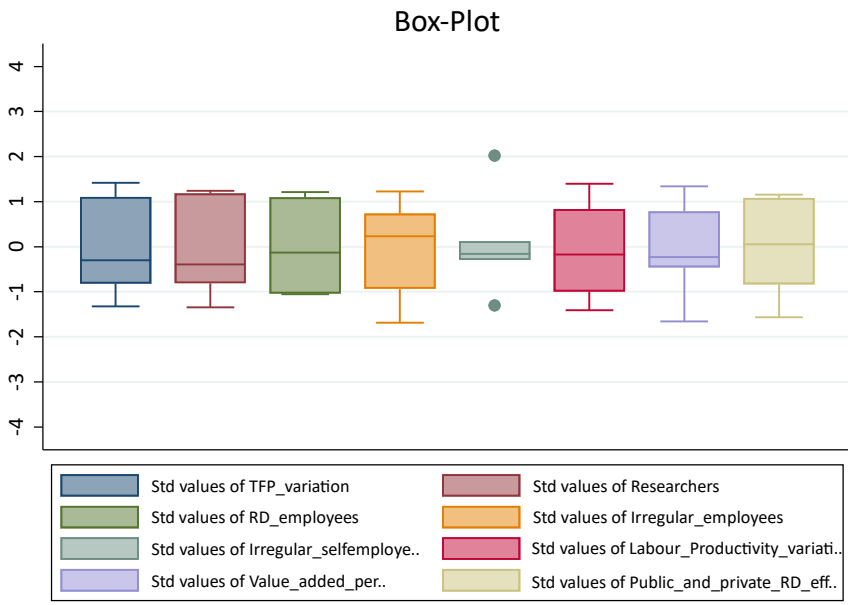
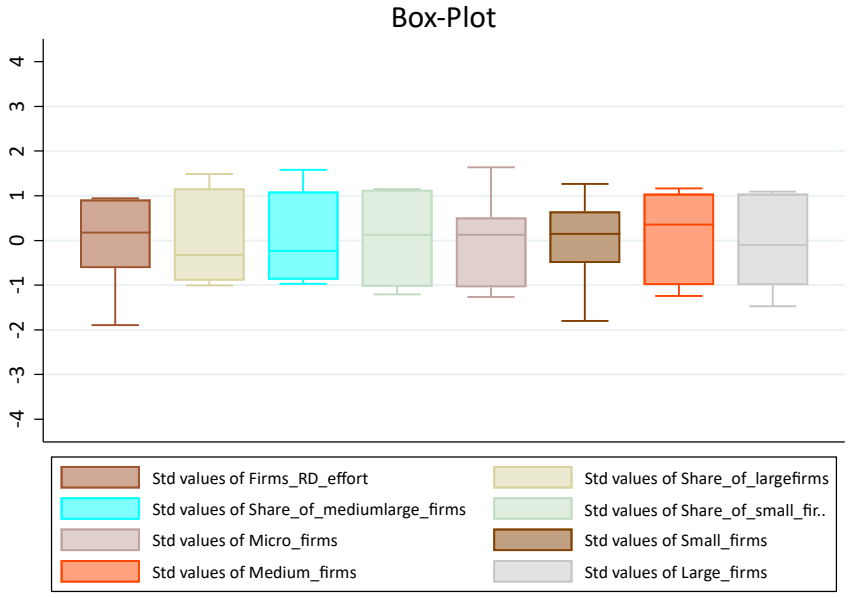


Figure 34



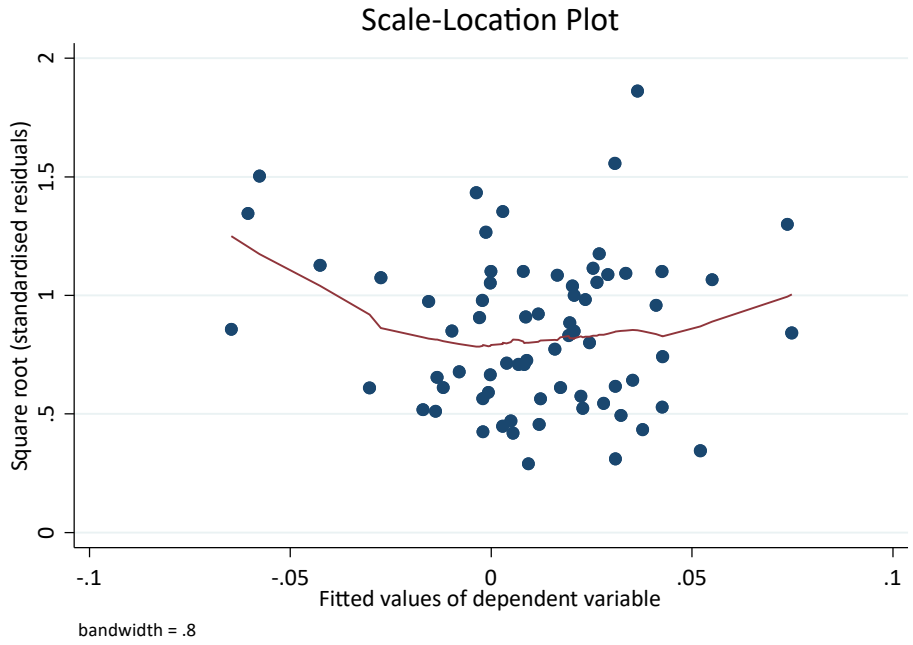
The Breusch-Pagan test for heteroskedasticity shows that *Model-4* is affected by heteroskedasticity. In fact, such an elevated p-value (0.74) suggests rejecting the null hypothesis (according to which all error terms have the same variance) and, therefore, accepting the alternative hypothesis.

Exhibit 23

Assumption:	Normal error terms
Variable:	Fitted values of TFP_variation
H0:	Constant variance
chi2(1)	0.11
Prob > chi2	0.7404

The presence of heteroskedasticity within *Model-4* can be also graphically confirmed by the Scale-Location plot contained in **Figure 25.** As a matter of fact, the u-shaped red line in the graph cannot be approximated by a horizontal segment, neither in the left side of the distribution, nor in the right one.

Figure 25



With regards to the analysis of the residuals, the Jarque-Bera skewness and kurtosis tests for normality shows that the error terms of *Model-4* present a normal distribution.

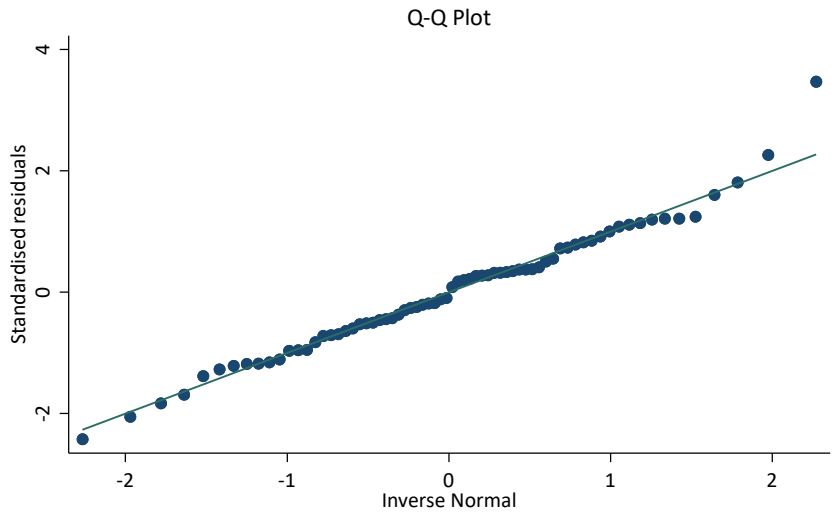
Exhibit 24

				----- Joint test -----	
Variable	Observations	Pr(skewness)	Pr(kurtosis)	Adj chi2(2)	Prob>chi2
Residuals	70	0.077	0.067	6.080	0.048

The normal distribution of the residuals is also graphically confirmed by the quantile-quantile plot contained in **Figure 26**, from which it can be noticed that the standardised error terms tend to be distributed in an almost identical way to that of a theoretical normal random variable.

Figure 26

Testing the normality of Model-4 residuals



In addition, the mean estimation of *Model-4* residuals shows that, within a 95% confidence interval, the error terms of the model have an expected value significantly close to zero:

Exhibit 25

	Mean	Std.err.	Number of obs = 65 [95% conf. interval]	
Residuals	0.0112623	0.0032036	0.0048713	0.0176533

With regards to the eventual presence of multicollinearity among the predictors included within *Model-4*, **Exhibit 26** shows that the analysis is affected by average strong relationship among the independent variables, as “Mean VIF” is higher than 5.

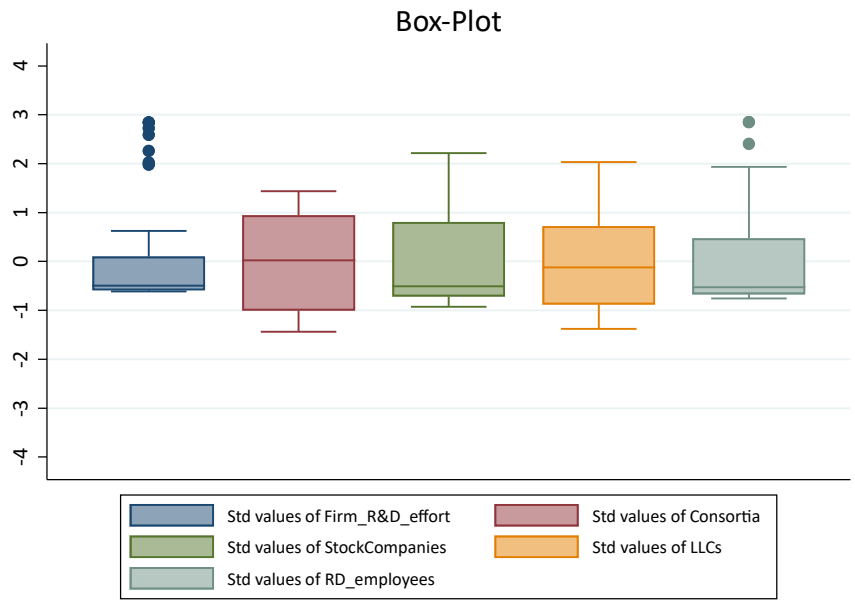
Exhibit 26

Variables	VIF	1/VIF
Public_and_private_R&D_effort	306.79	0.003
Firms_R&D_effort	190.59	0.005
Share_of_mediumlarge_firms	173.74	0.006
Researchers	132.01	0.008
Share_of_large_firms	93.57	0.011
R&D_employees	39.32	0.025
Share_of_small_firms	28.36	0.035
Irregular_employees	6.82	0.147
Irregular_selfemployed_workers	6.08	0.165
Micro_firms	5.55	0.180
Small_firms	3.79	0.264
Value_added	2.11	0.473
Large_firms	1.77	0.565
Labour_Productivity_variation	1.68	0.594
Medium_firms	1.59	0.628
	Mean VIF 66.25	

Appendix VI: Robustness Checks concerning Subsection 4.4

On the basis of **Figure 27**, *Model-5* does not seem to be characterised by the presence of outliers. In this regard, the box-plots shown in **Figure 27** demonstrate that each variable included in this study has a z-score between -3 and +3.

Figure 27



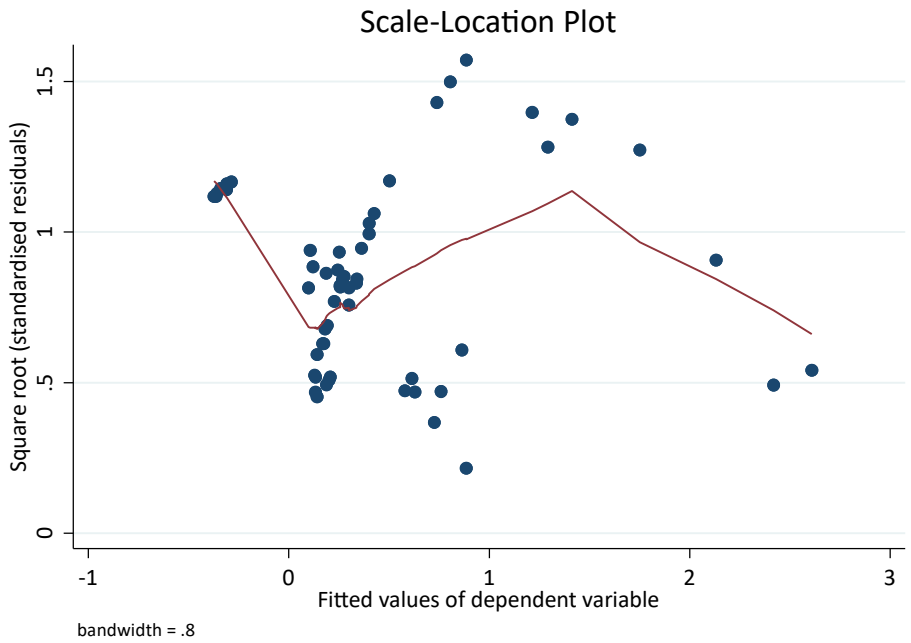
The Breusch-Pagan test for heteroskedasticity shows that *Model-5* is affected by heteroskedasticity. In fact, such an elevated p-value (0.27) suggests rejecting the null hypothesis (according to which all error terms have the same variance) and, therefore, accepting the alternative hypothesis.

Exhibit 27

Assumption: Variable: H0: chi2(1)	Normal error terms Fitted values of TFP_variation Constant variance 1.18
Prob > chi2	0.2783

The presence of heteroskedasticity within *Model-5* can be also graphically confirmed by the Scale-Location plot contained in **Figure 28.** As a matter of fact, the irregular red line in the graph cannot be approximated by a horizontal segment, neither in the left side of the distribution, nor in the right one.

Figure 28



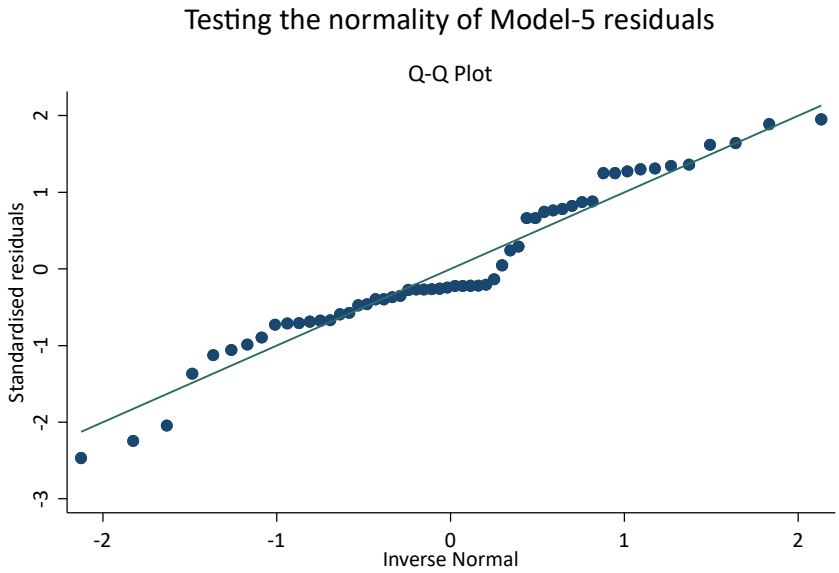
With regards to the analysis of the residuals, the Jarque-Bera skewness and kurtosis tests for normality shows that the error terms of *Model-5* present a normal distribution.

Exhibit 28

				----- Joint test -----	
Variable	Observations	Pr(skewness)	Pr(kurtosis)	Adj chi2(2)	Prob>chi2
Residuals	56	0.000	0.004	19.49	0.000

The normal distribution of the residuals is also graphically confirmed by the quantile-quantile plot contained in **Figure 29**, through which it can be observed that the standardised error terms tend to be distributed in an almost identical way to that of a theoretical normal random variable.

Figure 29



With regards to the eventual presence of multicollinearity among the predictors included within *Model-5*, **Exhibit 29** shows that the overall study is not affected by strong correlations among the predictors, as "Mean VIF" is lower than 5.

Exhibit 29

Variables	VIF	1/VIF
LLCs	3.02	0.331
R&D_employees	2.45	0.408
Consortia	1.41	0.710
Stock_companies	1.12	0.894
	Mean VIF 2.00	