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Dottorato in Scienze Economiche e Statistiche
Dipartimento di Scienze Economiche, Aziendali e Statistiche (DSEAS)
Statistica Economica SECS - S/03

ESSAYS ON THE DRIVERS OF FIRM COMPETITIVENESS

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CICLO XXXII
ANNO CONSEGUIMENTO TITOLO 2020

Acknowledgements

First and foremost I would like to thank my family. Words cannot express how grateful I am for the moral support and motivation you gave me to accomplish my personal goals.

Second, I would like to express my sincere gratitude to my advisors Prof. Davide Piacentino and Prof. Giorgio Fazio for being two essential pillars over these years. Thank you not only for all your precious teachings and suggestions, but also for guiding me with continuous support, encouragement and, especially, patience.

Many thanks to the Chair of the Ph.D program Prof. Andrea Consiglio and to the Head of the SEAS Department Prof. Angelo Mineo and his staff, for being always helpful during this period.

My thanks also go to all my Ph.D colleagues and, in particular, to Pietro, Simona and Caterina, for their suggestions, stimulating discussions and for all the fun we had during the three years.

Last but not least I thank Edoardo, essential presence over these years, for always believing in me and encouraging me to follow my dreams.

Contents

List of Figures

List of Tables

Introduction

Micro-founded studies on the drivers of countries and regions economic performance have grown significantly in the last twenty years, as a result of the increased availability of micro-data. This has fostered an intensive investigation of the determinants of firm-level heterogeneity and competitive advantage, which are crucial for understanding the underlying dynamics of countries economic growth and development. Indeed, firm heterogeneity is the basis of macro-level results and has a lot of implications on country growth, competitiveness and productivity (Bayar, 2018; Giordano and Lopez-Garcia, 2019).

This thesis focuses on two key drivers of firm's competitive advantage and economic performance: trade and innovation. The importance of these two sources, both at the micro and macro levels, have been recognized not only by the prevalent literature (see, among the others, Crépon, Duguet, and Mairesse, 1998; Frankel and Romer, 1999; Alcalá and Ciccone, 2004; Van Long, Raff, and Stähler, 2011), but also by different supranational institutions such as the European Commission that has placed innovation at the basis of the European 2020 Strategy[1] and the World Bank that emphasizes the role of trade as a way to enhance the inclusion of less developed and developing countries in the world economy[2]. Indeed, trade and innovation enable firms to acquire external resources, new skills and knowledge useful in improving efficiency, producing and commercializing new products or services and increasing their market share. Thus, a lot of studies have investigated their determinants in order to understand their individual and joint contribution to both firm and country productivity, and competitiveness (see, among the others, Parisi, Schiantarelli, and Sembenelli, 2006; Van Long, Raff, and Stähler, 2011; López-Bazo and Motellón, 2018; Fassio, 2017; Aghion et al., 2018). This thesis aims to contribute to the existing literature developing three essays on these fields. Specifically, it aims to add on the following aspects. First, merging the international trade literature, that has explored the determinants

[1] See https://ec.europa.eu/jrc/en/science-area/innovation-and-growth.

[2] See https://www.worldbank.org/en/topic/trade.

of firms exporting behavior mainly comparing exporters vs non-exporters, with international business and entrepreneurship literatures which recognize differences also between exporting firms. A greater picture of the distinguishing characteristics of exporting companies may be important to better target trade enhancing policies, especially when they are addressed to less developed and developing countries. Indeed, it allows to highlight those factors preventing firms from being "*active*" or "*committed*" to international markets. Second, providing new evidence on innovation in Italy. In this respect, we concentrate on the influence of the regional environment on firm innovative performance, departing from the prevalent literature which have mainly adopted a macro-level perspective. Third, investigating in a unique framework the different characteristics of firms combining technological and service-related innovative outputs (*innovative extensivity*) and, moreover, their relation with the introduction of environmental innovations. A deeper understanding of the territorial differences of innovative performance among Italian regions, as well as, of the distinguishing features of firms combining different types of innovative outcomes could be important to enhance the inclusion of lagging and peripheral areas (e.g. Southern regions). These topics are developed as follow.

The first chapter focuses on firm's exporting behavior. International trade theories have, traditionally, concentrated on the reasons for trade at the country-level. Product specialization, differences in technology and resource endowments have been highlighted as the main causes of international engagement (see Smith, 1776; Ricardo, 1891). These differences also exist at the firm-level. Indeed, the exploitation of detailed microdata has pinpointed a great *heterogeneity* in terms of outputs and characteristics among firms. This heterogeneity is identified both as a cause and a consequence of firm's involvement in international trade. Therefore, a growing literature has started to analyse the relationship between firm heterogeneity, economic performance and firm's decision to export (see, for example, the pioneer work by Bernard and Jensen, 1999). This is done through the comparison between exporting and non-exporting firms with the aim to highlight their distinguishing features. The main idea, corroborated by Melitz (2003), is that the existence of high sunk costs to enter the export market implies that only a small percentage of firms, specifically the most productive ones, enter international markets while all the other less efficient firms either exit or only serve the domestic market (see, among the others, Roberts and Tybout, 1997; Bernard and Wagner, 1997; Delgado, Farinas, and Ruano, 2002). The heterogeneity between exporters and non-exporters is then exacerbated by the exposure to knowledge spillovers, new and advanced technologies and the competition of international markets (see, for example, Girma, Greenaway, and Kneller, 2004; Van Biesebroeck, 2005).

This literature, however, has largely neglected the presence of heterogeneity among exporting firms themselves. This has been highlighted, instead, in international business and international

entrepreneurship. Indeed, exporters may follow different internationalization paths, specifically entering foreign markets gradually, e.g. born local firms, or abruptly, e.g. born global firms (see Cavusgil, 1984; Knight and Cavusgil, 2004; Cavusgil and Knight, 2015). Thus, this chapter aims to fulfill the international trade literature with the international business and international entrepreneurship ones providing evidence on the heterogeneity of firms entering international markets in differing ways. As argued by Verbeke and Ciravegna (2018), a greater interaction between these literatures allows to get a richer picture on the heterogeneous determinants of exporting firms. This chapter moves in this direction performing qualitative data models to compare domestic, born local and born global firms in a unique framework. The analysis exploits the data provided by the World Bank Enterprise Survey, which collects information on the internal and external factors affecting firm's internationalization. The data look at firms from 112 less developed and developing countries. These countries, which very often suffer for limited infrastructures, corruption and unfavorable regulatory environment to business development, may find in trade and exporting activities an important engine of job creation, poverty reduction and growth. Thus, providing additional evidence on the determinants of internationalization, specifically focusing on different exporter categories, may support policy makers which aim to favor the inclusion of lagging national economies into international markets.

The second and the third chapters concentrate on innovation, even though under different perspectives, using data of Italian firms. Focusing on an industrialized country in this case allows to exploit greater information and get a richer picture on innovation processes.

The second chapter looks at the influence of regional environments on firm innovative performance, considering a regional version of the pioneer model by Crépon, Duguet, and Mairesse (1998). In this way it departs from the prevalent literature, which have mainly adopted a macro-level perspective, and embraces the micro-founded approach developed in recent studies to investigate the influence of the regional context on firm's innovative behavior (see, among the others, Mate-Sanchez-Val and Harris, 2014; López-Bazo and Motellón, 2018; Crescenzi and Gagliardi, 2018). The basic idea in this approach is that regional factors influence both the ability of firms to realize innovations and to absorb external knowledge. Indeed, the role of the regional environment is extremely important since it may favor the development of different localized paths (see Iammarino, 2011; Ascani et al., 2012). In this respect, little attention has been given to Italy in recent years, despite its relevance in terms of regional disparities. Thus, the empirical analysis aims to fill this gap using the last available wave of the Italian Community Innovation Survey (CIS-2014) to investigate the influence of the regional context on the innovative input-output relationship taking into account possible selection bias and the nature of innovation as a multidimensional process that involves as many inputs and outputs. In particular, the

analysis provides evidence on both the entire nation and on the macro-regions identified using the NUTS 1 classification. This allows to infer macro-regional characteristics of the innovation processes starting from micro-level data. This analysis provides a more complete and recent picture of regional innovation, that can be critical to formulate adequate policies for regional growth and cohesion, especially in the case of Italy given its well known North-South divide.

Finally, the third chapter focuses on the relationship between investment intensity and innovation "extensivity". Traditional literature on innovation has focused on the comparison between innovators and non-innovators, or on evaluating the determinants of specific innovative outputs mainly technological innovations, e.g. product or process innovations (Mate-Sanchez-Val and Harris, 2014; Szczygielski, Grabowski, Pamukcu, and Tandogan, 2017; López-Bazo and Motellón, 2018). Hence, neglecting in this way that not all the firms engage in innovation with the same extent, i.e. firm's ability to realize different type of innovations at the same time. The importance of the "*extensivity*" of firms' innovative behavior emerges only in few studies that mainly use this innovative "extensivity" as an explanatory variable into their model (see Webster, 2004; Evangelista and Vezzani, 2010; D'Este, Iammarino, Savona, and Tunzelmann, 2012). This chapter focuses, instead, specifically on analysing the differentiating features of firms with different extent of engagement in innovation. In particular, it aims to evaluate whether having a different "extensivity" in innovation is linked to differences in terms of investment intensity and absorptive capacity. Indeed, while some studies find a positive impact of R&D investment on innovative outputs (see, among the others, Parisi, Schiantarelli, and Sembenelli, 2006; Audretsch, Coad, and Segarra, 2014), it can also be that the relation between R&D investment and innovation is non-linear (see, for example, Berchicci, 2013 and Kim, 2018). Thus, exploiting the 2014 Italian Community Innovation Survey (CIS) and using qualitative data models, the empirical investigation evaluates whether investing a lot in innovative inputs (e.g. intramural and extramural R&D and machinery investment) is associated with having a greater extent of innovative activities, i.e. firms combine different types of innovative outputs, or there is a threshold beyond which investing in R&D is associated with a reduction of the extent of engagement in innovation. Finally, it looks at the relationship between innovative "extensivity" and environmental innovations. This investigation allows to get a greater picture of the distinctive characteristics of firms with a different "extent" of engagement in innovative activities which may be important to better target innovation policies.

The thesis provides a rich empirical evidence on different aspects of two key drivers of economic performance: trade and innovation. Unfortunately, due to the lack of data the analysis could just exploit the two drivers separately and could not focus on their mutual relationship. In this respect, the availability of longitudinal data would allow to investigate the direction of

causality between the two drivers, i.e. it is export that causes innovation or vice versa, on which there is not unique consensus in the literature (see, for example, Cassiman et al., 2010; Aghion et al., 2018). Moreover, panel data would be also well suited in describing the incremental internationalization mode analysed in the first chapter. These points will be object of further research[3].

[3]See the limitations and further direction section for more discussion.

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Chapter 1

Firm Exporting Performance. Extensive and Intensive margins

1.1 Introduction

In the era of globalization, the wealth of nations relies increasingly on understanding the sources of the international competitiveness of firms. This is the subject of a vast academic literature in economics, international business and international entrepreneurship. These disciplines have all looked at the process of firm's internationalization and delved into the specific characteristics of international firms, but have kept some degree of separation.

In economics, the increasing availability of firm-level data from the 1990s has prompted investigations into the sources of firm heterogeneity in economic performance, including exporting. This has allowed researchers to uncover that the access to international markets is actually rare and limited to firms with specific characteristics, suggesting that firm's internationalization is the result of a selection process both in term of trade participation (i.e. extensive margin of trade) and of trade volumes (i.e. intensive margin of trade). In particular, productivity has been emphasized as a key determinant in this selection process.[1] Indeed, in the seminal theoretical contribution of Melitz (2003) under costly access to international markets there is a sort of "Darwinian" selection process where only the most productive firms export, while the less productive will either cease to exit or survive to serve the domestic market only.[2] This "Darwinian" selec-

[1] In their pioneering paper, Bernard and Jensen (1999) show that exporting manufacturing firms in the US are larger and more productive than their non-exporting counterparts and define this as the "*export premium*". Similar results are also found in a number of papers looking at different countries (see Roberts and Tybout, 1997; A. B. Bernard and Wagner, 1997; Delgado, Farinas, and Ruano, 2002; Ottaviano and Volpe-Martincus, 2011).

[2] Exporting typically involves sunk costs, such as those needed to establish new distribution channels, transporting and marketing products to the standard of foreign markets.

tion process generates, on aggregate, greater overall national productivity and is the source of the gains from trade. Besides productivity, over time the literature identifies other determinants of the "extensive" margin of trade such as size, age and foreign ownership (see, among the others, Bernard and Wagner, 2001; Alvarez and Lopez, 2005; De Loecker, 2007; Gashi, Hashi, and Pugh, 2014).

Empirically, this selection in trade participation translates in a two-stage process where selection into exporting, i.e. the extensive margin of trade, is critical to obtain unbiased estimates of the trade exposure, i.e. the intensive margin of trade (see Bayar, 2018 for an extensive review). In this second stage trade volumes are generally considered as linearly determined by firm characteristics and environmental factors. However, this may not be the case. Indeed, in some cases the internationalization process of firms may be the result of a strategic decision plan, while in some others firms never establish in domestic markets and directly "born to export" in foreign markets. This is recognized outside international trade in international business and international entrepreneurship. In particular, scholars in international business consider the firm's path to internationalization as a discrete, staged or incremental, and not as a continuous process. Indeed, firms first "born local" and then gradually enter international markets. For example, in the Uppsala theory and the Innovation-Related Internationalization models, this gradual internationalization path is the consequence of uncertainty and incomplete information embedded in international trade. Thus, firms first establish in local markets, then start to export on an experimental basis to markets with "physical and cultural proximity", and then increase their commitment of managerial and economic resources to boost their export volumes and reach further distant markets (Bilkey and Tesar, 1977; S. T. Cavusgil, 1980; Reid, 1981; Czinkota, 1982). Moreover, a further distinction is made by scholars in international entrepreneurship who emphasize that not all the firms struggle in the domestic market before reaching the international markets. These firms skip entirely the Darwinian selection process and do not follow any incremental path. Indeed, they directly "born global" and export soon after their inception (McDougall, 1989; Rennie, 1993). These firms have distinctive characteristics, they are typically younger, smaller, costumer-oriented, highly innovative and technological and led by entrepreneurs with huge international experience (see Moen, 2002; Knight and Cavusgil, 2004; Taylor and Jack, 2013; Cavusgil and Knight, 2015).

While these two literatures point to "selection" beyond the extensive margin, i.e. at the intensive margin of trade, there is a lack of empirical evidence on such selection process. Arguably, a better understanding of the nature and characteristics of internationally operating firms may

be possible from the interaction of these three approaches[3]. Recently, Verbeke and Ciravegna (2018) already argue the need for greater interaction between the concepts in international business and international entrepreneurship.

This chapter[4] aims at filling this gap contributing to the empirical literature on firm heterogeneity and trade. Specifically, in line with existing studies we look at firm-level heterogeneity at both extensive and intensive margin of trade. However, differently from the past we consider selection into different trade intensities, borrowing the born local and born global concepts from international business and international entrepreneurship to allow for possible discretization of the intensive margin of trade.

The chapter will try to answer the following research questions:

- What are the main determinants of the firms' selection into trade?
- What are the characteristics of firms that are first born local and later become international? Are these characteristics different across firms with different level of international involvement?
- To what extent the born globals, e.g. firms that enter international markets soon after their inception, are different from domestic and born local firms?

These questions are investigated using a very large sample of around 20,000 Small and Medium Enterprises (SMEs) from a cross-section of 112 countries drawn from the World Bank Enterprise Survey. Unfortunately, due to data limitations we cannot perform a dynamic longitudinal analysis, thus, we try to capture the historical behavior of firms using information about when they have entered international markets. However, the inclusion of a heterogeneous set of firms and countries with different degree of development allows performing a rich investigation into firm-level heterogeneity and trade behavior. This is done considering a large set of internal and external, tangible and intangible, micro and macro drivers of SMEs international status that have been considered in recent empirical models (see, for example, Suárez-Ortega, 2003; Paul,

[3]Attempts to integrate different research fields, albeit under different perspectives, are also in Yi and C. Wang (2012) and in Albornoz et al., (2012). Yi and Wang (2012) try to merge into a unique framework heterogeneous trade models, the international business literature, the process-view and the international new ventures, using a dynamic probit to model the decision to export of Chinese firms. Albornoz et al. (2012) incorporate the ideas behind the Uppsala model in an international trade framework. Using data from Argentina, their model tries to explain firms sequential exporting strategies, assuming that their decision to export is characterized by initial uncertainty (which is then resolved through the accumulation of experience in foreign markets) and that export profitability is correlated over time and across destination markets.

[4]This chapter has inspired the realization of a co-authored paper with Professors Giorgio Fazio and Davide Piacentino. This paper has been presented at the 58th Conference of the Italian Economists Society (19-21 October 2017) with the title "When it comes to exporting, not all SMEs are born equal" and in a lunch seminar at the University of Barcelona (13 December 2017). It is now submitted.

Parthasarathy, and Gupta, 2017). From the methodological standpoint, the analysis is based on binary outcome models to exploit the main determinants of exporting behavior, in line with traditional trade models (Melitz, 2003), and later exploits the intensive margin of trade through the use of multiple outcome models to model the possible discretization of the trade exposure in line with international business and international entrepreneurship.

The analysis provides a number of novel insights that would not be possible by keeping the three approaches separated. Briefly, we find evidence that further selection stages apply also in the intensive margin of trade, where the international involvement of firms can be seen as a discrete process on the lines of the stages internationalization theories. An important result is that productivity is non-linearly related to trade exposure. Indeed, it affects the likelihood of exporting, but not with high commitment to international markets. Further interesting results emerge comparing domestic firms, born local and born global.

The rest of the chapter is organized as follows. The next section provides a brief review and synthesis of the relevant literatures. Section 1.3 describes the estimation strategy, Section 1.4 illustrates the data and variables used in the empirical analysis and presents the results. The final section concludes.

1.2 Literature Review

As discussed above, this chapter builds on the new trade theories looking at the difference between exporters and non-exporters and reaches out to the international business management and entrepreneurship literatures to consider the possible differences among firms that achieve different levels of international exposure either in stages or abruptly. This section provides a short reference to the relevant literature.

Empirical trade literature

Traditionally, international trade and the new trade theories have concentrated on the determinants of the extensive margin of trade and, in particular, on the process of "selection into exporting". Indeed, accounting for this selection is extremely important to obtain unbiased estimates of trade volumes, i.e. the intensive margin of trade. From the theoretical standpoint, this follows Melitz (2003)[5] where only firms that survive a Darwinian selection process based on their productivity and profitability export. Indeed, the sunk costs to enter international markets imply

[5]This pioneer model has been extended in later studies see, for instance, Bernard, Redding and Schott (2007), Helpman, Melitz and Rubinstein (2008) and Eaton, Kortum, and Kramarz (2011).

that only firms that are productive beyond a certain threshold can profitably internationalize, while all the others will either serve the domestic market or exit altogether.

The empirical studies in this literature focus on the comparison between exporters and non-exporters to evaluate the determinants of the selection into exporting (see, among the others, Bernard and Jensen, 1995; Bernard and Wagner, 1997; Delgado et al., 2002). Together with productivity, other firm-level characteristics affect the ability of firm to export. Size, age and foreign ownership are some of the most relevant (see, for example, Bernard and Jensen 1999; Ottaviano and Volpe-Martincus, 2011; LiPuma, Newbert, and Doh, 2013; Gashi, Hashi, and Pugh, 2014; Ahasan, 2017; Boddin, Raff, and Trofimenko, 2017; Huang, Wang and Bao, 2015; Padmaja and Sasidharan, 2017). Firm size is usually associated with greater resource availability and higher labor productivity (Costa, Pappalardo, and Vicarelli, 2017). Age implies the accumulation of market experience, resources and know-how in the domestic market (Robert and Tybout, 1997; LiPuma, Newbert, and Doh, 2013; Olney, 2016). The ownership structure, and in particular the presence of foreign owners, is supposed to provide the knowledge, technology and resources needed to compete in international markets (Gashi, Hashi, and Pugh, 2014; Boddin, Raff, and Trofimenko, 2017).

A large number of empirical studies also shows that together with firm's internal characteristics, macro factors, such as the cultural and institutional background, and the environmental context in which firms operate explain a large part of the heterogeneity in export. In this respect, greater attention has been devoted to the firm's geographical location (Farole and Winkler, 2014; De Matteis, Pietrovito, and Pozzolo, 2016), the quality of the institutional context, e.g. corruption (LiPuma, Newbert, and Doh, 2013; Olney, 2016; Krammer, Strange, and Lashitew, 2018) and domestic infrastructures (Albarran, Carrasco, and Holl, 2013). For instance, Farole and Winkler (2014) argue that firms are more likely to export if they are located in high income countries, with better institutions, infrastructures and services, but also in regions with larger agglomeration and urbanization effects. De Matteis et al. (2016) show, using data of Italian manufacturing firms, that the proximity to foreign markets, a high level of human and social capital and a high degree of efficiency of the public administration are significant determinants for both the extensive and intensive margin of trade. The evidence on the influence of the quality of the institutional context and, in particular, on the impact of corruption on exporting is, however, mixed with some studies finding a positive impact (Olney, 2016) and others finding a negative impact (Liu, Lu, and Ma, 2015). For instance, Ahsan (2017) finds using data of the World Bank Business Environment and Enterprise Performance Surveys (BEEPS), that corruption can attenuate the overall negative effect of bureaucracy. Krammer et al. (2018) find a positive effect of political instability and informal competition but an insignificant effect of cor-

ruption, although this result may depend on how corruption is measured. These opposite results have been given different interpretation. According to some authors, corruption represents a cost that reduces firms' profits in the domestic market and increases their desire to operate also in international markets. According to others, corruption causes resource misallocation, discourages investment and reduces efficiency with a negative and detrimental effect on growth and exports.

In summary, in the empirical trade literature both internal and external (tangible and intangible) factors matter in the choice of exporting, but with mixed evidence.

From the methodological standpoint, the characteristics that influence the intensive margin are investigated after controlling for the selection bias on the extensive margin using a two-steps procedure, such as the Heckman's estimation method[6]. This procedure simultaneously estimates the determinants of the export decision in the selection equation and, then, that of the exports volume through the second equation (see, among the others, Castellani, 2002; Secchi, Tamagni, and Tomasi, 2016; Krammer, Strange, and Lashitew, 2018). Therefore, while the extensive margin is expressed through a non-linear equation, trade at the intensive margin is usually considered a "linear" function of internal and external determinants. This implies, for example, that productivity has to be beyond a certain threshold in order to allow participation into the international market, but it is then assumed to monotonically determine higher export volumes.

International business: the born local

In international business literature, the international exposure results not from a continuous but from a discrete process. Studies in this literature investigate why firms are characterized by different degree of foreign market participation gradually moving from being purely domestic to fully international. Therefore, these studies investigate firm internationalization process focusing not only on the differences between exporters and non-exporters, but also on the differences among exporting firms (see Paul, Parthasarathy, and Gupta, 2017 for an extensive review). This literature comprehends three streams of research: the incremental or processual, the FDI and the network approaches[7]. For the purposes of this chapter, the analysis concentrates on the popular incremental approach that views internationalization as a dynamic process along a staged path (Vernon, 1966; Johanson and Vahlne, 1977; S. T. Cavusgil, 1980; Reid, 1981). In particular,

[6]Heckman's procedure has been also applied to the estimation of gravity equation models which are very used in international trade to model bilateral interactions among trading partners (see, for example, Chaney, 2008; Helpman, Melitz and Rubistein, 2008; Head and Mayer, 2014; Christen et al., 2019).

[7]The FDI school is due to Williamson (1975), Dunning (1980) and Anderson and Gatignon (1986) and looks into the different foreign markets entry strategies and the factors (mainly ownership and location-specific determinants) affecting the pattern and the distribution of international activities. The network approach analyzes the role of cooperation in international business (e.g. Holm, Eriksson, and Johanson, 1996).

the focus is on the Innovation-Related Internationalization models (I-M) due to separate contribution of Bilkey and Tesar (1977), Cavusgil (1980), Reid (1981), Czinkota (1982). These models, which build on the Uppsala model of internationalization due to Johanson and Vahlne (1977)[8], consider internationalization as similar to an innovation process that can start either from a "*push*" mechanism, i.e. an external opportunity that drives the firm in undertaking the decision to enter foreign markets (Bilkey and Tesar, 1977; Czinkota, 1982), or a "*pull*" mechanism, i.e. a *stimulus* that operates inside the company. This process brings the firm to gradually enter foreign markets after being well-established in the domestic market. These firms, commonly known as born local, follow a sequential staged path where they become more and more committed to international markets.

This literature has concentrated on the key determinants of this staged internationalization process underlying the importance of factors such as the size of the local market and industry of activity and the manager's characteristics, e.g. education, knowledge and experience, to progress across the different stages (see, for example, Wickramasekera and Oczkowski, 2004). For instance, Bilkey and Tesar (1977) use a sample of Austrialian firms to analyse the determinants of the different export stages. Their internationalization model, which consists of six stages that differ for the increasing interest and commitment to exporting activities, shows that the quality, dynamism and expectations of firm's managers are the main determinants of exporting across the different stages. Similarly, Wickramasekera and Oczkowski (2004) highlight, using a survey of Australian winery firms and structural equation modelling technique, the importance of management commitment, previous export experience and training in export across the stages. Cavusgil (1984) uses data from a sample of 70 manufacturing firms operating in Wisconsin and Illinois and groups firms by degree of internationalization, specifically distinguishing: *experimental exporters* (with less than 10 percent share of exported sales), *active exporters* (those exporting between 10 and 40 per cent of their sales), and *committed exporters* (exporting more than 40 per cent of their production). He then compares these categories on the basis of internal company's characteristics and environmental factors, finding that exporters differ in terms of size, with committed companies that tend to be larger and face higher competition and saturation of the domestic market.

The I-M models, in general, and the Cavusgil's classification, in particular, highlight the importance to consider exporters as a heterogeneous more than homogeneous group to better

[8]The Uppsala model (Johanson and Vahlne, 1977) describes the internationalization process as a series of incremental steps where firm gradually increases its knowledge and commitment to international markets. Thus, as the foreign market knowledge increases and the firm recognizes new opportunities, it decides first to export to physically close markets and then to progressively establish export channels and foreign subsidiaries to more distant markets.

disentangle the different factors affecting firms with different degree of internationalization. For the purposes of this chapter, the analysis adopts Cavusgil's classification to model a discrete intensive margin of trade.

International entrepreneurship: the born global

Together with globalization it has emerged the phenomenon of the so called "*born global*" firms. This term was first coined by Rennie (1993) to indicate those companies that undertake high level of internationalization at their inception or early after their funding. There is not *consensus* in the literature on the definition of born globals firms, however, the two most used criteria that have been adopted to identify these firms are the interval time between foundation and internationalization and the percentage of sales exported. In this respect, some authors consider a interval period of 2 years after the inception (Moen, 2002), some others 3 years (Knight and Cavusgil, 2004) or more (McDougall, Shane, and Oviatt, 1994; Zahra, Ireland, and Hitt, 2000). While, looking at the percentage of international sales on revenues, some authors consider a threshold of at least the 5 per cent (McDougall, 1989), some others the 25 per cent (Moen, 2002; Knight and Cavusgil, 2004), or more than the 50 per cent (Gabrielsson and Kirpalani, 2004).

Clearly, the surge in these firms cannot be explained by the staged approach of the I-M models. The born global, instead, have been the main focus of the international entrepreneurship literature where it is argued that these firms tend to differ from the born local because of product specialization (Evangelista, 2005), the realization of high-quality or niche products, superior innovative culture and superior market knowledge, organizational capabilities, the support of networks and alliances with foreign companies and suppliers and the role of network relationship (see Knight and Cavusgil, 2004; Freeman, Edwards, and Schroder, 2006; Taylor and Jack, 2013; Cannone and Ughetto, 2014; Hennart, 2014; Cavusgil and Knight, 2015; Bruneel, Clarysse, and Autio, 2018). For instance, Knight and Cavusgil (2004) realize a survey-based study on a random sample of 900 manufacturing firms founded in the US in or after 1980 and that export at least the 25 per cent of their production, and use confirmatory factor analysis to investigate the characteristics of the born globals. Their findings show that early internationalization is linked to international entrepreneurial orientation and strong innovativeness, which favour the development of unique high-quality products.[9] Similarly, Dib, Da Rocha, and Da Silva (2010) show, using a sample of 79 Brazilian software firms and logistic regression model, that the born global are younger and smaller, more innovative and customer-oriented (i.e. focused on realizing

[9]The importance of product quality and niche products is underlined also by Hennart, Majocchi, and Forlani (2019) in the case of family-owned SMEs.

products to fit customer needs) compared to firms that follow a "traditional" internationalization path. On the same line, Hennart (2014) argues that the competitive advantage of born global firms derive from their business model that is, from their ability to sell niche products to different foreign markets using low-cost delivery methods.

Together with firm internal characteristics, also the environmental context conditions play a role in this rapid internationalization process of the born global firms. Indeed, external factors, such as the size, saturation and competition of the domestic market, as well as its economic development and institutional quality influence the emergence of born globals. In this direction, for example, Taylor and Jack (2013) conduct a case study on four non-high tech firms to analyse the pace (the time between the inception and the entry into international markets), the scale (the extent of international operations) and the pattern of firm internationalization (the choice of both the entry mode and international markets). Using an explorative qualitative case study methodology they show that the presence of "a small and mature domestic market" reduces the time span between firm inception and entrance into international market, thus, increases the likelihood of being born global. Similarly, Cannone and Ughetto (2014) show, using data on high-tech start-ups from different countries and qualitative data models, that a small domestic market positively influences both the probability of being a born global and the "degree of born globalness".

Recent contributions, however, highlight that born global are not so "special" compared to other exporters or start-ups in general. In particular, Choquette, Rask, Sala, and Schröder (2017) using data of approximately 20,000 Danish manufacturing start-ups founded between 1994-2008, compare the born globals to domestic firms, Late Exporters (i.e. those that start to export after three years from their inception) and Born Exporters (i.e. those that start exporting within three years from their inception like the born global, but a smaller fraction of their turnover) to better disentangle their distinctive characteristics. They find, running a pooled Ordinary Least of Square regression with domestic firms as the baseline category, that despite some superior characteristics for example in terms of employment and number of export destination markets, born globals are not so different from other international firms in terms of productivity and turnover growths, respectively.

An evaluation of the current debate

These "mixed" results underline the need for further investigation aimed at comparing born globals with both domestic firms and firms that follow a staged internationalization path, in order to understand whether specific characteristics are peculiar of born globals or are associated, in general, with firms internationalization. Knight and Liesch (2016) provide a thorough review of

the internationalization literature on the incremental approach and the born global phenomenon, and call for deeper theoretical and empirical investigations of the latter, in order to understand their better capabilities and performance and their long-run trajectory. Similarly, in a recent paper Verbeke and Ciravegna (2018) argue that in order to obtain a better understanding of the firm's internationalization process and of the characteristics of internationally operating firms, it would be important to integrate the international business and international entrepreneurship literatures. Indeed, join the fields of international business and entrepreneurship would enrich the analysis of international companies, allowing a multi-level approach involving firms internal characteristics, the role of the entrepreneurs and the external context. We move in this direction developing an empirical framework to compare and understand the main features of domestic, born local and born global firms. Moreover, born globals are also interesting from the perspective of the international trade literature, as they seem to escape the Darwinian selection process discussed by Melitz (2003). Indeed, rather than acquiring over time the resources and the ability to enter international markets, they seem to have innate properties that make them naturally inclined to early internationalization.

This brief review shows how international economics, international business and international entrepreneurship analyse the export behavior of firms from different perspectives. While international economics focuses on the determinants of the firm decision or ability to export (hence, the comparison between exporting and non-exporting firms) and consider the intensity of exporting as monotonic, the international business literature looks, instead, at the determinants of firms that follow a staged internationalization path with increasing degree of commitment to foreign markets. Finally, international entrepreneurship focuses on born global firms which are at the odd with the above theories. Therefore, an empirical investigation that combines the main elements of the three approaches can lead to a better understanding of the complexities behind the internationalization of the firm. The next section describes how this objective is pursued in this chapter.

1.3 Empirical Strategy

The objective of this chapter is to provide a comprehensive investigation of the internationalization of Small and Medium Enterprises (SMEs). Empirically, we build on the standard empirical international trade models. In this context, the first step consists in the analysis of the selection process into trade comparing exporters and non-exporters to outline their differentiating features. This represents our baseline model (see subsection 1.3.1). In the second step, the analysis departs from the standard empirical trade literature that looks at the intensive margin of trade

as a linear, monotonic function of firm's internal characteristics and environmental factors and considers the heterogeneity among exporters along the lines of the international business literature. Specifically, adopting the taxonomy by Cavusgil (1984) the analysis exploits whether the trade determinants differ across firms with different degree of internationalization (see subsection 1.3.2). Finally, in the third step the analysis concentrates on the born global firms to check the robustness of the results on the born local and to see whether, as suggested by the international entrepreneurship literature, they are different from the born local and the domestic firms (Section 1.3.3).

1.3.1 First step: Exporters vs non-exporters. The determinants of the extensive margin of trade

In the empirical trade literature[10], following Roberts and Tybout (1997), it is common to estimate the likelihood of a firm's export status using a probit model where a dummy taking value one if the firm is an exporter is expressed as a function of a set of firm-specific characteristics, environmental factors and other control variables. Building on this approach, the first step of the analysis is to model the determinants of the likelihood of being an exporter using logit regression methods, specified as follow:

$$ln\left(\frac{\pi_i}{1-\pi_i}\right) = \alpha + \mathbf{x}_i'\beta + \mathbf{z}_i'\theta + \varepsilon_i, \tag{1.1}$$

where the probability of being an exporter, π_i, rather than a non exporter, $(1-\pi_i)$, is regressed on a vector $\mathbf{x}_i$ of variables of interest and $\mathbf{z}_i$ of control variables. In line with the international trade, international business and international entrepreneurship literatures, the set $\mathbf{x}$ contains a set of internal firm characteristics including a measure of productivity (lagged to reduce the risk of reverse causality), intangible obstacles, measures of institutional quality (e.g. corruption) and tangible obstacles (e.g. quality of public utilities). The full set of variables in $\mathbf{x}_i$ and $\mathbf{z}_i$ is discussed in section 1.4.1 and reported in table 1.1.

[10]Early empirical models (see, for example, Bernard and Jensen, 1999) showed the heterogeneity of international firms using a simple approach that highlighted the impact of exporting on a number of firm characteristics (e.g. size of workforce, average wage, shipments, total factor productivity). These were regressed using simple OLS on a dummy variable denoting the firm's export status that would be positive and statistically significant in the presence of an "export premium". These studies typically showed that exporters tend to be larger and perform better than non-exporters.

1.3.2 Second step: The "born local" exporters and heterogeneity in the intensive margin

In the second step, we extend the above approach to consider not just the heterogeneity between exporters and non exporters, but also among exporting firms. As mentioned in the literature review section, the international business literature has extensively discussed the internationalization of firms that are born local and become international after gaining experience in the local (domestic) market. In the traditional international business models, this internationalization process is incremental and ignores the case of rapid internationalizing firms, i.e. the born globals. Thus, initially we pool all firms together without making this distinction, later we isolate the born globals to focus, specifically, on their characteristics.

To carry out this second stage of analysis, we follow Cavusgil (1984) who distinguishes exporting firms in *experimental exporters* (those with exports share of sales less than 10%), *active exporters* (those with export share of sales between 10% and 40%) and *committed exporters* (those with export share of sales greater than 40%). This taxonomy is related to the different stages of an incremental internationalization process. From the methodological stand point, this translates into a dependent variable that is no longer binary as in equation (1.1), but categorical with three possible outcomes, each denoting a different "stage" of internationalization.

A caveat is necessary. It is not possible to pinpoint from the data, whether firms are in a specific stage as a result of an incremental process (i.e. an incremental step from the previous category) or as a consequence of a "disruptive" process that makes them reach a higher level of internationalization without experiencing first a lower one. Moreover, the internationalization could also simply be "opportunistic", rather than strategic if firms simply respond to an increase in the demand by foreign consumers. To take into account these possibilities, we consider both the chance that the above different categories can be the result of an ordered process, where firms internationalize incrementally, or of a multinomial process, where firms "jump" from the domestic status to any of the levels in the taxonomy of Cavusgil. Therefore, in the first case, we estimate a generalized ordered logit model as specified below:[11]

$$p(Y_i > j) = g(\mathbf{x}_i'\beta, \mathbf{z}_i'\theta) = \frac{e^{\alpha_j + \mathbf{x}_i'\beta_j + \mathbf{z}_i'\theta_j}}{1 + e^{\alpha_j + \mathbf{x}_i'\beta_j + \mathbf{z}_i'\theta_j}}, \; j = 1, ..., J-1 \tag{1.2}$$

where j indicates the type of exporter, among the possible J categories Domestic, Experimental, Active, Committed:

[11] We started estimating a simple ordered logistic regression. However, running the Brant test it suggested a violation of the parallel line assumption, thus, we decide to switch to a generalized ordered logit to take into account the ordinal nature of the dependent variable.

$$J = \begin{cases} 0 & \text{Domestic, if exports = 0} \\ 1 & \text{Experimental, if 0<exports<10\%} \\ 2 & \text{Active, if 10\}\leq\text{exports }\leq 40\% \\ 3 & \text{Committed, if exports >40\%} \end{cases} \tag{1.3}$$

and $\mathbf{x}_i'$ and $\mathbf{z}_i'$ are the same vector of covariates as in equation (1.1). In line with the categories of Cavusgil (1984), $J = 4$. In this model, the probability of Y being in a higher category is relative to the probability of being in one of the lower categories, e.g. being in $J = 3$ compared to being in $J = 0, 1, 2$. To consider the second possibility, we estimate a multinomial logit model where each stage J of internationalization is compared to the baseline case of the domestic only firms:

$$ln\left(\frac{\pi_{ij}}{\pi_{iJ=D}}\right) = \alpha_j + \mathbf{x}_i'\beta_j + \mathbf{z}_i'\theta + \varepsilon_i \tag{1.4}$$

where, again, j indicates the type of exporter and J is in the case of the multinomial the domestic-only reference category, D.

The two models entail different interpretations. In the generalized ordered logit model, the different stages can be seen as sequential as in the I-M models. In the multinomial logit case, instead, the probability of being in one category is considered with respect to the reference category, that is domestic. This second model is then more able to capture "disruptive" internationalization, where a firm jumps to a specific category from being entirely domestic. This disruptive internationalization does not need to be strategic and it can simply result from opportunistic behavior in front of a sudden rise in foreign demand for domestic products. The comparison across models allows richer inference on the nature of the firm internationalization process and on how each determinant may affect this process in a different way.

1.3.3 Third step: The "born global" exporters

In the third and final step, we take into account more closely those firms characterized by early internationalization, i.e. the born globals, extensively considered in the international entrepreneurship literature. To this end, despite the different criteria used to define these firms, as discussed in the review, we follow Knight and Cavusgil (2004) and define born globals as all the firms that export within three years from their inception and that sell abroad more than the 25 per cent of their sales. This is achieved exploiting the survey questions that asks when the firm has started operation and exporting activities.

To better disentangle the characteristics of this type of firms, we first re-run the model in

equation 1.4 by excluding the born global firms from the analysis. This allows checking if their presence influences the results obtained in the second stage. Then, we contrast the born globals with domestic and born local firms using both logistic regression models that compare categories directly in separate binary settings and multinomial logit models that compare the domestic, born local and born global firms in a single setting. Again, in the discussion of the results it is the comparison across models that allow to draw inference on the differences between international firms.

1.4 Empirical Analysis

1.4.1 Data: World Bank Enterprise Survey

With the exception of few cross-country analyses (Cannone and Ughetto, 2014; Krammer, Strange, and Lashitew, 2018), most empirical research in this field is based on single-country qualitative and quantitative studies (see, among the others, Knight and Cavusgil, 2004; Yi and Wang, 2012; Uner et al., 2013). However, the use of a large dataset allows the consideration of firms with greater heterogeneity in terms of economic, environmental and institutional backgrounds, this can be important to understand their internationalization. Therefore, the empirical analysis exploits the data collected by the World Bank Enterprise Survey using a standardized questionnaire at the plant-level. The data includes a large sample of plants from 112 high, medium and low income countries belonging to six macro-regions (East Asia and Pacific, Europe and Central Asia, Latin America & Caribbean, Middle east and north Africa, South Asia and Sub-Saharan Africa) and interviewed in different survey years.[12]

The original sample is reduced to 19,290 observations after isolating SMEs (defined as those with more than 10 and less than 250 employees) operating in the manufacturing and services sectors (84% and 16% respectively) and after a data cleaning process.[13] Table A.1.2 in Appendix 1.A provides the main summary statistics. The 29 per cent of SMEs in the sample operates in international markets and within the group of exporters the born local firms are around two times the born global firms, the 68 per cent and the 32 per cent, respectively.

To investigate the features of international SMEs, we exploit the rich set of questions included in the survey and consider most of the variables discussed in international trade, international business and international entrepreneurship. Clearly, in achieving this data availability

[12] See http://www.enterprisesurveys.org for further information.

[13] Data cleaning has been carried out to exclude outliers in the labor productivity variable. After an extensive robustness analysis, 4% of observations associated to extreme values have been dropped from the sample. This analysis is reported in the Technical note 1.B.

and possible differences in variable definitions due to the specific set of questions included in the standardized questionnaires may be a constraint. Notwithstanding, the analysis tries to estimate the richest possible regressions including both firm's internal characteristics and external factors to see their influence on the internationalization status and internationalization levels of SMEs. Specifically, the following variables are considered.

Regarding firm's internal characteristics, in line with the empirical trade literature, the analysis considers the well known export-productivity nexus, which is assumed to be positive (see, among the others, Alvarez and Lopez, 2005; Ottaviano and Volpe-Martincus, 2011; Yi and Wang, 2012; Kiyota, Matsuura, and Nesta, 2019). Following the standard approach, a lagged measure of the labour productivity is used to limit the risk of possible reverse causality and endogeneity. In addition, a list of other variables usually associated positively with exporting is considered. This includes measures of international linkages (see Ahsan, 2017; Yi and Wang, 2012; Boddin et al., 2017) such as foreign ownership, as the presence of foreign partners may bring know-how and competences that help the firm to easily deal with the fixed sunk costs and the "barriers" associated to exporting; and, the adoption of foreign technology which is seen as a positive determinant of internationalization as it enhances the flow of knowledge and denotes greater propensity to acquire advanced technologies, both key factors of international competitiveness (see Alvarez and Lopez, 2005, and, more recently, Krammer, Strange, and Lashitew, 2018). In the World Bank Enterprise Survey foreign ownership refers to the nationality of the shareholders, thus, it can be considered as a measure of inward FDI. Unfortunately, the questionnaire do not ask firms whether they possess foreign owned subsidiaries abroad so we could not take into account outward FDI. Moreover, in line with the international business and international entrepreneurship, the manager experience in the firm sector of activity is included. Indeed, managers experience enhances the ability of the firm to recognize market opportunities and set appropriate strategies (see Krammer, Strange, and Lashitew, 2018).

The empirical analysis considers also an extensive set of "control" variables that should all significantly and positively affect the probability of exporting. These include the firm's age that implies the accumulation of market experience, resources and know-how in the domestic market (LiPuma, Newbert, and Doh, 2013; Olney, 2016; Krammer, Strange, and Lashitew, 2018), being part of a large company and the acquisition of international quality certifications. In particular, the latter can be considered as a sunk cost that acts as a signal, in principle, for international customers and it should therefore be associated with the internationalization strategy of the firm. On this point, Knight and Cavusgil, (2004) and Dib et al., (2010) emphasize how the importance of quality signals in international markets is a strong feature of the born global.

Also the external environment, as embedded in the country degree of development and the

importance of tangible and intangible obstacles, matters in firm's internationalization process. The inclusion of the country degree of development (high or low income) works as a proxy of the home country characteristics, which have been indicated as determinant of firm internationalization (see Taylor and Jack, 2013; Cannone and Ughetto, 2014). In particular, firms in high income countries should be more likely to export and being either born locals or born globals. Tangible and intangible obstacles include the quality of public utilities (e.g. water and electricity supply) and the extent of corruption in business activities, respectively.[14] The inclusion and the interpretation of these variables is guided by a vast literature on the impact of barriers to export (see, for example, Leonidou, 2004; Uner et al., 2013; Krammer, Strange, and Lashitew, 2018). According to some authors (see Olney, 2016, and Krammer, Strange, and Lashitew, 2018), these barriers may positively impact firms internationalization. Indeed, they may act as "push" factors towards international markets allowing firms to bypass domestic market obstacles. Moreover, as argued by Uner et al. (2013), the impact of barriers to export may vary according to the different internationalization modes.[15] Thus, it is important to disentangle their effect across domestic, born locals and born globals.

An alternative quick way to incorporate the role of the external environment is to add country-level fixed effects. However, their inclusion made the most of the models computationally too cumbersome[16]. Moreover, while country effects would act as good control variables, they would "hide" all underlying country-level or environmental variables of interest. For these reasons, we decide not to pursue this choice in the end and try as a robustness check to estimate all models with the inclusion of a set of macro-level country variables, i.e. GDP at PPP, Land Area in sq. km and Population size by area, from the World Bank Indicators database[17]. The inclusion of these variables did not affect our core results.

As argued at the beginning, the standardized data are collected over different years, for this reason all the regressions include year dummies to account for potential survey-year effects. Please refer to Table A.1.1 in Appendix 1.A for the list of countries, year of collection and number of observations per country and to table 1.1 for the full list and definition of the variables

[14]The number of days to clear export would be a more appropriate proxy of tangible obstacles. Unfortunately, there is insufficient information about this in the data set.

[15]For instance, Uner et al. (2013) argue that informational barriers, marketing-product barriers and functional barriers differently impact born local and born global firms. In particular, the authors show that informational barriers matter more for non-exporting firms and lose their importance as the commitment to international market increases; procedural barriers (e.g. unfamiliar exporting procedure) matter more for experimental exporters and born global firms. For more details, see Uner et al. (2013) from page 805.

[16]We were able to obtain the estimates with country fixed-effects only for the logit models in the first and third step of analysis and results do not change. We get only, as expected, an insignificant coefficient of the variable related to the country degree of development. However, the generalized ordered logit and the multinomial logit model do not achieve convergence with the inclusion of country fixed-effects.

[17]see https://data.worldbank.org/indicator/.

included in the final specifications.

Finally, all regressions are run using the survey weights.[18]

<*Please insert Table* 1.1 *about here*>

1.4.2 The extensive margin of trade

In this section, we describe the results of the analysis in line with the empirical strategy discussed in section 1.3. Table 1.2 reports the results of equation 1.1. Specifically, it displays the average marginal effects of a series of logit models aimed at investigating the determinants of the extensive margin of trade by comparing exporting versus non-exporting firms. The model starts considering first the well known export-productivity nexus in column 1 and then progressively adding the internal and external factors discussed in the previous section. Overall, the empirical analysis returns evidence that is strongly supportive of the theoretical expectations with all the variables robustly entering the regressions with the expected positive sign and high statistical significance. In line with previous studies, higher (lagged) productivity is associated with higher probability to export. However, as pointed out by Armenter and Koren (2015), productivity is not the unique determinant of the export decision. Firm's age, as discussed by Li Puma et al., (2013), has a positive and significant effect in column 2 and turns marginally significant or insignificant when further controls are included. The manager's experience is, instead, always positive and significant, in line with Knight and Cavusgil (2004) and Taylor and Jack (2013).[19] The factors related to the firm's ability to compete internationally and link to international networks, such as being part of a large company, having international quality certifications, having foreign ownership and the adoption of foreign technologies are also significant and positively signed. This evidence is in line with that of Yi and Wang (2012), Gashi et al. (2014) and Boddin et al. (2017). External factors, such as intangible (e.g. corruption) and tangible (e.g. lack of public utilities) obstacles, similarly increase the probability that firms sell abroad. This last result is in line with Olney (2016) who argues that corruption push firms from the domestic to the international market and with Krammer et al. (2018) who find that obstacles, such as political instability, informal competition and corruption are positively associated with the probability to export.

[18]The analysis is conducted using Stata svy commands, which provide robust standard errors. Survey weights are needed when working with stratified random sample.

[19]The evidence on the role of managerial experience is, however, not univoque. For instance, Krammer et al., (2018) find this variable to be not statistically significant.

Other interesting, though unsurprising, results are that firms in high-income countries have a significantly higher probability of exporting and service sector firms are less likely to be exporters compared to those in manufacturing (see Gabriele, 2006; Zahler, Iacovone, and Mattoo, 2014; Ariu, 2016). Traditionally, services have been considered as less tradeable than manufactured goods because of the so called *joint production requirement*, which implies that they must be consumed in the same place they are produced (see Hill, 1977). This condition has changed, however, especially in recent years thanks to the widespread of information and communication technologies (ICTs) (Freund and Weinhold, 2002; Choi, 2010). As a consequence, an increasing literature has analysed the characteristics of service tradability and their contribution to economic growth (see, among the others, Lejour and Paiva Verheijden, 2007; Breinlich and Criscuolo, 2011; Ariu et al., 2019; Gervais and Jensen, 2019). Despite their increasing importance, a lot need to be done to favor the inclusion especially of less developed and developing countries in services international trade flows. Indeed, as pointed out also by the WTO[20], many of these countries still need structural reforms to improve infrastructures and remove regulatory barriers that still prevent them to fully enjoy trade in services.

<*Please insert Table* 1.2 *about here*>

1.4.3 Staged internationalization: born local SMEs

In order to account for the heterogeneity among exporters highlighted in the international business literature on staged internationalization, as discussed in subsection 1.3.2, following the taxonomy proposed by Cavusgil (1984) exporting firms are distinguished in *experimental*, *active* or *committed*. The probability of falling in one of these categories has been modeled using two different approaches: the (generalized) ordered and the multinomial logit models. The first is more suitable to capture the internationalization strategy as an incremental process. However, Cavusgil (1984) also acknowledges that some firms may simply decide to adopt an opportunistic, rather than an incremental, strategy. This behavior is better captured by the multinomial model. Clearly, the two models rely on different assumptions and are designed to capture slightly different phenomena, thus they also require different interpretations. Therefore, a complete picture can only be obtained by comparing the results of both models. For this reason, table 1.3 presents alongside the ordered and the multinomial logit regressions.

Initially, the analysis concentrates on the full sample of firms without distinguishing between born local and born global firms. These firms have substantial foreign presence but are very young. As such, they do not fit the narrative of incremental or opportunistic internation-

[20]World Trade Organization. Annual Trade Report (2019): The future of service trade.

alization process of international business and have been the object of study of international entrepreneurship theories that consider these type of firms as substantially different from other exporters. To the extent that this type of firms is different from the born local, results in table 1.3 will be affected by their inclusion in the sample. Therefore, the two previous models are repeated after having identified and removed these firms from the sample. These results are reported in table 1.4.

<Please insert Table 1.3 here>

<Please insert Table 1.4 here>

A much richer picture of the heterogeneity among exporting firms emerges from looking and comparing tables 1.3 and 1.4. Starting from the role of productivity, the generalized ordered model in table 1.3 shows that productivity helps firms incrementally reach higher levels of internationalization[21], while the multinomial model suggests that higher productivity helps firms being experimental and active, but not committed[22]. Interestingly, however, when the born global are excluded from the sample as in table 1.4, productivity looses its significance for the probability that firms are committed exporters also in the generalized ordered model. This suggests that the presence of the born global firms was "inflating" the previous results for this type of firms. Therefore, in the internationalization process of born local firms, productivity seems to matter only in order to experiment international trade or become either incrementally or opportunistically active exporters, but not committed exporters. In other words, once this category is reached, the productivity level becomes irrelevant to raise exports. This non-linearity is a novelty with respect to the existing empirical trade studies, where only one productivity threshold is considered as a determinant of the decision to enter international markets and the intensive margin is assumed to be a monotonic function of both firm's internal characteristics and external factors (see, among the others, Bernard and Jensen, 1999; Robert and Tybout, 1997; Bernard and Wagner, 1997).

Great heterogeneity and non-linearities emerge also with respect to other factors. For instance, age affects the probability of being a experimental or active exporters in the generalized ordered model in table 1.3 and also of being active rather than domestic in the multinomial logit model. Moreover, older firms are less likely to be committed in the generalized ordered logit case. As in the case of productivity, the inclusion of born globals affects these results. Indeed, results in table 1.4 show that, when born globals are excluded from the sample, age positively

[21]The generalized ordered logit model reports for each category, the contribution of a specific variable to the probability of being at least in that category and not in the lower ones.

[22]In the multinomial logit model, the coefficients express the probability of being in one category compared to being in the base case of purely domestic.

affects also the probability of being committed both in the ordered and in the multinomial logit model. The negative result in table 1.3 derives from the nature of the born globals, that are by definition more active/committed and younger.

Managerial experience is also important. It turns out to be positive and statistically significant in the generalized ordered model both in table 1.3 and 1.4. In the multinomial model, instead, it increases the probability of being experimental or committed both including and excluding born global firms. These results are not in line with those in Krammer et al., (2018) who do not find supportive evidence of the effect of manager experience on the probability of exporting.

Looking at the factors affecting firm competitiveness and networking, results for the multinomial logit model (with and without born globals) show that being part of a large company matters for higher levels of international involvement either active or committed, while it is statistically significant only at 10 per cent for experimental exporters. Having an international quality certification or foreign ownership matters both for moving incrementally from one category to the next and from domestic to any category in table 1.3, but they do not affect the probability of being committed in the multinomial model when the born global are excluded. See table 1.4. The use of foreign technologies affects the probability of being an active or committed exporter in both table 1.3 and 1.4. This result slightly changes in the multinomial logit model when the born global are excluded. In this case, differently from Krammer et al., (2018), a positive and slightly statistically significant effect emerges only on the probability of being an active exporter. This is interesting, since the comparison of table 1.3 and 1.4 seem to show that born globals are more likely to be international also because of their dynamism in adopting foreign technologies.

Looking at the external factors, also the tangible and intangible obstacles are non-linearly linked with the different levels of commitment to exporting. In both tables 1.3 and 1.4, irrespective of the sample used, the intangible obstacles never affect the ordered probabilities, while they affect the probability of being an active exporter in the multinomial model. Tangible obstacles only affect the probability of being an active exporters irrespective of the estimation method and sample used. These results seem to reinforce the interpretation given in the literature by Olney (2016) and Krammer et al., (2018) that those firms that are mostly affected by domestic obstacles are pushed towards international markets. These results indicate that these firms are more likely to be directly active. Indeed, experimental firms still have a predominantly domestic focus, only marginally diverting their sales to the international markets, so that they are largely unaffected by these obstacles, while committed firms that have a predominantly international outlook see these domestic obstacles as less relevant for their decision.

A richer evidence emerges in tables 1.3 and 1.4 about the firm sector of activity. Indeed, while in table 1.2 firms in the service sector were less likely to be exporters, now it emerges that they are not statistically different from manufacturing firms in terms of experimenting with international trade. However, they are less likely to be active or committed exporters.

Finally, firms in high income countries are more likely to be active or committed exporters in both table 1.3 and 1.4. Thus, there is no statistical difference in the probability of being an experimental exporter between firms located in countries with different levels of development. This highlights that the problem of firms in less developed and developing countries is not as much to access, but to have a sizable presence in international markets.

1.4.4 Rapid internationalization: born global SMEs

As discussed in the literature review section, the international entrepreneurship literature has emphasized the exceptional nature of born globals with respect to other kind of firms. In the previous subsection, the comparison of tables 1.3 and 1.4 already goes in this direction showing that removing the born globals from the full sample changes the sign or the statistical significance of some of the determinants of international involvement of the born local firms.

The last step of the analysis focuses explicitly on born globals to better disentangle their distinctive characteristics. Table 1.5 presents the results of different models comparing born globals versus born local and domestic firms. In columns 1 and 2 the table reports the results of two logit models that contrast, respectively, born locals and born globals with domestic SMEs. Columns 3 and 4 reports the results of a multinomial logit models in which domestic (baseline category), born local and born global firms are contrasted in a unique framework. Finally, column 5 displays the results of a logit model that compares directly born globals to the born local firms (baseline category).

Overall, the results in table 1.5 confirm the hypothesis that born globals are different. For example, the productivity level matters for born local, but not for born global, compared to domestic firms. This results is in line with the descriptive statistics reported in table A.1.2 in Appendix 1.A which shows that productivity is on average higher for born local than born global firms. Moreover, in the last column productivity turns out to be negative when born globals are contrasted directly with the born locals. Similarly, age is positively associated with being a born local and negatively with being a born global. This result is coherent with the definition of these firms which are very young and early international.

Looking at the variables related to international competitiveness and networking, results show that being part of a large company positively affect the probability of being a born local, but not a born global. Adopting foreign technologies affects more the probability of being born

global than born local, in line with Alvarez and Lopez (2005) and Krammer et al., (2018). International quality certifications and foreign ownership affect both the types of firms. These results are coherent with the literature, that describes the born global firms as more open and innovative than the domestic and born local firms. It can be argued, on the line of the Resource Based View started from the pioneer work of Penrose (1959), that foreign linkages and product quality focus are two main value-creating factors that born global firms could strategically adopt to outperform born locals and gain competitive advantage on foreign markets.

As it can be expected, firms are more likely to be born globals if they belong to high income countries, while they are less likely if they operate in the service sector.

Finally, looking at environmental or external factors, tangible and intangible obstacles differently impact born global and born local in agreement with Uner et al., (2013). For instance, intangible obstacles proxied by corruption affect the likelihood of being born local rather than domestic firms in line with Olney (2016) and Krammer et al. (2018), while they do not impact on born global, as reported in columns 4 and 5 in table 1.5. Tangible obstacles, instead, proxied by the lack of public utilities, affect only the probability of being born global rather than born local. Thus, a domestic market with poor services and infrastructures pushes firms more rapidly toward international markets.

<Please insert Table 1.5 about here>

1.5 Conclusions

The international trade literature has been mainly focused on analysing firm heterogeneity in terms of selection into trade, i.e. participation in export markets, to avoid bias in the estimation of the intensive margin. This is considered, in this literature, as a linear function of both firm's internal characteristics and external factors. Differently, the international business and international entrepreneurship literatures look at the heterogeneity in terms of internationalization strategies, specifically distinguishing firms that follow a staged or incremental path and a rapid process, i.e. born local and born global. This chapter aims to provide an empirical investigation of the internationalization of firms, merging in a unique framework the international trade, business and entrepreneurship literatures. This is done first looking at the determinants of the extensive margin of trade along the lines of empirical trade models and then testing for further heterogeneity by considering a discretization of the intensive margin of trade borrowing the taxonomy of the born local due to Casvusgil (1984) and the definition of born global due to Knight and Casvusgil (2004).

This chapter exploits a large survey dataset provided by the World Bank and uses qualitative

data models to perform a cross-country analysis of the heterogeneous determinants of firm export behavior. Results confirm the differences between purely domestic and international firms (exporters vs non-exporters) in terms of both micro and macro-level determinants. In particular, productivity, manager experience, the use of foreign technology, as well as the presence of foreign ownership and international quality certifications are all positive determinants of the probability that a SME engages in international activities. Moreover, being located in high-income countries and operating in the manufacturing sector positively affect SMEs decision to enter foreign markets. Importantly, in line with previous findings, domestic tangible and intangible obstacles push firms towards exploring international markets.

Interesting evidence emerges especially when looking at the heterogeneity among exporting firms. Indeed, a number of differences characterize experimental, active and committed born local SMEs. A notable example of this heterogeneity is in the export-productivity nexus. Indeed, contrary to the standard assumption of trade models, a non-linearity emerges in the role of productivity since it affects the probability of being a experimental or active exporter, but not a committed one. This non-linearity emerges also in other determinants and, in particular, with respect to the adoption of foreign technology, the role tangible and intangible obstacles, the location in high-income countries and being a manufacturing firm.

Regarding born global SMEs, the analysis shows that these firms do not rely on high productivity levels but, instead, on the acquisition of international quality certifications and the adoption of foreign technology as their main distinctive characteristics. Indeed, they act, respectively, as a signal of product-quality and a sign of greater dynamism and technological orientation.

These results contribute to the literature on the internationalization of SMEs, adding new evidence on the different nature and determinants of exporting firms, specifically, fulfilling international trade with the born local and born global concepts from international business and international entrepreneurship.

These evidence supports the view of internationalization as a complex phenomenon and that when it comes to exporting not all SMEs are born equal. From the policy standpoint, these results highlight that even if SMEs in less developed and developing countries are able to escape from inefficient domestic environments (indeed tangible and intangible obstacles push firms toward foreign markets), they still face some limitations that prevent them to be committed or born globals. The ability to adopt foreign technologies and create international linkages with foreign entities can represent a way to remove these limitations and favor the birth of SMEs that more quickly achieve international competitiveness.

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Table 1.1: Variables description

Variables	**Definition**
Export Status	Dummy variable taking value 1 if the establishment exports and 0 otherwise.
Born Local	Categorical variable indicating domestic plant (exports = 0), experimental exporters (0<exports<10%), active exporters (10%exports 40%) and committed exporters (exports>40%).
Born Global	Dummy variable taking value 1 if the establishment exports within 3 years from the inception and more than the 25% of its sales, and 0 otherwise.
Productivity$_{t-3}$	Productivity in the 3 previous fiscal years. It is the log of total annual sales 3 fiscal years before the survey year divided by the number of workers in the 3 previous fiscal years.
Age	Number of years the firm has been in operation (survey year minus the year the firm started operation).
Manager experience	Top manager years of experience working in the sector.
Part of a large company	Dummy variable taking value 1 if the establishment is part of a large firm and 0 otherwise.
International Quality Certification	Dummy variable taking value 1 if the establishment has an internationally-recognized quality certification when it started operations and 0 otherwise.
Foreign Ownership	Dummy variable taking value 0 if the firm is owned by private domestic individuals, companies or organization and value to 1 if at foreign individuals, companies or organization hold at least 10 percent of the shares.
Foreign Technology	Dummy variable taking value 1 when the establishment uses technology licensed from a foreign-owned company and 0 otherwise.
High-Income	Dummy variable taking value 1 if the firm is located in a high income country, and 0 otherwise.
Intangible Obstacles	Dummy variable taking value 1 if the respondent answers that the plants pays gifts to obtain an operating license.
Tangible Obstacles	Proxy obtained from the first principal component of a polichoric Principal Component Analysis of questions about the quality of water supply, power and telecommunication.
Service Sector	Dummy variable taking value 1 if firm is in the services sector and 0 if in the manufacturing sector.
Region dummy	Dummy coding for the region where the firm is located.
Survey year dummy	Dummy coding for the year when the survey data is collected.

Table 1.2: Estimation of the extensive margin of trade

	Exporters vs Domestic Firms									
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Productivity$_{t-3}$	0.048***	0.046***	0.045***	0.041***	0.029***	0.025***	0.023***	0.022***	0.023***	0.018**
	(5.98)	(5.80)	(5.52)	(5.31)	(3.98)	(3.55)	(3.30)	(3.00)	(3.21)	(2.22)
Age		0.049***	0.028*	0.030*	0.022	0.024	0.023	0.024	0.026*	0.018
		(2.87)	(1.66)	(1.79)	(1.34)	(1.51)	(1.43)	(1.47)	(1.67)	(1.07)
Manager Experience			0.052***	0.054***	0.054***	0.063***	0.065***	0.065***	0.063***	0.068***
			(2.64)	(2.92)	(3.06)	(3.99)	(4.04)	(4.11)	(4.16)	(4.62)
Part Large Company				0.115***	0.099***	0.073***	0.072***	0.070***	0.083***	0.092***
				(3.62)	(3.20)	(2.78)	(2.77)	(2.68)	(3.55)	(4.02)
Internat. Quality Certif.					0.145***	0.136***	0.121***	0.117***	0.119***	0.128***
					(7.98)	(7.52)	(6.51)	(6.21)	(6.35)	(6.41)
Foreign Ownership						0.221***	0.205***	0.209***	0.205***	0.192***
						(6.98)	(6.07)	(6.17)	(6.18)	(6.16)
Foreign Technology							0.093***	0.094***	0.088***	0.095***
							(3.93)	(3.98)	(3.75)	(3.71)
High-Income Country								0.141***	0.140***	0.202***
								(3.59)	(4.23)	(4.90)
Intangible obstacles									0.185***	0.181***
									(2.90)	(2.80)
Tangible obstacles										0.036**
										(2.57)
Service Sector	-0.296***	-0.289***	-0.286***	-0.286***	-0.263***	-0.251***	-0.248***	-0.2513***	-0.255***	-0.259***
	(11.70)	(11.41)	(11.27)	(11.45)	(10.80)	(10.47)	(10.30)	(10.23)	(10.39)	(3.60)
Obs	19,290	19,212	19,077	19,077	19,077	19,077	19,077	19,077	18,937	15,215

Notes: Coefficients reported are average marginal effects. Standard errors in parentheses. *p<0.1; **p<0.05; ***p<0.01.
All regressions include region and survey year dummies.

Table 1.3: Internationalization of born local firms

	Generalized ordered logit			**Multinomial logit**		
	Experimental	**Active**	**Committed**	**Experimental**	**Active**	**Committed**
	(1)	(2)	(3)	(4)	(5)	(6)
Productivity$_{t-3}$	0.010***	0.012***	0.005**	0.003**	0.017***	-0.003
	(8.27)	(5.74)	(2.11)	(1.97)	(2.65)	(0.49)
Age	0.006***	0.028***	-0.009**	-0.000	0.040***	-0.021
	(2.85)	(6.81)	(2.19)	(0.22)	(3.12)	(1.58)
Manager Experience	0.011***	0.011***	0.014***	0.029***	-0.001	0.040***
	(5.47)	(2.75)	(3.41)	(3.93)	(0.05)	(3.80)
Part Large Company	0.004	0.027***	0.036***	0.008*	0.053***	0.028
	(0.94)	(3.85)	(5.37)	(1.73)	(3.57)	(1.33)
Internat. Quality Certif.	0.022***	0.076***	0.059***	0.025***	0.063***	0.039**
	(7.43)	(13.43)	(10.25)	(3.10)	(4.29)	(2.56)
Foreign Ownership	0.027***	0.053***	0.094***	0.021***	0.085***	0.084***
	(4.50)	(5.93)	(11.84)	(3.75)	(4.80)	(3.62)
Foreign Technology	-0.001	0.023***	0.024***	-0.010	0.044**	0.058***
	(0.20)	(3.28)	(3.53)	(1.44)	(2.220)	(3.636)
High-Income Country	-0.002	0.062***	0.032***	-0.002	0.130***	0.090***
	(0.36)	(6.73)	(3.65)	(0.25)	(3.46)	(4.24)
Intangible obstacles	0.004	0.016	0.011	0.018	0.139***	0.014
	(0.46)	(1.07)	(0.76)	(1.59)	(2.764)	(0.37)
Tangible obstacles	0.002	0.010***	-0.002	-0.003	0.024**	0.013
	(1.12)	(2.62)	(0.64)	(0.76)	(2.19)	(1.36)
Service Sector	-0.017	0.004	-0.078***	0.006	-0.120**	-0.163***
	(1.22)	(0.14)	(2.87)	(0.22)	(2.28)	(3.41)
Obs		15,215			15,215	

Notes: Coefficients reported are average marginal effects. Standard errors in parentheses.*p<0.1; **p<0.05; ***p<0.01.
All regressions include region and survey year dummies.

Table 1.4: Internationalization of born local firms (excluding the born global)

	Generalized ordered logit			**Multinomial logit**		
	Experimental	**Active**	**Committed**	**Experimental**	**Active**	**Committed**
	(1)	(2)	(3)	(4)	(5)	(6)
Productivity$_{t-3}$	0.011***	0.014***	0.001	0.004**	0.018***	0.002
	(8.11)	(6.27)	(0.42)	(1.97)	(2.83)	(0.59)
Age	0.007***	0.032***	0.035***	-0.008	0.046***	0.050***
	(2.95)	(7.17)	(10.77)	(1.08)	(3.74)	(4.48)
Manager Experience	0.012***	0.011**	0.006**	0.035***	0.014	0.014**
	(4.69)	(2.45)	(2.18)	(4.14)	(1.32)	(2.06)
Part Large Company	0.008	0.029***	0.014***	0.010*	0.067***	0.009
	(1.62)	(3.98)	(2.88)	(1.94)	(5.29)	(1.21)
Internat. Quality Certif.	0.027***	0.081***	0.025***	0.033***	0.049***	0.007
	(7.44)	(13.59)	(5.87)	(3.47)	(3.36)	(0.66)
Foreign Ownership	0.033***	0.042***	0.029***	0.031***	0.085***	0.018
	(4.72)	(4.29)	(4.48)	(4.55)	(5.13)	(1.41)
Foreign Technology	0.003	0.026***	0.012**	-0.012	0.038*	0.011
	(0.60)	(3.56)	(2.49)	(1.47)	(1.83)	(1.17)
High-Income Country	0.002	0.053***	0.030***	0.001	0.080***	0.072***
	(0.33)	(5.02)	(4.32)	(0.11)	(3.05)	(4.16)
Intangible obstacles	0.012	0.017	0.007	0.017	0.076**	0.010
	(1.15)	(1.08)	(0.61)	(1.34)	(2.20)	(0.54)
Tangible obstacles	0.001	0.011***	-0.001	-0.003	0.023**	-0.008
	(0.47)	(2.68)	(0.47)	(0.53)	(2.03)	(1.16)
Service Sector	-0.020	-0.017	-0.017	-0.001	-0.099**	-0.059***
	(1.45)	(0.71)	(0.95)	(0.04)	(2.20)	(2.76)
Observations		13,686			13,686	

Notes: Coefficients reported are average marginal effects. Standard errors in parentheses.*p<0.1; **p<0.05; ***p<0.01.
All regressions include region and survey year dummies.

Table 1.5: Born global vs born local

	Logit	**Logit**	**Multinomial Logit**		**Logit**
	Born Local vs Domestic	**Born Global vs Domestic**	**Born Local**	**Born Global**	**Born Global vs Born local**
			vs Domestic		
Variables	(1)	(2)	(3)	(4)	(5)
Productivity$_{t-3}$	0.024***	-0.003	0.022***	-0.005	-0.032***
	(3.29)	(0.47)	(3.48)	(0.95)	(2.68)
Age	0.085***	-0.080***	0.104***	-0.091***	-0.324***
	(5.11)	(5.79)	(6.80)	(7.60)	(12.93)
Manager	0.064***	0.026**	0.047***	0.022**	-0.013
Experience	(4.57)	(2.14)	(3.68)	(2.16)	(0.48)
Part Large	0.088***	0.037	0.074***	0.011	-0.102*
Company	(5.61)	(1.46)	(5.16)	(0.49)	(1.93)
Internat. Quality	0.089***	0.090***	0.064***	0.065***	0.058*
Certif.	(4.68)	(5.50)	(3.68)	(4.70)	(1.75)
Foreign	0.139***	0.129***	0.100***	0.089***	0.034
Ownership	(5.81)	(4.57)	(4.92)	(3.79)	(0.60)
Foreign	0.038*	0.087***	0.022	0.070***	0.130***
Technology	(1.65)	(4.42)	(1.08)	(4.22)	(3.92)
High-Income	0.134***	0.141***	0.101***	0.102***	0.043
Country	(4.42)	(4.50)	(3.63)	(3.80)	(0.77)
Intangible	0.109***	0.092**	0.107***	0.056	-0.079
obstacles	(2.88)	(2.01)	(3.27)	(1.41)	(1.09)
Tangible obstacles	0.013	0.031***	0.008	0.026***	0.039*
	(0.99)	(2.74)	(0.66)	(2.79)	(1.70)
Service Sector	-0.148**	-0.227***	-0.094*	-0.180***	-0.157
	(2.47)	(3.42)	(1.68)	(3.16)	(0.99)
Observations	13,686	12,046	15,215		4,698

Notes: Coefficients reported are average marginal effects. Standard errors in parentheses.*p<0.1; **p<0.05; ***p<0.01.
All regressions include region and survey year dummies.

1.A Appendix: Data description

TABLE A.1.1: LIST OF COUNTRY BY REGION GROUPS

EAST ASIA AND PACIFIC	SURVEY YEAR	OBSERVATIONS
Indonesia	2009/2015	516
LaoPDR	2016	45
Malaysia	2015	188
Mongolia	2013	127
Myanmar	2014	112
Papua New Guinea	2015	15
Philippines	2015	254
Solomon Islands	2015	18
Timor-Leste	2015	30
Thailand	2016	267
Vietnam	2009/2015	184
EUROPE AND CENTRAL ASIA	**SURVEY YEAR**	**OBSERVATIONS**
Croatia	2007/2013	181
Czech Republic	2013	106
Estonia	2013	89
Fyr Macedonia	2013	136
Georgia	2013	81
Hungary	2013	66
Kazakhstan	2013	144
Kosovo	2013	74
Kyrgyz Republic	2013	125
Latvia	2013	62
Lithuania	2013	71
Moldova	2013	115
Montenegro	2013	37
Poland	2013	129
Romania	2013	195
Russia	2012	879
Serbia	2013	135
Slovak Republic	2013	82

Slovenia	2013	109
Tajikistan	2013	38
Turkey	2013	348
Ukraine	2013	121
Uzbekistan	2013	117
LATIN AMERICA AND THE CARIBBEAN	**SURVEY YEAR**	**OBSERVATIONS**
Costarica	2010	107
Dominica	2010	11
Dominican Republic	2010	51
Ecuador	2010	57
El Salvador	2010	56
Grenada	2010	9
Guatemala	2010	138
Guyana	2010	32
Honduras	2010	48
Jamaica	2010	22
Mexico	2010	473
Nicaragua	2010	44
Panama	2010	28
Paraguay	2010	55
Peru	2010	338
St Lucia	2010	38
St Vincent and Grenadines	2010	15
St Kitts and Nevis	2010	10
Suriname	2010	54
Trinidad and Tobago	2010	73
Uruguay	2010	130
Venezuela	2010	35
MIDDLE EAST AND NORTH AFRICA	**SURVEY YEAR**	**OBSERVATIONS**
Djibouti	2013	27
Egypt	2013	366
Iraq	2011	168
Israel	2013	176
Jordan	2013	192

Lebanon	2013	163
Morocco	2013	115
Tunisia	2013	344
West Bank and Gaza	2013	64
Yemen	2013	111
SOUTH ASIA	**SURVEY YEAR**	**OBSERVATIONS**
India	2014	4299
Nepal	2013	120
Pakistan	2013	243
Sri Lanka	2011	91
SUB-SAHARAN AFRICA	**SURVEY YEAR**	**OBSERVATIONS**
DRC	2010/2013	56
Ethiopia	2011/2015	137
Ghana	2007/2013	101
Kenya	2013	186
Malawi	2014	63
Mali	2007/2010	96
Mauritania	2014	23
Mozambique	2007	136
Nigeria	2014	161
Namibia	2014	22
Rwanda	2011	20
Senegal	2007/2014	157
South Sudan	2014	14
South Africa	2007	440
Sudan	2014	7
Tanzania	2013	76
Uganda	2013	67
Zambia	2007/2013	77
Zimbabwe	2011	40

TABLE A.1.2: SUMMARY STATISTICS

Variables	Whole sample				Domestic firms				Born Local				Born Global			
	Obs.	Mean	Std. Dev.	%	Obs.	Mean	Std. Dev.	%	Obs	Mean	Std. Dev.	%	Obs	Mean	Std. Dev.	%
Export Status	19,290			29%	13,691			71%	3,772				1,827			
Productivity$_{t-3}$	19,290	12.05	1.38		13,691	11.93	1.37		3,772	12.40	1.30		1,827	12.21	1.44	
Age	19,212	3.80	0.66		13,639	3.75	0.65		3,746	4.05	0.64		1,827	3.60	0.61	
Manager Experience	19,154	3.70	0.70		13,599	3.66	0.71		3,743	3.87	0.66		1,827	3.71	0.67	
Part Large Company	19,290	-	-	18%	13,691	-	-	16%	3,772	-	-	24%	1,827	-	-	26%
Internat. Quality Certif.	19,290	-	-	34%	13,691	-	-	28%	3,772	-	-	49%	1,827	-	-	49%
Foreign Ownership	19,290	-	-	8%	13,691	-	-	5%	3,772	-	-	13%	1,827	-	-	22%
Foreign Technology	19,290	-	-	15%	13,691	-	-	12%	3,772	-	-	21%	1,827	-	-	23%
High-Income Country	19,290	-	-	46%	13,691	-	-	41%	3,772	-	-	62%	1,827	-	-	50%
Intangible Obstacles	19,147	-	-	3%	13,585	-	-	2.97%	3,747	-	-	3.31%	1,815	-	-	3.47%
Tangible Obstacles	15,489	-0.47	0.73		10,702	-0.49	0.71		3,236	-0.42	0.77		1,551	-0.51	0.75	
Sector:																
Manufacturing	16,250	-	-	84%	11,209	-	-	82%	3,364	-	-	89%	1.,677	-	-	92%
Service	3,040	-	-	16%	2,482	-	-	18%	408	-	-	11%	150	-	-	8%

1.B Technical note: Data cleaning

Data cleaning is extremely important especially when working with survey data, whose information are self-reported. Indeed, this could imply the presence of misleading information that may negatively affect the quality of the data. To this end, we perform some descriptive analyses looking at the distribution of labor productivity and at correlation between the total annual sales and the number of employees. This analysis is performed by progressively dropping the lower and upper values of the observations that correspond to the different percentiles (1, 2, 3, 4 and 5 per cent) of the variable of interest, e.g. labor productivity.

As the figures below show, the productivity distribution significantly improves starting from dropping the 3 per cent of the lower and upper values. Indeed, it progressively approximates a normal distribution even if asymmetric. The correlation between total annual sales and number of employees becomes relevant starting from dropping the 3 per cent of the extreme observations (it is approximately 0.44) and increases dropping the 5 per cent of them. Based on these results, we decide to perform the analysis on the sample obtained dropping the 4 per cent of lower and higher values. Then, as a robustness check, we re-run the analysis on the sample obtained dropping the 5 per cent of the extreme values. Results do not change.

Figure 1.1: PRODUCTIVITY DISTRIBUTION

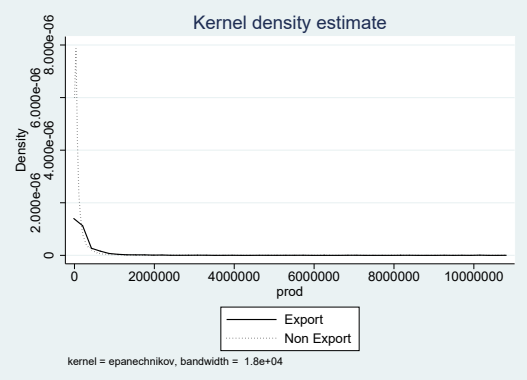


Figure 1.2: PRODUCTIVITY DISTRIBUTION 1%

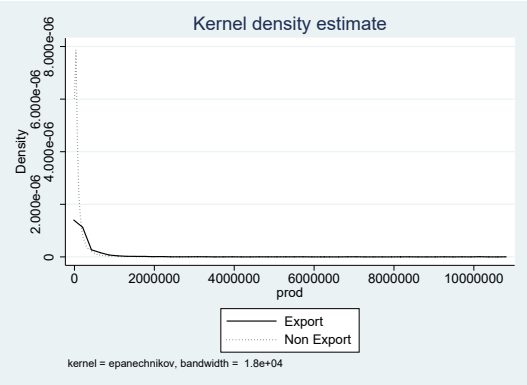


Figure 1.3: PRODUCTIVITY DISTRIBUTION 2%

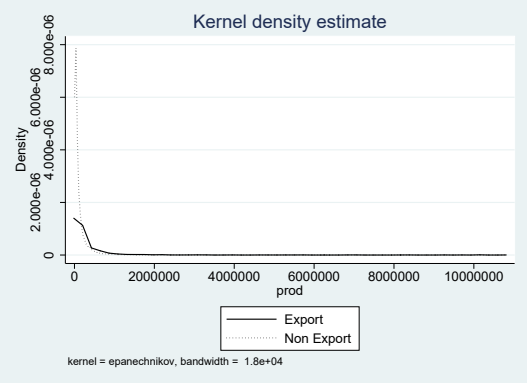


Figure 1.4: PRODUCTIVITY DISTRIBUTION 3%

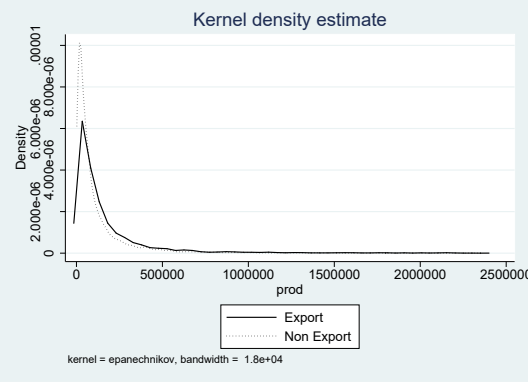


Figure 1.5: PRODUCTIVITY DISTRIBUTION 4%

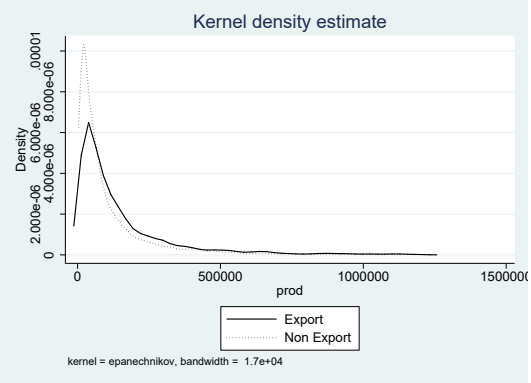
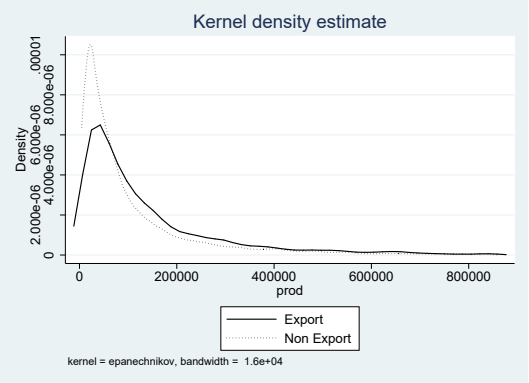


Figure 1.6: PRODUCTIVITY DISTRIBUTION 5%



Chapter 2

Firm Innovative Performance. Influence of Regional Environment

2.1 Introduction

The spatial nature of innovation is emphasized in several contributions in regional science (see, among the others, Capello and Lenzi, 2014; Capello and Lenzi, 2015). Indeed, starting from the early study of agglomeration economies due to Marshall (1920), traditional theories consider regions as the *locus* where innovation takes place thanks to the strength of knowledge externalities. The knowledge "created" in a region cannot be easily codified and, therefore, transmitted beyond the regional borders, this is the cause of the observed spatial heterogeneity in innovative performance.[1]

A limitation of this approach is that it tends to consider firms as the: "*...passive recipients of knowledge with limited attention to differences in their capacity to take advantage of localized sources of knowledge*" (Crescenzi and Gagliardi, 2018, p. 783). However, on the ground of the seminal contributions by Griliches (1979; 1990) and Crépon, Duguet, and Mairesse (1998), innovation can be considered as the result of a micro-founded Knowledge Production Function (KPF) where firms transform innovative inputs (e.g. expenditure in research and development, knowledge often proxied by human capital, etc) into innovative outputs (e.g. new or improved products or processes, etc).[2] While this approach is clearly micro-founded, some regional studies have often estimated KPFs at the macro regional level, where regional innovative outcomes are investigated under the assumption that firms within the considered spatial unit are homoge-

[1] This perspective later became the root of the Regional Innovation Systems (see Isaksen, Martin, and Trippl, 2018; Martin, Aslesen, Grillitsch, and Herstad, 2018).

[2] Hall and Mairesse (1995) emphasize how the traditional economic literature that looks at innovation as a determinant of productivity and growth tends to neglect that innovation is also the outcome of a production process.

neous (e.g. Charlot, Crescenzi, and Musolesi, 2015; Crescenzi and Jaax, 2017). However, this assumption can be rather stringent for innovation, as well as for other economic outcomes, as space and firms interact to create the above mentioned spatial heterogeneity (see on this point, for example, Fazio and Piacentino, 2010).

Recent studies have fully embraced the micro-founded nature of the KPF approach to look at the influence of the regional environment on firm's innovative performance (see Mate-Sanchez-Val and Harris, 2014; Crowley and McCann, 2015; Tavassoli and Karlsson, 2018; Crescenzi and Gagliardi, 2018; López-Bazo and Motellón, 2018). The basic idea in this approach is that firms produce innovation by exploiting both internal and external sources of knowledge under the influence of the regional environment: the regional factors influence the ability of firms to innovate but their strength depends on the ability of the firm to absorb such external knowledge. Little attention has been given to the regional dimension of innovation in Italy under such micro-level perspective. This is particularly surprising, given the country's growing regional inequalities and slow productivity growth. Yet, a more complete and recent picture of regional innovation can be critical to formulate adequate policies for regional growth and cohesion. Thus, this chapter[3] aims to fill this gap in the literature by exploiting firm-level data from the most recently available wave of the Italian Community Innovation Survey (CIS-2014)[4] and by looking at regional differences at the NUTS-1 level. To the best of our knowledge, no study has investigated in a unique framework regional and firm-level Knowledge Production Functions in Italy for the last twenty years. Indeed, recent studies mainly concentrate on firm-level neglecting the regional dimension, and earlier regional studies on the Italian regional divide adopt a purely macro-level approach.[5] Therefore, this analysis adds new and much needed empirical evidence on regional innovation in Italy exploiting firm-level micro data to provide inference on the macro-regional characteristics of the innovation process. Moreover, this chapter extends on past analyses by exploring how the regional environment affects the relation between innovative inputs and outputs, i.e. the slopes of the KPF. This is particularly important as one would expect the ability of firms to generate innovation via their innovative effort to vary greatly across different regional environments, as the same innovative effort may generate different outputs depending on the firm location. Indeed, the regional environment may favor the development of different localized paths (see Iammarino, 2011; Ascani, Crescenzi, and Iammarino, 2012). To this end, this chapter considers a regional version of the pioneer model suggested by Crépon, Duguet, and Mairesse

[3]This chapter has inspired the realization of a co-authored paper with Professors Giorgio Fazio and Davide Piacentino. This paper has been presented at the Regional Innovation Policy Conference (Florence, 7-8 November 2019) and it is now submitted.

[4]Micro data from CIS-2016 are still not available in Italy.

[5]See Section 2.2.2 for a specific discussion on the Italian case.

(1998), where firms first decide to invest in innovative inputs, then the intensity of investment and, finally, combine inputs to obtain innovative outputs.

The empirical investigation takes into account both possible selection bias and the nature of innovation as a multidimensional process that involves as many inputs and outputs as it is allowed by data availability. In terms of inputs, the empirical analysis looks at internal, external and embodied sources of knowledge and considers their interaction in order to capture the firm "absorptive capacity". In terms of outputs, it focuses on both technological (product and process) and non-technological or service-related (organizational and marketing) innovations. The extensive nature of the analysis allows to gather a number of interesting results, where, in line with expectations, innovation emerges as a phenomenon that varies greatly both with respect to the firm's characteristics, its location and the type of innovative output considered. Results on the full sample highlight that the decision to invest in intra-mural R&D (internal knowledge) is more likely for firms that are large, belong to a group, receive public funding, cooperate with others in order to innovate, and have access to international markets. Similar results apply to the role of extra-mural R&D (external knowledge). Differently, the decision to invest in machinery for innovative activity (i.e. embodied knowledge) is mainly dependent on the support of local public funding. Firms located in the South are more likely to invest in embodied knowledge and less likely to invest in other sources of knowledge. In the second stage of the analysis, results show that intra-mural and extra-mural R&D influence all types of innovative outputs, while machinery investment has a role only in the case of organizational innovation. Firms located in the North are more likely to realize technology-related innovation in comparison with both firms located in the Centre and in the South and Islands. Importantly, a deeper characterization than the usual well-know North-South divide emerges when considering the regional sub-samples to estimate regional KPFs. While, overall, firms in the North display, in general, stronger innovative performance, an interesting difference emerges even within this part of the country between the North-West and North-East, with firms in the latter displaying greater ability to absorb and transform external knowledge. Hence, the North-East seems to have, potentially, a more dynamic innovative profile.

The chapter is structured as follows. Section 2.2 provides a review of the most relevant related literature with a particular focus on studies looking at the Italian case. Section 2.3 describes the empirical strategy while Section 2.4 discusses the data and the results. Finally, section 2.5 draws some conclusions.

2.2 Literature Review

2.2.1 Micro-founded approach to regional innovation

Recent studies have investigated the role of the regional environment on innovation developing from the KPF approach at the firm-level (see Mate-Sanchez-Val and Harris, 2014; Crowley and McCann, 2015; Tavassoli and Karlsson, 2018; Crescenzi and Gagliardi, 2018; López-Bazo and Motellón, 2018). All these studies assume that the external sources of knowledge influence the realization of innovation by firms either directly or indirectly, thus, influencing the ability of the firm to absorb external knowledge. However, the debate is still open on the mechanisms underlying the ability of firms to "absorb" such knowledge (Fitjar and Rodríguez–Pose, 2015).
Using data from Community Innovation Surveys (CIS), Mate-Sanchez-Val and Harris (2014) compare the role of external knowledge on the innovative performance of firms operating in two countries with different industrial and technological endowment, the United Kingdom and Spain. They find that while firms in the UK rely more on external sources of knowledge and international linkages, firms in Spain rely more on public support. The authors take into account regional heterogeneity by means of dummy variables at NUTS-2 level and adding some of the characteristics of the regions where firms are located.
Crowley and McCann (2015) consider a sample of Irish firms and find that innovative effort and human capital play a role only for product innovation and firm size only for process and organizational innovations. Moreover, they find that the effect of firm's location and operating context differs among innovation types: urbanization matters more for product than for process innovation. Using the Swedish CIS, also Tavassoli and Karlsson (2018) find that innovation, and in particular, its persistency, varies depending on the regional context. Specifically, firms' innovative behavior, measured using a multidimensional approach that looks at different types of innovation, is more persistent in regions with a "thicker" labor market and stronger knowledge spillovers. This study is particular original due to the fact that it extends the analysis to consider also non-technological or service-related innovations (e.g. organizational and marketing innovations), moving beyond the commonly explored technology-related innovation.
López-Bazo and Motellón (2018) reconsider the Spanish case and focus on product and process innovation providing a number of interesting results. First, the regional determinants influence small and medium sized firms more than large firms; second, cooperation with external partners is more important for firms located in less innovative regions than in other areas; third, the regional context affects innovative behavior not directly, but indirectly through absorptive capacity, thus by moderating the role of internal determinants. Combining CIS and patent data for the UK, Crescenzi and Gagliardi (2018) find that firms complementing potential and realized

absorptive capacities are able to take advantage of innovation prone external environment to increase their innovative performance. They use human capital to measure the potential absorptive capacity and consider an explicit survey question asking whether the firm exploits external sources of knowledge to measure realized absorptive capacity. Finally, a recent paper by Tojeiro-Rivero and Moreno (2019) analyse the influence of the regional context on firms' networking activities for innovation. Using multilevel models on data of Spanish manufacturing firms, results show that the regional context represents a considerable part of the variability of firms' innovative performance. In particular, it exerts also an indirect effect influencing the efficiency of firms' networking activities: firms operating in developed and knowledge intensive regions benefit more from cooperation strategies than firms in less knowledge-advanced regions that, instead, should rely more on R&D outsourcing strategies.

Building on this background, the aim of this chapter is to provide new evidence on regional innovation in Italy along the lines traced by the above micro-founded studies. Indeed, as it will be argued in the next section, recent studies on the Italian case use micro-level data, but tend to overlook regional differences.

2.2.2 Regional Innovation in Italy

A large number of studies have investigated the Italian national innovation system, highlighting its backward position in comparison to other European countries, especially after the global economic crisis of 2008 (see Gallino, 2003; Bugamelli, Cannari, Lotti, and Magri, 2012; Amatori, Bugamelli, and Colli, 2013; Lucchese, Nascia, and Pianta, 2016; Nascia, Pianta, and La Placa, 2018). Despite the reported regional differences within the country, research on the regional dimension of innovation in Italy has been rather scarce over the last two decades (see, for example, Nascia, Pianta, and La Placa, 2018).

Given the long tradition of studies on innovation in Italy, this section concentrates, for brevity, on the last twenty years which are summarized in table 2.1. Large part of the recent micro-level studies exploit the data from the Community Innovation Survey (CIS) which is the main source of information on the use of innovative inputs and realization of innovative outputs at the firm-level.[6] Most of these studies employ the KPF approach to explore the determinants of innovative

[6]The first edition of this survey appeared in 1993 and initially focused on the introduction of product or process innovations by firms in the manufacturing sector. Firms were initially surveyed every 4 years up to 2005 (1993, 1997, 2001 and 2005), then every 2 years (from 2005 until now). Starting from 2001, the survey has progressively been enriched. For instance, the population has been enlarged to include firms from the trade and service sectors, organizational and marketing innovations have been included and, additional modules such as environmental benefits (CIS2008 and CIS2014), skills and creativity (CIS2010), public procurement, companies strategies (CIS2012) and logistics innovations (CIS2016) have been introduced.

activities and their impact on firm's economic performance without emphasizing, however, the regional dimension of innovation. For instance, Parisi, Schiantarelli, and Sembenelli (2006) concentrate on the role of R&D expenditures, fixed capital, and their interaction, as determinants of product and process innovation at the firm-level. Their findings show that R&D expenditures is positively related to the introduction of product innovations, while new fixed capital matters more for process innovations. Moreover, a positive absorption effect emerges: R&D spending increases the ability to assimilate and exploit external knowledge. Similar results are in Hall, Lotti, and Mairesse (2009) who focus on the determinants of innovation and its impact on productivity showing that investment in equipment and R&D intensity are the main determinants of both product and process innovations and that these in turn play a major role in boosting the firm's productivity. Evangelista and Vezzani (2010), instead, evaluate the impact of technological and non-technological innovations on firm's economic performance, showing that innovative strategies combining both the type of innovations allow firms to gain competitive advantage and have better economic outcomes. Cainelli, Evangelista and Savona (2006) use data on Italian service firms from the CIS for the period 1993-1995 and estimate a two equations model linking innovative and economic performance. They find a "self-reinforcing" mechanism between innovation and economic performance: innovation is affected by past innovative performance and in turn it positively impacts on productivity and growth. Similarly, Bogliacino, Lucchese, Nascia, and Pianta (2017) estimate a three equations model linking innovative inputs, outputs and economic performance. They show that the accumulation of knowledge and the development of new capabilities enhance innovative activities, that in turn positively affect economic performance. However, the results underline the presence of a sort of "virtuous cycle": indeed, an improvement of economic performance positively influences innovation.

While the above mentioned studies mainly emphasize the crucial role of R&D investment and of knowledge acquisition and accumulation for innovative activities, other studies also emphasize the importance of the external sources of knowledge. For instance, Pellegrino, Piva, and Vivarelli (2012) analyze the relationship between innovative inputs and outputs, specifically product innovation, for a small sample of Italian firms and show that the main determinant of innovation in young firms is the acquisition of external technologies. Berchicci (2013) investigates the role of intramural and extramural R&D on the firm's innovative performance using data from the Survey of Italian Manufacturing firms by Capitalia. Results show that firms relying more on extramural R&D have better innovative performance, yet up to a certain threshold beyond which it negatively affects the firm's innovative ability. Paula and Silva (2017) look at the internal and external sources of knowledge (i.e. intramural and extramural R&D, training, and external information) as determinants of innovation and show that investment to leverage

internal knowledge sources is more important for high-tech than low-tech firms which, instead, rely more on external knowledge sources. Finally, Pennacchio, Piroli, and Ardovino (2018) look at the role of R&D cooperation for different innovative outputs (e.g. product, process, organizational and marketing innovations) providing evidence of the importance of collaborations and alliances with both non-competitive and competitive partners for the firm's innovative performance.[7]

As said before, few papers specifically focus on the role of the regional context on innovation. Indeed, the few papers looking at this in Italy have mostly adopted a macro-level perspective. For instance, Evangelista et al. (2001) explore the contribution of different Italian regions to the National Innovation System using data from the CIS1 (1990-92). In particular, considering indicators of innovation strategy (e.g. total innovation expenditure, acquisition of patents, etc.), innovation performance (e.g. amount of resources for innovation, etc.) and innovation system (e.g. information channels, obstacles to innovation), they show that regions differ in terms of types of innovation and innovative performance. In a subsequent study, Evangelista et al. (2002) explore the existence of innovation systems at the regional level. Using NUTS-2 data from CIS1, they distinguish Italian regions into four clusters on the basis of their innovativeness. The first cluster of regions is characterized by poor technological performance and the non-innovation system sample includes almost all the Southern and Insular regions (Sicily, Campania, Sardinia, Apulia, Molise and Abbruzzo). The second cluster of weak innovation system regions is composed by some of the North-Eastern regions (Veneto, Friuli, Trentino) and some Centre-Southern regions (Umbria, Marche, Basilicata and Calabria). The third cluster of "informal learning system" regions includes two Central regions (Emilia Romagna and Tuscany). Here, innovation determines positive economic results and is favoured by environmental conditions. Finally, the fourth cluster includes regions which have strong innovation systems, characterized by intensive R&D activities and good technological infrastructures and networks. This cluster includes the North-Western regions (Piedmont, Lombardy, Liguria) and the Central region of Lazio. This study highlights the deep divide between Northern and Southern Italy in terms of innovative ability. While regions in the North account for the largest part of the innovation in the country, the South emerges as the most backward part not only in terms of general innovative performance, but also in terms of favorable innovation environment. This well known North-South Divide is accurately described and justified in the review provided by Iammarino (2005), who describes the North as the most innovative area, with the North-West strongly oriented towards R&D investments and the North-East strongly based on learning pro-

[7] In another paper using micro-level Italian data, Barbieri, Piva, and Vivarelli (2018) look at the role of innovative investment on employment, finding a positive impact of R&D related to product innovation and a negative effect of embodied technological change (used as proxy of process innovation).

cesses, and the South as the peripheral area characterized by a lack of innovation, qualified relationships and attributes. Similar findings emerge in Quatraro (2009), using aggregate data on patent applications and region-by-region feasible generalized least square estimation, who finds that North-Eastern and Central regions are characterized by high exploitation of innovation capabilities favored by greater technological opportunities and strong productive systems. More recently, Ascani, Balland, and Morrison (2019) look at the role of inward FDI on innovation using patent data of Italian provinces, and find that Northern regions benefit more than Central and Southern regions from the positive influence of inward FDI, especially those related to the Science-Based and Scale-Intensive sector.

All these valuable studies, however, adopt a macro-level perspective using aggregate regional data. To the best of our knowledge, no further evidence on regional innovation has been provided over recent years, especially with a micro-level focus. In this respect, the literature on regional innovation in Italy seems to be far behind that of other European countries.

<Please insert Table 2.1 about here>

2.3 Empirical Strategy

As said at the beginning, the aim of this chapter is to analyse the influence of the regional environment on firm's innovative behavior adopting the micro-founded Knowledge Production Function (KPF) approach in line with the recent development in the literature discussed above. The first attempts to model innovation as a production function are due to Griliches (1979; 1990), who, however, had to limit his analysis to only one innovative input (R&D expenditure) and one innovative output (patents) due to the lack of data.

Innovation is, instead, a far more complex phenomenon that involves and combines different inputs to obtain different outputs. A deep analysis of these inputs and outputs has been possible from the nineties thanks to the increased availability of innovation surveys.[8] In this direction, Crépon, Duguet, and Mairesse (1998) extended the model by Griliches (1979; 1990) and proposed a structural model, the so-called CDM model, where firms sequentially: (i) decide to engage in innovative activities and the amount of investment in innovative input (*innovative input equation*s); (ii) use innovative input to realize an innovative output (*KPF equation*); (iii) and, finally, use the realized innovative output as a determinant of an augmented Cobb-Douglas

[8]These surveys have become a crucial source for scholars and policy analysts (see Mairesse and Mohnen, 2010; Mohnen and Hall, 2013).

production function (*production function equation*). Specifically, the CDM uses R&D expenditure and patents (or, alternatively, innovative sales) as innovative input and output, respectively. From this seminal contribution, other studies have tried to enrich the base specification considering additional innovative inputs (e.g. extramural R&D expenditure and machinery investment) and outputs (e.g. product and process innovations), as well as some firm's characteristics, such as size, human capital and networking with external partners (see, for example, Zahra and George, 2002; Parisi, Schiantarelli, and Sembenelli, 2006; Hall, Lotti, and Mairesse, 2013; Crescenzi and Gagliardi, 2018).

Building on Crépon, Duguet, and Mairesse (1998), the analysis focuses on the first two stages of the CDM model which are related to the innovation input and KPF equations. Differently from the original version of the model, the present analysis extends the number of innovative inputs and outputs included in the equations.[9] Specifically, it considers investment in machinery for innovative activities, intramural and extramural R&D expenditures as inputs, and product, process, organizational and marketing innovations as innovative outputs. To the best of our knowledge, few studies jointly consider all these inputs and outputs (see, for example, Tavassoli and Karlsson 2018).

The first stage estimates the investment in each of the three innovative inputs accounting for the selection bias that may arise for the fact that we observe the investment in R&D only of those firms that actually decide to innovate (see Crépon, Duguet, and Mairesse, 1998):

$$Pr(\text{Investment Decision}_{ik} = 1) = \mathbf{W}\beta_i + u_i \tag{2.1}$$

$$\text{Investment Intensity}_{ik} = \mathbf{Z}\gamma_i + v_i \tag{2.2}$$

Equations 2.1 and 2.2, which are estimated using Heckman's sample selection model (1979), refer to the probability to engage in an innovative activity and its intensity of investment, respectively. Specifically, "Investment Decision" is a dummy variable taking value one if the firm decides to invest in a given input k (Intra-mural R&D, Extra-mural R&D and Machinery investment) and zero otherwise; "Investment Intensity" expresses, instead, the intensity of investment in the specific input k, measured in terms of expenditure per employee; $\mathbf{W}$ and $\mathbf{Z}$ are vectors of covariates that differ for the presence of exclusion restrictions in $\mathbf{W}$[10]; u_i and v_i are the usual random terms which are assumed to be normally distributed but not uncorrelated. Indeed, the

[9] Due to the lack of data about the factors of production, the analysis does not include the last stage of CDM model.

[10] Exclusion restrictions are variables that appear only in the selection equation, that is in equation 2.1 in this case.

equation 2.2 includes a correction factor, the so called Mill's ratio, that account for the correlation between the error terms. If this correlation is null, it is possible to conclude that there is no sample selection bias thus, it is possible to directly look at the observed values of the "Investment Intensity" in the second stage of the analysis.[11]

The second stage estimates the KPF using a multivariate probit model for the four possible innovative outputs, $j = 1,\ldots,4$. One of the main benefits of the multivariate probit model, compared to its "simple" alternative, is that it allows accounting for the possible dependence among innovative outputs. Indeed, the ability of the firm to innovate in one innovative output is not orthogonal to that of innovate in another one.[12] Therefore, the model allows for the vectors of normally distributed error terms, ε_j below, to be correlated across the outcome equations. The models is specified as follows:

$$\begin{aligned} Pr(\text{Output}_j = 1) = \textstyle\sum_k (\alpha_{jk} \cdot \widehat{Investment Intensity}_k) + \\ + \theta_j \cdot \text{Human Capital} + \rho_j \cdot \text{Absorption} + \mathbf{X}\delta_j + \varepsilon_j \end{aligned} \tag{2.3}$$

In equation 2.3, "Output" denotes a set dummy variables that assume value one when the firm successfully realizes a given type of innovation (e.g. product, process, organizational and marketing innovations) and zero otherwise; "$\widehat{Investment\ Intensity}$" is the predicted value obtained from equation 2.2. The inclusion of the predicted values of investment intensity allows controlling for sample selection bias, if it results from the first stage of analysis (see, among the others, Hall, Lotti, and Mairesse, 2009; Baumann and Kritikos, 2016). "Human Capital" is a dummy variable that compares high and low share of graduate employees in the firm. "Absorption" is a measure of the capacity of firms to assimilate external knowledge. With respect to absorptive capacity, defined as *"the ability to exploit external knowledge"*, Cohen and Levinthal (1990) argue that *"is [thus] a critical component of innovative capabilities*" (p. 128). In literature, there are different proposals on the measure of absorptive capacity (see Harris and Yan, 2018 for an extensive review). In their pioneering contribution, Cohen and Levinthal (1989) suggest that R&D effort could be used as proxy of absorptive capacity since it influences innovation not only directly but also indirectly. The idea is that employees involved in R&D activities are more able to exploit, assimilate and recombine external knowledge compared to employees involved in other activities. Parisi, Schiantarelli, and Sembenelli (2006) use, instead, a interaction term between intramural R&D and fixed investment to measure the absorptive capacity of Italian

[11] See Heckman (1979) for further details on the sample selection model.

[12] The joint realization of different innovative outputs is common in this literature (see, for example, Parisi, Schiantarelli, and Sembenelli, 2006; Tavassoli and Karlsson 2018).

firms over the period 1992-1997. They find a significant influence of this measure of absorptive capacity on the probability to innovate but only for the case of process innovation. Zahra and George (2002) claim, instead, that absorptive capacity should be distinguished in "potential" or "realized" capacity. The potential absorptive capacity (PACAP from now on) refers to the ability of firms to absorb external knowledge[13]. Instead, the realized absorptive capacity (RACAP from now on) measures how firms exploit, recombine, transform and use the acquired knowledge. The same distinction is considered by Crescenzi and Gagliardi (2018) that exploring data of UK firms argue that the innovative ability of firms increases when both potential and realized absorptive capacities are combined. The authors measure potential capacity by the share of graduate employees and R&D investment and find that these positively influence innovation. However, this effect is reduced when realized absorptive capacity is considered. This is measured specifically asking firms whether they exploit external sources of knowledge. The Authors conclude that external and internal knowledge are complementary. Similarly, López-Bazo and Motellón (2018), estimating the knowledge production function for a sample of Spanish firms, find that absorptive capacity expressed as R&D expenditure and share of high skilled employees positively influences both product and process innovation. Here, we use human capital as a measure of PACAP and Absorption, expressed through some interaction terms between internal and external knowledge sources, as a measure of RACAP. See the next section for a detailed description of these variables. Finally, $\mathbf{X}$ is a vector of controls..

As discussed in subsection 2.2.2, recent regional studies have concentrated on analyzing how the external conditions influence the firm's innovative behavior. From a methodological standpoint, many of these studies run nation-level regressions to estimate the KPFs on firm-level data and include regional dummies to account for "unobservable" regional effects, or include explicit regional determinants of innovation (e.g. regional R&D expenditure) to account for "unobservable" or observed regional variation. However, there may be further hidden regional heterogeneity in the specific mechanism that "transform" innovative inputs into innovative outputs as a consequence of the influence of the regional environment. In order to capture this heterogeneity, this chapter provides, together with the national-level estimates, region-level estimates using regional sub-sample regressions. This allows to see also the inter-regional variation in the innovation processes (i.e. the relationship between inputs and outputs), rather than just on the actual realization of innovation. In doing that, the analysis considers different types of innovation and the role of absorptive capacity, which may also vary at the regional level. Thus, this work can help understanding the heterogeneous characteristics of firms across the country and the formulation of regionally oriented policies.

[13] See also Fosfuri and Tribó (2008) on the antecedents of potential absorptive capacity.

2.4 Empirical Analysis

2.4.1 Data: Italian Community Innovation Survey (CIS2014)

The empirical analysis exploits the 2014 Italian Community Innovation Survey (CIS2014) that provides information about firm's characteristics, innovative outputs and inputs over the period 2012-2014.[14] The original sample consists of approximately 17,532 firms, but it has been reduced to 6,363 after the selection of firms that have or have tried to innovate. Indeed, the questionnaire is structured so that only firms that answer positively to at least one of the questions related to the *status* of their innovative activity (i.e. "abandoned", "still ongoing" or "realized innovation", either product or process) can answer to the sections related to R&D activities and expenditure, cooperation and public financial support for innovation. Therefore, only those firms that answer all sections related to innovative inputs and outputs are included in the sample. This allows to exploit the largest possible set of information regarding firm's innovative behavior. Due to the lack of sufficient observations at NUTS-2, the analysis considers the NUTS-1 classification.

Table 2.13 in Appendix 2.A shows the geographical distribution of firms. Specifically, more than 70% of the interview entities is located in the Northern regions, while only the 16% and 12% of the sampled units are located in the Centre and in the South and Islands, respectively. Moreover, table 2.14 in the Appendix 2.A reports that large part of the firms in the sample are of small and medium size, the 44% and the 32%, respectively, only the 24% of firms is large-sized. However, there are differences across space. Indeed, the most unbalanced is the South and Islands with a larger share of small firms (52%) and a lower of large firms (14%) and the more even is in the North-West (36%, 32%, 32%, respectively).

The 82 per cent of firms in the final sample declares to have introduced at least one type of innovation. While this percentage is quietly stable across space, some regional differences emerge when looking at the specific types of innovative outputs. For instance, firms located in the South and Islands seem to be less oriented towards product and organizational innovations compared to the rest of the country and are more oriented towards process innovations. There are not regional differences in terms of marketing innovation. Looking at innovative inputs, firms operating in the South and Islands are less involved in intramural and extramural R&D investments (28% and 9%) and prefer investment in machinery (73%). Firms located in the Northern part of the country rely more on invest more on intramural R&D and machinery investment. A slightly

[14]The elaborations have been carried out at the Istat Data Analysis Laboratory of Palermo, in compliance with the legislation on the protection of statistical confidentiality and personal data protection. The results and opinions expressed are the sole responsibility of the authors, do not constitute official statistics and do not engage in any way the ISTAT.

higher percentage of firms for the investment in extramural R&D is founded for the North-West and the North-East.

Table 2.2 reports the list of all variables employed in the analysis, innovative inputs, outputs and internal and external determinants. The investment decision is measured by a set of dummy variables, one for each innovative input (Intramural R&D, Extramural R&D and Machinery Investment). Then, for each of these innovative inputs the analysis considers the corresponding amount of investment per employee, i.e. the investment intensity. Finally, four different innovative outputs measured by a set of dummy variables are used to estimate the KPF. These innovative outputs are commonly distinguished into technology-related (product and process) and service-related innovations (organizational and marketing).

The independent variables in the equations have been chosen following the suggestions of past studies. For example, information about public support for innovation by the local administration, the central government or European sources have been considered as important (*Funding*). Indeed, the presence of informational asymmetries, financial constraints and externalities can cause market failures in R&D and innovative activities that make the appropriability of innovative outcomes more difficult, causing under-investment by privates. Public support should allow firms to bypass these market failures (see, among the others, Almus and Czarnitzki, 2003; Czarnitzki and Hussinger, 2018; Aristei, Sterlacchini, and Venturini, 2017). For instance, Szczygielski, Grabowski, Pamukcu, and Tandogan (2017) find, looking at the cases of Turkey and Poland, that government support, more than European funding, positively affects innovation. Similarly, exploring seven European countries, Carboni (2017) finds that government subsidies have an additional effect on R&D spending. In other words, firms spend more than they would have spent without government support. Some studies argue, however, that public funding may act as a substitute (crowding-out effect) more than as a complement to private investment (additive effect). See David, Hall, and Toole (2000) for an extensive review on this point.

Another determinant of innovative investment is related to the participation in a group (*Group*). Indeed, being part of a group may allow firms to benefit from the knowledge, experience and technological dynamism of the other group members and take advantage of easier access to financial support (see, for example, Parisi, Schiantarelli, and Sembenelli, 2006; Pellegrino, Piva, and Vivarelli, 2012; López-Bazo and Motellón, 2018; Crowley and McCann, 2018).
In line with past literature, firm size, cooperation with other partners for innovative activity and internationalization are used here as exclusion restrictions, i.e. they influence the investment decision but not the investment intensity (see for example Crépon, Duguet, and Mairesse, 1998). There is not unique *consensus* in the literature regarding the role of firm size (*Size*). Empirical

evidence is still conflicting (see Crépon, Duguet, and Mairesse, 1998; Rogers, 2004; Hall, Lotti, and Mairesse, 2009; Mate-Sanchez-Val and Harris, 2014; López-Bazo and Motellón, 2018). Indeed, some authors find that small firms are well-suited to innovation thanks to their flexibility and the lower level of embedded routines (see also Schumpeter, 1934). For example, Rogers (2004) finds that smaller firms in the manufacturing industry exhibit a strong and positive relation between networking and innovative activities. Others assert, instead, that large firms may be more successful in innovating due, for example, to the ability to sustain R&D departments, the availability of financial resources or the exploitation of economies of scale (see, for example, Schumpeter, 1942; Evangelista and Mastrostefano, 2006; Hall, Lotti, and Mairesse, 2009). For instance, López-Bazo and Motellón (2018) find that larger firms are more likely to introduce both product and process innovations. They also find that, differently than in large firms, innovation in smaller firms is more dependent on the regional context where the firm operates. The collaboration with external partners (*Cooperation*) and the internationalization of the firm (*Market*) are considered as two other important sources of knowledge. Indeed, cooperation allows internalizing technological spillovers, making use of external resources otherwise unavailable to the firm, reduces uncertainty and allows sharing the costs associated with R&D and the realization of innovative outputs (see, among the others, Cassiman and Veugelers, 2002; Becker and Dietz, 2004; Chun and Mun, 2012; Iammarino et al., 2013; Pennacchio, Piroli, and Ardovino, 2018). Similarly, internationalization contributes to the accumulation of knowledge and the adoption of new technologies through learning-by-exporting mechanism (see Mate-Sanchez-Val and Harris, 2014; López-Bazo and Motellón, 2018; Crescenzi and Gagliardi, 2018).

Two key variables in the specification of the KPF are human capital and absorptive capacity. As anticipated in the previous section, here the firm's potential absorptive capacity is captured using a dummy variable taking value one if the share of graduate employees in the firm is greater than 25% and zero otherwise (*HCapital*). The threshold to classify human capital in high and low values has been decided on the basis of statistical frequencies, taking a higher share of graduate employees as threshold dramatically unbalances the two categories. Realized absorptive capacity is expressed, instead, using two alternative set of measures. First, interacting human capital (*HCapital*) with the two external sources of knowledge (e.g. extramural R&D and machinery investment). This measure allows to observe how the presence of human capital helps absorbing new investments in external knowledge. Second, the realized absorptive capacity is measured in a more traditional way by interacting intramural R&D with both extramural R&D and machinery investment. This measure aims to capture the capacity of new investment in internal knowledge to absorb new investment in different sources of external knowledge.

The analysis includes the variables described above in all the specifications both at the national

and regional-level. The next sections provide the results.

<Please insert Table 2.2 about here>

2.4.2 National-level Estimates

As discussed in the empirical strategy section, the analysis focuses first on the estimation of equations 2.1, 2.2 and 2.3 over the national sample (Tables 2.3 and 2.4) and then on the NUTS1 regional sub-samples (Tables 2.5-2.11). As described in section 2.3, the analysis consists of two stages. In the first, equations 2.1 and 2.2 are estimated using Heckman's model in order to control for potential sample selection bias in the input equation. Then the predicted values of inputs are used to estimate the KPF (equation 2.3). However, this is done only if sample selection bias emerges from the first stage (i.e. the Mill's ratio is significant), otherwise the observed values of inputs are included.

Table 2.3 reports the estimates of the sample selection equation at national level for three different inputs: intramural R&D (columns 1-2); extramural R&D (columns 3-4); and machinery investment (columns 5-6). The variables *Size*, $Market$, and $Cooperation$ are used as exclusion restrictions. Some interesting differences emerge between the different inputs. Public funding at the local, national and European level ($Funding$) affect positively the decision to invest in intramural and extramural R&D, while only local and national level play a role in the decision to invest in machinery. Looking at the investment intensity, we find a positive and significant effect of local and national funding only in the case of intramural and extramural R&D. Being part of a group (*Group*), as well as operating in international markets, positively influences intramural and extramural R&D, but negatively the investment in machinery. Firm size (*Size*) and collaboration with external partners ($Cooperation$) influence both intramural and extramural R&D, but do not matter for machinery investment. Some differences emerge also looking at geographical location. Firms located in the South and Islands are less likely to engage in intramural and extramural R&D than firms in the $North-West$ (taken as reference category), but they are more likely to engage in machinery. This evidence highlights how Southern and Insular areas are less advanced in economic and technological terms than the rest of Italy. Finally, there is evidence of sample selection bias only for extramural R&D and machinery investment. Indeed, in these cases the Mill's ratio is positive and significant.

Table 2.4 reports the estimates of the KPF at national level. As said above, this second stage considers four different types of innovative outputs: *Product, Process, Organizational,*

Marketing. The first two are technology-related innovations, while the other two outputs are service-related innovations (non-technological ones). These innovations are not mutually exclusive. Indeed, firms often decide to simultaneously introduce different types of innovation. To this end, as said in the empirical strategy section, it is assumed that the error terms in equation 2.3 are correlated, so that it is estimated using a multivariate probit model. As table 2.4 shows, for each innovative output three specifications that differ in terms of the presence and measurement of absorptive capacity are proposed. In the first specification, only potential absorptive capacity (HCapital) is included. In the other two, instead, we include also realized absorptive capacity that is measured first as the interaction between human capital and external knowledge (columns 2 in table 2.4) and then as the interaction between intramural R&D and external knowledge (columns 3 in table 2.4). Where external knowledge is expressed either by extramural R&D or by machinery investment. In line with previous studies, results show that both intramural and extramural R&D positively influence innovation (see, among the others, Crescenzi and Gagliardi, 2018). However, there are not significant differences between the different types of output and this is in contrast with results by Crowley and McCann (2015) who find, for Irish firms, that R&D exclusively influences product innovation. Investment in machinery is statistically insignificant or even negatively signed in the case of organizational innovation. In line with past studies, Human capital, which is used as a proxy of potential absorptive capacity, positively influences the introduction of product, organizational and marketing innovations (see also López-Bazo and Motellón, 2018; Crescenzi and Gagliardi, 2018). However, the interaction terms between human capital with both extramural R&D and machinery investment, which are used to proxy realized absorptive capacity, are never statistically significant. Similar results are obtained from the interactions of intramural R&D and machinery investment. In this respect, this result differs from Parisi, Schiantarelli, and Sembenelli (2006) who find, in the case of process innovation, significant results for the interaction between intramural R&D and machinery investment. Unexpectedly, the interaction between intramural and extramural R&D is significant and negative in the case of process and organizational innovations. This means that internal and external R&D have a direct and positive impact on innovation when individually considered, but not if jointly considered. Therefore, they seem to be substitute and not complement inputs in the cases of process and organizational innovations. Summarizing, results show some evidence of the importance of "potential" but not "realized" absorptive capacity. Finally, regional differences emerge in the four types of innovation, as highlighted by the regional dummies. Indeed, firms located in Central and Southern and Insular regions are less likely to introduce product innovations, while firms in the North-East are, instead, more likely to introduce organizational and marketing innovations. There are not significant differences between the North-West and

the North-East, in the cases of product and process innovations.

<Please insert Tables 2.3 and 2.4 about here>

2.4.3 Regional-level Estimates

Tables 2.5 to 2.11 report the results on the regional differences in the relationship between input and output and the capacity to absorb external knowledge. To this end, equations 2.1, 2.2 and 2.3 are estimated for each NUTS1 region. Tables 2.5-2.7 report the results of the estimation of the innovative inputs equations.

In particular, table 2.5 shows the results for Intramural R&D. They highlight that the investment decision in intramural R&D is strongly influenced by public funding at different levels of governance. The only exception is for Central regions where European funding is not statistically significant. Public funding influences also the intensity of intramural R&D investment but mostly from local and national sources. Indeed, European funding is significant only for the North-West. For the Central regions, instead, do not emerge any significant effect. However, in these last regions being part of a group seems to be more important for both investment decision and intensity of intramural R&D, while in the other regions it influences only the investment decision but not the intensity of intramural R&D. Heterogeneous effects emerge for the exclusion restrictions. Specifically, firm size is significant only for firms in the North (both West and East) and in the South and Islands but not for those in the Centre, while operating in international markets and cooperating for innovation are significant for firms in the North and in the Centre but not in the South and Islands. Finally, the Mill's ratio is never statistically significant, meaning that no sample selection occurs for intramural R&D independently on the geographical area.

Table 2.6 reports the results for extramural R&D. In this case public funding, in particular local and national, influences the investment decision but not the intensity of investment. This is true also for European funding in the case of the North-West. Being part of a group positively influences the decision to invest in extramural R&D with the exception of firms in the Southern and Insular regions where there is no significant effect on the investment decision and a negative and significant effect on the intensity of investment. One possible explanation for this result is that firms may be discouraged to invest in extramural R&D since they can receive support for their innovative activity from the group. In other terms, being part of a group could generate a sort of substitution effect. Looking at the exclusion restrictions, results show a significant effect of large size in the case of firms located in the North and in the Centre, but not in the South

and Islands. International markets and cooperation for innovation are significant, instead, irrespective of the geographical location. However, the effect of operating in international markets is negative in the case of firms located in the South and Islands. Thus, it seems to discourage the investment decision in extramural R&D. Finally, the Mill's ratio is statistically significant only in the cases of the North-Western and Southern and Insular regions providing evidence of sample selection bias. Therefore, in these two cases the predicted values are used to estimate the KPF equation.

Table 2.7 reports the results of the machinery investment regressions. Public funding is in this case rarely significant and only when considering the investment decision and it is never significant for the firms located in the Central regions. Specifically, local funding is positive and significant only for the North-East, as well as European funding, while National funding plays a role for the North-West and the South and Islands. Being part of a group is significant but with a negative sign in all the regions, with the exception of the Centre where the variable is not statistically significant. In terms of the exclusion restrictions, these are significant in few cases. In particular, medium size is significant only for the Southern and Insular firms. Operating in international markets is significant and negative only for the firm located the North, while cooperation is never statistically significant. Finally, there is evidence of sample selection bias only for the North-West (the Mill's ratio is significant and positive).

Concluding, some important differences emerge across regions in the input equations. While the national analysis provides evidence of sample selection bias for extramural R&D and machinery investment, the regional analysis reveals that these results are not widespread across space. Specifically, there is evidence of sample selection bias only for firms located in the North-West for both extramural R&D and machinery investment, and in the South and Islands only in the case of extramural R&D. Moreover, results show significant regional differences both in the determinants and the exclusion restrictions. In particular, in the case of intramural and extramural R&D there are relevant differences between firms located in the South and Islands compared to those located in the rest of Italy. When we consider machinery investment, the most important differences emerge instead from the comparison of the Centre with the other regions.

<Please insert Table 2.5 to 2.7 about here>

Even more interesting differences emerge from the estimation of the regional KPFs. These results are reported from table 2.8 to table 2.11.

Table 2.8 reports the estimates for the North-West. In this case, intramural R&D has a positive influence on the probability of all types of innovative outputs. Similar effects are found for extramural R&D, that is particularly significant in the case of organizational innovation. Machinery investment is, instead, never statistically significant. Here, the predicted values of the

three innovative inputs are included only if the sample selection bias emerged in the estimation of input equations. In this case, this symbol " ^ " is added to the name of the variable. Human Capital, here interpreted as a proxy of potential absorptive capacity, positively influences only process and organizational innovation. Realized absorptive capacity is measured in two alternative ways. The first, based on human capital and its interaction with external knowledge sources, is significant but negative in the case of absorption of extramural R&D to realize process innovation. The second, based on intramural R&D and its interaction with external knowledge sources, is significant and negative in the case of absorption of extramural R&D to realize organizational innovation. Thus, a sort of substitution effect emerges between internal and external knowledge to realize process and organizational innovation. No further evidence of absorptive capacity emerges for firms located in the North-West.

Table 2.9 reports the KPF for the North-East. Intramural R&D is positive and significant for all types of innovation outputs also in this case. Extramural R&D is strongly significant only for product innovation, while the results for the other types of innovation depend on the specification adopted. Indeed, it turns out to be positive and strongly statistically significant for organizational innovations (column 3) and marketing innovations (column 1). Machinery investment positively influences process and organizational innovations (specifications in column 1 and 2), but negatively product and marketing innovations (column 3). Moreover, results provide evidence of potential absorptive capacity. Indeed, human capital is positive and statistically significant in the case of product, organizational and marketing innovations, but not for process innovation. However, there is not evidence of realized absorptive capacity looking at the interaction of human capital with both extramural R&D expenditure and machinery investment. On the contrary, looking at the interaction between intramural R&D and machinery investment, there is evidence of realized absorptive capacity for all the innovative outputs with the exception of process innovations. The interaction terms between intramural R&D and extramural R&D, instead, is negative and significant in the case of process and organizational innovation. This confirms the presence of a substitution effect between intramural and extramural R&D as in the case of the North-West.

Table 2.10 reports the results of Central regions. In this case, intramural R&D is positive and statistically significant only for product and marketing innovations. This is not unexpected. Indeed, a quite robust literature finds evidence of a positive role of intramural R&D on product innovations, but not on process innovations (see, for example, Parisi, Schiantarelli, and Sembenelli, 2006; López-Bazo and Motellón, 2018; Crescenzi and Gagliardi, 2018). Extramural R&D positively influences only the process and organizational innovations, while machinery investment, in line with past evidence, positively influences process innovations but negatively

product and marketing innovations (see Parisi, Schiantarelli, and Sembenelli, 2006). Looking at absorptive capacity, there is evidence of potential absorptive capacity in the case of organizational and marketing innovations, while there is not significant evidence of realized absorptive capacity if this is measured by the interaction between human capital and external knowledge. On the contrary, a positive relation exists between intramural R&D and machinery investment in the case of organizational and marketing innovations, but a negative relation is found in the case of extramural R&D for process and organizational innovations.

Finally, the results for Southern and Insular regions are reported in Table 2.11. In this case, in line with the results for the North, Intramural R&D has a positive influence on all types of innovation. Extramural R&D has, instead, a negative impact on process and marketing innovations. Thus, in these cases using extramural R&D as innovative input seems to be an unproductive investment, i.e. just a cost. Machinery investment positively influences mostly process innovation (see Parisi, Schiantarelli, and Sembenelli, 2006). Differently from the previous findings on Northern and Central regions, human capital is never statistically significant. Therefore, there is no evidence of potential absorptive capacity for firms in the South and Islands. This is not a positive sign, as this can exacerbate the already lagging position of Southern and Insular regions. On the contrary, there is some evidence of realized absorptive capacity. In particular, in the case of process innovation the interaction term between intramural R&D and machinery investment is positive and slightly significant. A substitution effect (i.e.negative interaction term) emerges, instead, when looking at the interaction term between intramural R&D and extramural R&D in the case of product innovations.

Summing up, results highlight the presence of significant differences across regions not only in the relation between innovative inputs and outputs but also in the capacity of firms to absorb external knowledge. Different regional innovative profiles may be drawn, which confirm the analysis and historical justification of the macro-regional differences argued in previous findings (Iammarino, 2005). Indeed, some important differences emerge not only in terms of the well-known North-South divide, but also within the Northern part of the country. Firms located in the North-East seem to be more able than those located in the North-West to absorb external knowledge both in potential and realized terms. In particular, these firms benefit from the presence of a high share of graduate employees (HCapital) and are more able to absorb knowledge embedded in machinery by means of investment in intramural R&D. The North-West is, instead, characterized by profitable investment in innovative inputs - specifically intramural and extramural R&D - and potential absorptive capacity, but it suffers from a lack of realized absorptive capacity. The Centre is particularly oriented to service-related innovation (organizational and marketing), with respect to which results highlight a significant evidence of potential and real-

ized absorptive capacity. Finally, as expected, the South and Islands is the less innovative area. In this case, there is some evidence of realized absorptive capacity, while no evidence of potential absorptive capacity. This last evidence should be interpreted as an warning signal for the future of these regions. The main results are summarized in table 2.12.

<Please insert Table 2.8 to 2.12 about here>

2.5 Conclusions

Notwithstanding the growing regional disparities, the literature on the Italian case seems to lack empirical evidence on the micro-level heterogeneity underlying the regional innovative phenomenon. This recent trend has been, instead, largely pursued for other European countries. This chapter aims at filling this gap in the literature and providing an extensive analysis of regional innovation in Italy. To this end, the information provided by the 2014 Community Innovation Survey are exploited to investigates the relation between innovative inputs and outputs at the NUTS1 level. Specifically, the analysis uses a two-step approach to estimate the Knowledge Production Function (KPF) taking into account possible selection bias using Heckman's model (1979) and considering innovation in its multidimensional nature, i.e. as the combination of different innovative inputs (Intra-mural R&D, Extra-mural R&D, Machinery investment) and outputs (Product, Process, Organizational and Marketing innovation).

Following the recent micro-founded approach, the analysis first provides estimates on the full sample of firms (national-level estimates) including regional fixed effects to model regional differences, i.e. accounting for the possible differences in average innovative performance across regions. Some interesting results emerge in this setting. For example, firms located in Central and Southern and Insular regions are found to be less likely to introduce product innovations than firms in the North-West, while firms in the North-East are more likely to introduce service-related innovations. Then, the analysis provides regional-level estimates at the NUTS1 level in order to provide a deeper understanding of regional disparities in the innovative input-output relationship. This allows to appreciate whether different regional environments also influence the translation of innovative inputs into innovative outputs, i.e. the coefficients of the KPF, and the capacity of firms to absorb external knowledge in both potential and realized terms. Looking at these results, in line with previous literature (Iammarino, 2005), different regional innovative profile are drawn.

The most interesting profile is that of firms located in the North-East. In this case, results highlight the presence not only of profitable investment in inputs to realize different types of

innovation but also significant evidence of potential and realized absorptive capacity. A similar behavior emerges in the North-West. Indeed, it is also characterized by a good innovative profile where inputs positively influence the realization of different types of innovation and some evidence of potential absorptive capacity emerges. Differently from the North-East, firms located in these areas seem to suffer from a lack of realized absorptive capacity. Firms in the Central Italy are particularly involved in the introduction of service-related innovations. Indeed, it emerges a positive effect both in terms of profitability of inputs and absorption of external knowledge. The South and Islands is the less innovative area where firms are particularly oriented towards process innovations, i.e. the less radical among the technology-related ones.

Moreover, results show the presence of a "substitution effect" between external and internal knowledge. However, this effect differs across regions and innovation types. In particular, there seems to be a significant substitution effect between intramural R&D and extramural R&D in the case of product innovations in the South and Islands; intramural R&D and extramural R&D to realize process and organizational innovations in the North-East, as well as, in the Centre; human capital and extramural R&D to realize process innovations in the North-West.

In conclusion, this analysis reveals innovation in Italy as a quite complex phenomenon characterized by great heterogeneity across the country. The identified spatial variation and, especially, the ability to absorb external knowledge (absorptive capacity) of firms depends not only on the firm characteristics, but also on its location and on the type of innovation produced. Given the growing regional disparities and the recent decline in the country's productivity, these results offer insights on the importance to adopt innovation policies that are aware of regional and firm-specific characteristics and are able to stimulate the absorptive capacity of firms especially in the lagging geographical areas.

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Table 2.1: Literature on the Italian case

AUTHOR	DATA SOURCE	PERIOD	FIRM-LEVEL	REGIONAL-LEVEL
Ascani at al., (2019)		1999-2006	No	Yes
Barbieri at al., (2018)	CIS	1998-2000; 2002-2004; 2006-2008; 2008-2010	Yes	No
Pennacchio et al., (2018)	CIS	2006-2008	Yes	No
Paula and Silva (2017)	CIS	2008-2010	Yes	No
Bogliacino et al., (2017)	CIS	1998-2000; 2002-2004; 2004-2006	Yes	No
Pellegrino et al., (2012)	CIS	1998-2000	Yes	No
Evangelista and Vezzani (2010)	CIS	2002-2004	Yes	No
Quatraro (2009)	European Patent Office and Istat	1980-2001	No	Yes
Hall et al., (2009)	Mediocredito-Capitalia Survey	1995– 2003	Yes	No
Cainelli et al., (2006)	CIS	1993-95	Yes	No
Parisi et al., (2006)	Mediocredito Centrale Surveys	1994–1992; 1997–1995	Yes	No
Evangelista et al., (2002)	CIS	1990-1992	No	Yes
Evangelista et al., (2001)	CIS	1990-1992	No	Yes

Table 2.2: Variables description

Variables	**Definition**
Investment decision:	
Intramural R&D	Dummy variable equals to 1 if the firm invests in intramural R&D and 0 otherwise.
Extramural R&D	Dummy variable equals to 1 if the firm invests in extramural R&D and 0 otherwise.
Machinery	Dummy variable equals to 1 if the firm invests in machinery and equipment for innovative activities and 0 otherwise.
Investment intensity:	
Intramural R&D	Expenditure in intramural R&D in 2014/ number of employees.
Extramural R&D	Expenditure in extramural R&D in 2014/ number of employees.
Machinery	Expenditure in acquisition of machinery, equipment, and software in 2014/number of employees.
Innovative outputs:	
Product	Dummy variable equal to 1 if the firm has realized product innovation and 0 otherwise.
Process	Dummy variable equal to 1 if the firm has realized process innovation and 0 otherwise.
Organizational	Dummy variable equal to 1 if the firm has realized organizational innovation and 0 otherwise.
Marketing	Dummy variable equal to 1 if the firm has realized marketing innovation and 0 otherwise.
Independent variables:	
HCapital	Dummy variable equal to 1 if the share of graduate employees is more than 25% and 0 otherwise.
Funding Local	Public financial support for innovation activities by Local or regional authorities.
Funding National	Public financial support for innovation activities by Central government.
Funding EU	Public financial support for innovation activities by the European Union.
Group	Dummy variable equals to 1 whether the firm is part of a group and 0 otherwise.

Table 2.2: Continued

Variables	**Definition**
Sector dummy	Dummy coding for the sector where the firm operates. See Appendix A for the complete list of sectors.
Region dummy	Dummy coding for the region where the firm is located: North-West; North-East; Centre; South and Islands.
Exclusion restrictions:	
Size	Categorical variable indicating the number of employees in 2014: 0 - Small: 1 - 49 employees; 1 - Medium >49 employees; 2 Large: >250 employees.
Market	Firms selling their goods in European or international markets.
Cooperation	Cooperation with external partners in innovative activity.

Table 2.3: Heckman Model - Full Sample Italy

Variables	Intramural R&D		Extramural R&D		Machinery Investment	
	Investment decision (1)	Intensity (2)	Investment decision (3)	Intensity (4)	Investment decision (5)	Intensity (6)
Funding-Local	0.234***	0.367***	0.252***	0.276*	0.120***	0.411
	(0.046)	(0.087)	(0.052)	(0.146)	(0.045)	(0.269)
Funding-National	0.542***	0.618***	0.348***	0.292*	0.103*	0.136
	(0.066)	(0.117)	(0.064)	(0.170)	(0.061)	(0.322)
Funding- EU	0.458***	0.136	0.212***	0.005	-0.028	-0.196
	(0.076)	(0.125)	(0.075)	(0.186)	(0.069)	(0.325)
Group	0.183***	0.206**	0.240***	0.078	-0.113***	-0.818***
	(0.042)	(0.094)	(0.054)	(0.175)	(0.040)	(0.229)
Size-Medium	0.159***		0.162***		-0.012	
	(0.044)		(0.056)		(0.042)	
Size-Large	0.420***		0.390***		0.042	
	(0.052)		(0.063)		(0.050)	
Market	0.387***		0.253***		-0.113***	
	(0.044)		(0.058)		(0.042)	
Cooperation	0.246***		0.524***		0.053	
	(0.040)		(0.045)		(0.038)	
North-East	0.081*	-0.011	0.068	-0.154	-0.031	0.044
	(0.042)	(0.079)	(0.050)	(0.136)	(0.040)	(0.198)
Centre	-0.084	-0.066	-0.030	0.048	-0.062	-0.071
	(0.052)	(0.103)	(0.063)	(0.175)	(0.049)	(0.252)
South and Islands	-0.294***	-0.393***	-0.183**	-0.114	0.072	0.518*
	(0.062)	(0.144)	(0.079)	(0.243)	(0.058)	(0.289)
Sector	Yes	Yes	Yes	Yes	Yes	Yes
Mill's ratio	0.248		0.471*		5.810**	
	(0.220)		(0.244)		(2.735)	
Constant	-2.367***	5.273***	-2.803***	4.864***	0.300***	3.429*
	(0.122)	(0.516)	(0.135)	(0.807)	(0.108)	(1.811)
Obs.	6,393		6,393		6,393	

Note: Standard Errors in parentheses. *** p< 0.01, **p <0.05, *p<0.1.

Table 2.4: Knowledge Production Function - Full Sample Italy

Variables	Product			Process			Organizational			Marketing		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
Intramural R&D	0.105***	0.105***	0.189***	0.021***	0.022***	0.142***	0.030***	0.030***	0.125**	0.033***	0.034***	0.081*
	(0.006)	(0.006)	(0.059)	(0.005)	(0.005)	(0.049)	(0.005)	(0.005)	(0.051)	(0.005)	(0.005)	(0.048)
Extramural R&D_hat	0.576***	0.601***	0.624***	0.407***	0.436***	0.518***	0.833***	0.851***	0.937***	0.279**	0.299***	0.328***
	(0.129)	(0.131)	(0.132)	(0.115)	(0.119)	(0.124)	(0.109)	(0.112)	(0.116)	(0.108)	(0.112)	(0.116)
Machinery Invest_hat	-0.024	-0.011	-0.007	-0.010	0.000	-0.002	-0.109***	-0.085*	-0.121***	-0.003	0.022	-0.003
	(0.043)	(0.048)	(0.045)	(0.041)	(0.047)	(0.044)	(0.039)	(0.044)	(0.042)	(0.040)	(0.045)	(0.043)
Human Capital	0.120***	0.513	0.121***	-0.051	0.298	-0.049	0.191***	0.561*	0.193***	0.136***	0.515	0.136***
	(0.041)	(0.359)	(0.041)	(0.039)	(0.362)	(0.039)	(0.037)	(0.339)	(0.037)	(0.037)	(0.341)	(0.037)
North-East	0.066	0.069	0.070	-0.041	-0.038	-0.033	0.121***	0.124***	0.127***	0.083**	0.085**	0.086**
	(0.047)	(0.047)	(0.047)	(0.044)	(0.044)	(0.044)	(0.042)	(0.042)	(0.042)	(0.042)	(0.042)	(0.042)
Centre	-0.117**	-0.115**	-0.118**	-0.076	-0.075	-0.075	-0.073	-0.074	-0.071	-0.049	-0.049	-0.048
	(0.054)	(0.054)	(0.054)	(0.051)	(0.051)	(0.051)	(0.049)	(0.049)	(0.049)	(0.049)	(0.049)	(0.049)
South and Islands	-0.134**	-0.131**	-0.134**	0.068	0.070	0.074	0.086	0.089	0.095	0.046	0.048	0.049
	(0.066)	(0.066)	(0.066)	(0.065)	(0.065)	(0.065)	(0.065)	(0.062)	(0.062)	(0.063)	(0.063)	(0.063)
HCapital*Extram.		-0.049			-0.048			-0.029			-0.031	
R&D		(0.050)			(0.052)			(0.048)			(0.048)	
HCapital*Mach. Invest.		-0.033			-0.023			-0.055			-0.055	
		(0.052)			(0.049)			(0.047)			(0.048)	
Intra. R&D*Extra.			-0.009			-0.020***			-0.021***			-0.009
R&D			(0.009)			(0.007)			(0.008)			(0.007)
Intra. R&D*Mach.			-0.009			-0.002			0.006			0.001
Invest.			(0.007)			(0.006)			(0.006)			(0.006)
Constant	-3.049***	-3.239***	-3.381***	-1.724***	-1.928***	-2.371***	-4.262***	-4.457***	-4.797***	-1.984***	-2.190	-2.251***
	(0.716)	(0.737)	(0.745)	(0.637)	(0.671)	(0.695)	(0.603)	(0.629)	(0.654)	(0.600)	(0.628)	(0.651)
Sector	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Obs.	6,393											

Note: Column 1 reports the result of the baseline specification, column 2 and column 3 add absorptive capacity measured respectively as the product between human capital, or Intramural R&D, and extramural R&D expenditures and machinery investments .
Robust Standard Errors in parentheses. *** p< 0.01, **p <0.05, *p<0.1.

Table 2.5: Heckman Model - Intramural R&D

Variables	North-West		North-East		Centre		South and Islands	
	Investment decision (1)	Intensity (2)	Investment decision (3)	Intensity (4)	Investment decision (5)	Intensity (6)	Investment decision (7)	Intensity (8)
Funding-Local	0.230**	0.466***	0.133*	0.266**	0.314***	0.303	0.536***	0.795**
	(0.092)	(0.168)	(0.068)	(0.113)	(0.118)	(0.248)	(0.135)	(0.370)
Funding-National	0.461***	0.667***	0.747***	0.523***	0.466***	0.127	0.474***	1.287***
	(0.117)	(0.200)	(0.119)	(0.173)	(0.159)	(0.298)	(0.163)	(0.391)
Funding- EU	0.445***	0.365*	0.629***	-0.272	0.202	0.184	0.502**	0.486
	(0.132)	(0.215)	(0.134)	(0.190)	(0.183)	(0.306)	(0.198)	(0.441)
Group	0.176**	-0.005	0.139**	0.189	0.242**	0.498**	0.256**	0.354
	(0.073)	(0.171)	(0.067)	(0.128)	(0.108)	(0.250)	(0.121)	(0.344)
Size-Medium	0.185**		0.202***		0.048		0.148	
	(0.076)		(0.074)		(0.112)		(0.129)	
Size-Large	0.411***		0.594***		0.108		0.600***	
	(0.085)		(0.092)		(0.128)		(0.178)	
Market	0.332***		0.479***		0.496***		0.150	
	(0.077)		(0.073)		(0.105)		(0.131)	
Cooperation	0.262***		0.230***		0.337***		0.133	
	(0.068)		(0.067)		(0.100)		(0.119)	
Sector	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Mill's ratio	0.218		-0.039		0.255		0.997	
	(0.397)		(0.278)		(0.590)		(0.781)	
Constant	-2.237***	4.344***	-2.617***	6.405***	-2.145***	5.986***	-2.845***	2.306
	(0.232)	(0.935)	(0.209)	(0.668)	(0.295)	(1.327)	(0.346)	(2.140)
Obs.	2,215		2,236		1,043		772	

Note: Standard Errors in parentheses. *** p< 0.01, **p <0.05, *p<0.1.

Table 2.6: Heckman Model - Extramural R&D

Variables	North-West		North-East		Centre		South and Islands	
	Investment decision (1)	Intensity (2)	Investment decision (3)	Intensity (4)	Investment decision (5)	Intensity (6)	Investment decision (7)	Intensity (8)
Funding-Local	0.173*	0.253	0.176**	0.293	0.430***	0.043	0.489***	-0.518
	(0.100)	(0.269)	(0.078)	(0.201)	(0.129)	(0.410)	(0.169)	(0.775)
Funding-National	0.220*	0.280	0.478***	0.283	0.280*	0.120	0.414**	-0.165
	(0.114)	(0.286)	(0.104)	(0.265)	(0.159)	(0.431)	(0.194)	(0.748)
Funding- EU	0.265**	0.143	0.156	-0.090	0.123	0.419	0.372	-0.962
	(0.125)	(0.310)	(0.129)	(0.295)	(0.183)	(0.474)	(0.228)	(0.782)
Group	0.306***	0.206	0.179**	0.101	0.300**	0.001	0.174	-0.961*
	(0.099)	(0.332)	(0.085)	(0.240)	(0.143)	(0.499)	(0.172)	(0.560)
Size-Medium	0.209**		0.142		0.077		0.222	
	(0.099)		(0.092)		(0.142)		(0.180)	
Size-Large	0.408***		0.453***		0.272*		0.169	
	(0.105)		(0.105)		(0.154)		(0.247)	
Market	0.342***		0.315***		0.361***		-0.312*	
	(0.104)		(0.096)		(0.135)		(0.186)	
Cooperation	0.520***		0.512***		0.545***		0.582***	
	(0.075)		(0.073)		(0.113)		(0.149)	
Sector	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Mill's ratio	0.744*		0.410		0.507		-2.116*	
	(0.395)		(0.354)		(0.662)		(1.100)	
Constant	-2.661***	3.543***	-2.741***	5.080***	-2.729***	4.675**	-3.704***	13.997***
	(0.262)	(1.361)	(0.209)	(1.159)	(0.332)	(2.010)	(0.478)	(4.287)
Obs.	2,215		2,236		1,043		772	

Note: Standard Errors in parentheses. *** p< 0.01, **p <0.05, *p<0.1.

Table 2.7: Heckman Model - Machinery Investment

Variables	North-West		North-East		Centre		South and Islands	
	Investment decision (1)	Intensity (2)	Investment decision (3)	Intensity (4)	Investment decision (5)	Intensity (6)	Investment decision (7)	Intensity (8)
Funding-Local	0.054	0.397	0.153**	0.240	0.107	-0.308	0.225	0.522
	(0.089)	(0.452)	(0.066)	(0.228)	(0.114)	(0.332)	(0.141)	(0.516)
Funding-National	0.295***	0.261	-0.096	-0.065	0.093	-0.149	0.394**	0.684
	(0.111)	(0.709)	(0.099)	(0.272)	(0.149)	(0.404)	(0.179)	(0.711)
Funding- EU	-0.222*	-0.362	0.302**	0.161	-0.212	-0.220	-0.203	-0.390
	(0.118)	(0.670)	(0.125)	(0.426)	(0.168)	(0.552)	(0.199)	(0.690)
Group	-0.202***	-1.242***	-0.023	-0.414***	-0.041	-0.384	-0.230**	-0.801*
	(0.072)	(0.424)	(0.064)	(0.149)	(0.100)	(0.263)	(0.115)	(0.416)
Size-Medium	-0.050		0.024		-0.141		0.258**	
	(0.074)		(0.071)		(0.104)		(0.122)	
Size-Large	0.087		0.053		-0.040		0.091	
	(0.083)		(0.088)		(0.120)		(0.168)	
Market	-0.139*		-0.134*		-0.045		-0.100	
	(0.074)		(0.070)		(0.098)		(0.123)	
Cooperation	0.087		0.073		0.006		-0.031	
	(0.066)		(0.063)		(0.094)		(0.114)	
Sector	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Mill's ratio	6.160**		3.109		-2.945		4.103	
	(3.087)		(2.078)		(3.152)		(2.947)	
Constant	0.673***	3.936**	0.025	4.870***	0.554**	8.618***	-0.010	4.447*
	(0.211)	(1.785)	(0.177)	(1.640)	(0.264)	(1.691)	(0.311)	(2.356)
Obs.	2,215		2,236		1,043		772	

Note: Standard Errors in parentheses. *** p< 0.01, **p <0.05, *p<0.1.

Table 2.8: Knowledge Production Function - North-West

Variables	Product			Process			Organizational			Marketing		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
Intramural R&D	0.088**	0.089***	0.145*	0.027***	0.028***	0.093	0.028***	0.028***	0.114*	0.027***	0.027***	0.038
	(0.009)	(0.009)	(0.081)	(0.008)	(0.008)	(0.060)	(0.008)	(0.008)	(0.062)	(0.008)	(0.008)	(0.057)
Extramural R&D_hat	0.408*	0.436*	0.462**	0.282	0.479**	0.393*	0.531***	0.556***	0.665***	0.274	0.315*	0.297
	(0.217)	(0.225)	(0.227)	(0.190)	(0.200)	(0.202)	(0.174)	(0.186)	(0.188)	(0.169)	(0.182)	(0.184)
Machinery Invest_hat	-0.028	-0.027	-0.019	0.054	0.079	0.050	-0.017	-0.022	-0.021	-0.004	-0.008	-0.008
	(0.059)	(0.067)	(0.062)	(0.055)	(0.064)	(0.058)	(0.052)	(0.060)	(0.055)	(0.052)	(0.060)	(0.056)
HCapital	0.076	0.347	0.077	-0.099	1.333**	-0.097	0.201***	0.360	0.202***	0.042	0.318	0.043
	(0.069)	(0.590)	(0.069)	(0.066)	(0.570)	(0.066)	(0.062)	(0.533)	(0.062)	(0.062)	(0.536)	(0.062)
HCapital*Extra. R&D		-0.052			-0.253**			-0.039			-0.060	
		(0.103)			(0.100)			(0.093)			(0.093)	
HCapital*Mach. Invest.		-0.001			-0.032			0.012			0.012	
		(0.067)			(0.063)			(0.060)			(0.061)	
Intram. R&D*Extram.			-0.009			-0.015			-0.019*			-0.003
R&D			(0.014)			(0.010)			(0.011)			(0.010)
Intram. R&D*Mach.			-0.002			0.005			0.005			0.002
Invest.			(0.009)			(0.008)			(0.007)			(0.007)
Constant	-1.728	-1.866*	-2.005*	-0.765	-1.771*	-1.259	-2.327***	-2.429***	-2.928***	-1.471*	-1.650*	-1.560*
	(1.068)	(1.112)	(1.118)	(0.932)	(0.992)	(0.994)	(0.854)	(0.918)	(0.927)	(0.835)	(0.901)	(0.909)
Sector	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Obs.	2,215											

Note: Column 1 reports the result of the baseline specification, column 2 and column 3 add absorptive capacity measured respectively as the product between human capital, or Intramural R&D, and extramural R&D expenditures and machinery investments.
Robust Standard Errors in parentheses. *** p< 0.01, **p <0.05, *p<0.1.

Table 2.9: Knowledge Production Function - North-East

Variables	Product			Process			Organizational			Marketing		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
Intramural R&D	0.103***	0.103***	0.068***	0.042***	0.042***	0.049***	0.046***	0.046***	0.021*	0.037***	0.037***	0.004
	(0.009)	(0.009)	(0.014)	(0.009)	(0.009)	(0.012)	(0.008)	(0.008)	(0.012)	(0.008)	(0.008)	(0.012)
Extramural R&D	0.059***	0.068***	0.068**	-0.004	-0.008	0.049*	0.018	0.020	0.074***	0.033***	0.034*	0.040
	(0.017)	(0.025)	(0.029)	(0.013)	(0.019)	(0.026)	(0.013)	(0.018)	(0.028)	(0.012)	(0.018)	(0.025)
Machinery Investment	-0.022***	-0.019*	-0.044***	0.083***	0.091***	0.086***	0.022***	0.028***	-0.001	0.005	0.015	-0.021**
	(0.008)	(0.010)	(0.010)	(0.008)	(0.010)	(0.010)	(0.007)	(0.010)	(0.010)	(0.007)	(0.010)	(0.010)
HCapital	0.195***	0.246**	0.186***	-0.003	0.071	0.001	0.229***	0.292***	0.225***	0.196***	0.304***	0.188***
	(0.069)	(0.107)	(0.069)	(0.065)	(0.095)	(0.065)	(0.061)	(0.093)	(0.061)	(0.061)	(0.094)	(0.061)
HCapital*Extram. R&D		-0.016			0.010			-0.001			0.001	
		(0.033)			(0.025)			(0.024)			(0.023)	
HCapital*Mach. Invest.		-0.008			-0.020			-0.014			-0.024	
		(0.017)			(0.016)			(0.015)			(0.015)	
Intram. R&D*Extram.			-0.003			-0.008**			-0.009**			-0.002
R&D			(0.004)			(0.004)			(0.004)			(0.003)
Intram. R&D*Mach.Invest			0.008***			-0.000			0.007***			0.008***
			(0.002)			(0.002)			(0.002)			(0.002)
Constant	0.093	-0.103	0.204**	-0.070	-0.103	-0.093	-0.258***	-0.286***	-0.157*	-0.497***	-0.544***	-0.368***
	(0.079)	(0.084)	(0.085)	(0.078)	(0.084)	(0.084)	(0.078)	(0.083)	(0.084)	(0.079)	(0.085)	(0.084)
Sector	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Obs.	2,363											

Note: Column 1 reports the result of the baseline specification, column 2 and column 3 add absorptive capacity measured respectively as the product between human capital, or Intramural R&D, and extramural R&D expenditures and machinery investments .
Robust Standard Errors in parentheses. *** p< 0.01, **p <0.05, *p<0.1.

Table 2.10: Knowledge Production Function - Centre

Variables	Product			Process			Organizational			Marketing		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
Intramural R&D	0.117***	0.116***	0.124***	0.013	0.013	0.021	0.020	0.019	0.003	0.041***	0.040***	0.016
	(0.015)	(0.015)	(0.023)	(0.013)	(0.013)	(0.017)	(0.012)	(0.012)	(0.017)	(0.012)	(0.012)	(0.017)
Extramural R&D	-0.003	0.030	0.007	0.039**	0.066*	0.124***	0.048***	0.081**	0.116***	-0.007	0.014	-0.011
	(0.022)	(0.037)	(0.038)	(0.019)	(0.035)	(0.047)	(0.019)	(0.032)	(0.043)	(0.017)	(0.030)	(0.034)
Machinery Investment	-0.044***	-0.046***	-0.044***	0.072***	0.073***	0.074***	0.012	0.015	-0.007	-0.011	-0.029*	-0.033**
	(0.012)	(0.017)	(0.014)	(0.012)	(0.016)	(0.015)	(0.011)	(0.016)	(0.015)	(0.011)	(0.016)	(0.014)
HCapital	0.110	0.131	0.107	0.082	0.119	0.077	0.326***	0.398***	0.306***	0.189**	0.062	0.171*
	(0.099)	(0.156)	(0.099)	(0.095)	(0.141)	(0.095)	(0.091)	(0.138)	(0.092)	(0.090)	(0.136)	(0.090)
HCapital*Extram. R&D		-0.048			-0.037			-0.047			-0.027	
		(0.044)			(0.041)			(0.038)			(0.036)	
HCapital*Mach. Invest.		0.003			-0.003			-0.007			0.033	
		(0.025)			(0.023)			(0.022)			(0.022)	
Intram. R&D*Extram.			-0.002			-0.013**			-0.011*			-0.000
R&D			(0.005)			(0.006)			(0.006)			(0.004)
Intram. R&D*Mach.			-0.001			0.000			0.006**			0.007**
Invest.			(0.004)			(0.003)			(0.003)			(0.003)
Constant	0.121	0.113	0.115	0.220	0.194	0.164	-0.057	-0.100	-0.002	-0.609***	-0.529***	-0.496***
	(0.185)	(0.198)	(0.191)	(0.185)	(0.195)	(0.192)	(0.182)	(0.194)	(0.194)	(0.177)	(0.187)	(0.185)
Sector	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Obs.	1,043											

Note: Column 1 reports the result of the baseline specification, column 2 and column 3 add absorptive capacity measured respectively as the product between human capital, or Intramural R&D, and extramural R&D expenditures and machinery investments .
Robust Standard Errors in parentheses. *** p< 0.01, **p <0.05, *p<0.1.

Table 2.11: Knowledge Production Function - South and Islands

Variables	Product			Process			Organizational			Marketing		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
Intramural R&D	0.119***	0.120***	0.394**	0.037**	0.038**	0.092	0.029*	0.029*	0.055	0.034**	0.032**	0.060
	(0.019)	(0.019)	(0.153)	(0.017)	(0.017)	(0.155)	(0.015)	(0.015)	(0.132)	(0.015)	(0.015)	(0.124)
Extramural R&D_hat	-0.076	-0.103	-0.026	-0.150*	-0.179*	-0.128	-0.162**	-0.141	-0.150*	0.015	0.065	0.023
	(0.082)	(0.091)	(0.090)	(0.086)	(0.093)	(0.091)	(0.078)	(0.086)	(0.087)	(0.081)	(0.091)	(0.090)
Machinery Investment	-0.019	-0.019	0.050***	0.065***	0.070***	0.050***	0.009	0.012	-0.000	0.017	0.013	0.017
	(0.014)	(0.018)	(0.017)	(0.014)	(0.019)	(0.017)	(0.013)	(0.017)	(0.016)	(0.013)	(0.017)	(0.016)
HCapital	0.049	-0.613	0.056	0.067	-0.470	0.056	0.077	0.563	0.067	0.114	1.061	0.112
	(0.107)	(0.824)	(0.115)	(0.115)	(0.866)	(0.115)	(0.103)	(0.802)	(0.104)	(0.105)	(0.831)	(0.105)
HCapital*Extram. R&D		0.064			0.058			-0.044			-0.097	
		(0.080)			(0.085)			(0.078)			(0.081)	
HCapital*Mach. Invest.		0.002			-0.010			-0.008			0.006	
		(0.028)			(0.028)			(0.026)			(0.026)	
Intram. R&D*Extram.			-0.026*			-0.009			-0.005			-0.003
R&D			(0.015)			(0.015)			(0013)			(0.012)
Intram. R&D*Mach.			-0.003			0.007*			0.004			0.000
Invest.			(0.004)			(0.004)			(0.004)			(0.004)
Constant	1.043	1.347	0.459	1.925*	2.233**	1.737	2.036**	1.796*	1.941*	-0.657	-1.195	-0.749
	(0.988)	(1.079)	(1.074)	(1.039)	(1.112)	(1.089)	(0.945)	(1.027)	(1.044)	(0.981)	(1.085)	(1.070)
Sector	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Obs.	772											

Note: Column 1 reports the result of the baseline specification, column 2 and column 3 add absorptive capacity measured respectively as the product between human capital, or Intramural R&D, and extramural R&D expenditures and machinery investments.
Robust Standard Errors in parentheses. *** p< 0.01, **p <0.05, *p<0.1.

Table 2.12: Significant Effects in Regional KPFs

	Product	**Process**	**Organizational**	**Marketing**
Intramural R&D	North-West(+); North-East (+); Centre(+); South and Islands (+)	North-West(+); North-East(+); South and Islands(+)	North-West(+); North-East (+); South and Island(+)	North-West(+); North-East(+); Centre(+); South and Islands (+)
Extramural R&D	North-West(+); North-East (+)	North-West(+); North-East(+); Centre(+); South and Islands (-)	North-West(+); North-East(+); Centre(+); South and Islands (-)	North-West(+); North-East(+)
Machinery Investment	North-East (-); Centre(-); South and Islands (+)	North-East(+); Centre(+); South and Islands (+)	North-East(+)	
Potential Absorptive Capacity	North-East(+)	North-West(+)	North-West(+); North-East(+); Centre(+)	North-East(+); Centre (+)
Realized Abs. Cap. of Ext. R&D: ***by Human Capital***		North-West(-)		
by Intramural R&D	South and Islands (-)	North-East(-) Centre(-)	North-West(-) North-East(-) Centre(-)	
Realized Abs. Cap. of Machinery: ***by Human Capital***				
by Intramural R&D	North-East (+)	South and Islands (+)	North-East(+); Centre(+)	North-East(+); Centre (+)

2.A Appendix: Data description

Table 2.13: Regional Division of Italy at the NUTS 1 level

REGION	OBS.	NUTS 1
Piemonte	503	**North-West (2,215 firms)**
Valle d'Aosta	32	
Liguria	176	
Lombardia	1,504	
Trentino-Alto Adige	578	**North-East (2,236 firms)**
Emilia Romagna	580	
Friuli-Venezia Giulia	376	
Veneto	829	
Toscana	289	**Central (1,043 firms)**
Marche	223	
Umbria	129	
Lazio	402	
Abbruzzo	104	**South and Island (772 firms)**
Basilicata	45	
Calabria	58	
Campania	149	
Molise	19	
Puglia	201	
Sardegna	72	
Sicilia	124	

Table 2.14: Summary Statistics

Variables	**North-West**			**North-East**			**Centre**			**South and Island**			**Italy**		
	Mean	S. D.	%	Mean	S. D.	%	Mean	S. D.	%	Mean	S. D.	%	Mean	S. D.	%
INNOVATIVE OUTPUT															
Innovation			82%			81%			82%			83%			82%
Product			75%			72%			71%			61%			71%
Process			73%			70%			71%			74%			72%
Organizational			57%			55%			56%			52%			56%
Marketing			49%			49%			48%			47%			49%
INNOVATIVE INPUT															
Intramural R&D															
Dummy			46%			45%			41%			28%			43%
Intensity	3.47	3.95		3.23	3.88		3.08	3.91		1.98	3.35		3.17	3.88	
Extramural R&D															
Dummy			16%			16%			14%			9%			15%
Intensity	1.02	2.45		0.98	2.38		0.96	2.44		0.58	1.95		0.95	2.37	
Machinery															
Dummy			67%			67%			66%			73%			68%
Intensity	4.51	3.63		4.64	3.64		4.47	3.68		5.13	3.58		4.63	3.64	
FIRM'S CHARAC-TERISTICS															
Human Capital			55%			40%			54%			43%			53%
Group			71%			58%			63%			47%			62%
Market			70%			63%			58%			46%			63%
Cooperation			29%			27%			31%			28%			29%
Funding Local			14%			25%			19%			18%			19%
Funding National			8%			9%			11%			12%			10%
Funding EU			7%			6%			8%			7%			7%
Size :															
Small			36%			49%			43%			52%			44%
Medium			32%			31%			32%			34%			32%
Large			32%			20%			25%			14%			24%

Table 2.14: Continued

Variables	**North-West**			**North-East**			**Centre**			**South and Island**			**Italy**		
	Mean	S. D.	%	Mean	S. D.	%	Mean	S. D.	%	Mean	S. D.	%	Mean	S. D.	%
Sector:															
Construction			4%			15%			5%			7%			9%
Manufacturing			48%			46%			43%			41%			45%
Wholesale and Retail			11%			17%			17%			22%			16%
Electricity, etc.			2%			1%			1%			2%			1%
Water supply, etc.			3%			2%			4%			6%			3%
Transportation and storage			5%			4%			4%			7%			5%
Information and communication			9%			6%			11%			5%			8%
Financial and insurance activities			8%			5%			9%			6%			6%
Mining and quarrying			1%			1%			1%			1%			1%
Other professional, scientific and technical activities			9%			3%			5%			3%			6%

Chapter 3

Firm Innovative Performance. Investment Intensity and Output "Extensivity"

3.1 Introduction

Given the importance of innovation for economic growth and competitiveness, it is not surprising that this issue has received great attention by academics and policymakers. As pointed out in the previous chapter, an extensive literature has focused on understanding the determinants of firm's innovative behavior to guide government policies (see, among the others, D'Este, Iammarino, Savona, and Tunzelmann, 2012; Mate-Sanchez-Val and Harris, 2014; López-Bazo and Motellón, 2018; Crowley and McCann, 2018). Both internal and external factors are found to matter. In particular, firm's internal characteristics such as size, age, number of skilled employees seem to be positively related to the innovative activity, but also external factors such as market or regulation barriers to innovation (see D'Este, Iammarino, Savona, and Tunzelmann, 2012; Amara, D'Este, Landry, and Doloreux, 2016) and the environmental framework (e.g. advanced or transition economies) in which the firm operates play a role (see López-Bazo and Motellón, 2018; Crowley and McCann, 2018).

Most of the existing studies analysing these internal and external determinants of innovative activities, mainly focus on the comparison between innovative and non-innovative firms or, among innovators, especially on those introducing technological innovations (i.e. product and process innovations). Indeed, to the best of our knowledge only few studies also consider non-technological innovations, i.e. organizational and marketing, despite their importance for firm's competitiveness. Moreover, very little is known on whether their role is to complement or substitute technological innovation, thus, it is important to analyse them jointly (see, for example, Evangelista and Vezzani, 2010; Crowley and McCann, 2015; Tavassoli and Karlsson, 2018).

This chapter[1] departs from the existing literature that, comparing innovative and non-innovative companies and focusing on specific kind of innovative outcomes (mainly product and process innovations), has largely neglected that not all firms engage in innovation with the same extent, i.e. their ability to realize and combine together different types of innovative outputs (both technological and non-technological) at the same time. The importance of the "*extensivity*" of firms' innovative behavior emerges in some studies that investigate, for example, the factors affecting firms to become more innovative than others (Webster, 2004), the impact of a combination of both technological and non-technological innovations on firm's economic performance (Evangelista and Vezzani, 2010) and the influence of the number of innovative activities carried out by firms on the perception of barriers to innovation (D'Este, Iammarino, Savona, and Tunzelmann, 2012). Most of these studies, however, mainly use the innovative "extensivity" as an explanatory variable into their models. Here, instead, the focus is specifically on analysing the differentiating features of firms with different extent of engagement in innovative activities. Specifically, the chapter investigates whether having a different "extensivity" in innovation is linked to differences in terms of investment intensity, absorptive capacity (i.e. firm's ability to assimilate, manipulate and use external knowledge) and other internal characteristics. Regarding investment intensity, the chapter considers three measures, e.g. intramural and extramural Research and Development (R&D), and investment in equipment and machinery for innovations, that have been underlined as the main inputs and differentiating features of innovative firms (see, for example, Crépon, Duguet, and Mairesse, 1998; Parisi, Schiantarelli, and Sembenelli, 2006; Mate-Sanchez-Val and Harris, 2014). However, there is not unique *consensus* in the literature on whether there is a linear or non-linear relationship between these innovative investments and innovative outcomes (see also Hall, Lotti and Mairesse, 2009; Berchicci, 2013; Kim, 2018). Thus, this chapter aims to provide additional empirical evidence on this point, linking investment intensity and output "extensivity". To this end, firms are distinguished in four categories: 1 if they realize only one technological innovation; 2 if they combine two innovations, either two technological ones or a technological and a non-technological; 3 if they combine three technological and non-technological innovations; and, finally, 4 if they realize all the possible innovative outputs jointly. Then, following this classification this chapter also adds to the existing literature linking the "extent" of engagement in innovative activities with the likelihood of introducing innovations with a positive environmental impact.

The attention to environmental innovations is gaining increasing importance, especially, in light of the current debate on climate change. As a consequence, a number of studies evaluate

[1]This chapter has inspired the realization of a co-authored paper with Professors Giorgio Fazio, Davide Piacentino and Jonathan Sapsed. This work is still in progress.

the determinants of these innovations, mainly comparing eco-innovators, i.e. innovators that pay attention to environmental sustainability, and other innovators (see, among the others, Triguero, Moreno-Mondéjar, and Davia, 2013; Cainelli, De Marchi, and Grandinetti, 2015) and the role of regulation and policies to promote their development (OECD, 2011a; OECD, 2011b; European Commission, 2016). Following this recent stream of research, the chapter aims to evaluate the factors affecting the introduction of environmental innovations and, in particular, whether these factors differ according to innovation "extensivity". Specifically, we aim to investigate whether firms in categories 3 and 4, combining both technological and non-technological innovations, are more likely than firms in categories 1 and 2 to introduce innovations with a positive environmental impact.

By doing so, this chapter contributes to the existing literature in four ways. First, exploiting the concept of innovative "extensivity". Second, considering both technological and non-technological innovations and the characteristics of firms combining both the type of innovative outputs. Third, providing additional evidence on the relationship between innovative inputs and innovative outputs. Specifically, considering the investment in different types of inputs (e.g. intramural and extramural R&D and machinery investment) and their impact on different extent of the innovative outputs. Finally, adding evidence on the determinants of environmental innovation and, moreover, linking this concept with that of innovative "extensivity".

Exploiting the 2014 Italian Community Innovation Survey (CIS) and using qualitative data models, the analysis moves onto investigating whether investing a lot in innovative inputs (e.g. intramural and extramural R&D and machinery investment) is associated with being in categories 3 and 4, or there is a threshold beyond which investing in R&D is associated with a reduction of the extent of engagement in innovative activities. Moreover, it investigates whether having a greater innovative "extensivity" increases the likelihood of realizing also innovations with a positive environmental impact.

The research questions can be stated as follow:

- Is there a different relationship between investment intensity and innovation among the levels of innovative "extensivity"?
- Are intramural R&D, extramural R&D and machinery investment complementary or substitute inputs for the different levels of innovative "extensivity"?
- Which is the relationship between innovative "extensivity" and environmental innovations?

The results underline the importance to look at the differences between firms with different innovation "extensivity". Indeed, they highlight the presence of a non-linear relationship between R&D investments and innovation "extensivity", with specific peculiarities between firms that combine more or less types of innovations. Moreover, they highlight a positive relationship between innovative "extensivity" and environmental innovations and a strong role of public support for their introduction.

The remainder of this chapter is structured as follow. The next section presents a brief review of the existing literature. Section 3.3 describes the empirical strategy, while Section 3.4 shows the data used in the analysis and displays the results. Finally, Section 3.5 concludes.

3.2 Literature Review

Starting from the nineties the increased availability of innovation surveys both at the national and at the European level has favored the rising of a number of studies investigating the determinants of innovation processes at the firm-level (see, for example, Crépon, Duguet, and Mairesse, 1998; Bhattacharya and Bloch, 2004; Parisi, Schiantarelli, and Sembenelli, 2006; Evangelista and Mastrostefano, 2006; Vaona and Pianta, 2008; Hall, Lotti and Mairesse, 2009). To this end, different indicators have been used by the literature to measure innovation, e.g. the number of patents, product and process innovations as the main innovative outputs, and expenditures in Research and Development (R&D) as the main innovative input. Despite the heterogeneity of measurements, some stylized facts emerge: investment in R&D positively affects innovation and this, in turns, positively affects firm growth (see, among the others, Parisi, Schiantarelli, and Sembenelli, 2006; Audretsch, Coad, and Segarra, 2014). Some authors argue, however, that the relation between R&D investment and innovation could also be non-linear. This means that the investment in R&D has a positive impact on innovative performance up to a certain point beyond which its effect becomes negative. For example, Berchicci (2013) shows that external R&D has an inverted U-shape relationship with innovative performance. Similarly, Kim (2018) shows that R&D investments have diminishing returns and are characterized by an inverted U-shape relationship with patents, i.e. as R&D investment increases the number of patents increases too, but at a decreasing rate. Large part of these studies exploit the determinants of innovative performance through the comparison between innovators and non-innovators and investigate the relation between investment intensity and innovation intensity concentrating mainly on the number of patents and technological innovations, as innovative outputs, and intramural R&D, as innovative input (see, among the others, Antonelli, Crespi, and Scellato, 2013; Mate-Sanchez-

Val and Harris, 2014; López-Bazo and Motellón, 2018). Hence, neglecting in this way not only the role of different types of innovative inputs (e.g. intramural R&D, extramural R&D and investment in machinery) but also the importance of non-technological innovations (e.g. organizational and marketing) and of their combination with the technological ones for firm's competitiveness[2]. Indeed, not all the firms engage in innovation with the same extent, i.e. their ability to realize different types of innovative outputs at the same time, thus, it is important to investigate their specific characteristics. To the best of our knowledge, only few studies have focused on this "*extensivity*" of innovation in differing ways. For instance, Webster (2004) investigates the forces that bring some firms to be more innovative than others.[3] Using non-linear estimation methods on data of 360 large Australian firms, the study shows that becoming a more innovative company does not necessarily requires a large amount of investment in innovative activities, but rather a set of complementary practices and routines within the organization (e.g. knowledge spillovers, learning capabilities and managerial approach). Evangelista and Vezzani (2010) look at the extent of engagement in innovative activities distinguishing four kinds of innovation modes on the basis of how firms combine technological (product and process innovations) and non-technological innovations (organizational and marketing innovations) and evaluate their impact on the economic performance of Italian firms.[4] They find that innovation strategies combining both technological and non-technological innovations are key drivers of firms' economic performance and competitive advantage. Finally, D'Este, Iammarino, Savona, and Tunzelmann (2012) analyse the impact of the extent of engagement in innovative activities, measured as the number of innovative activities realized, on the perception of barriers to innovation (e.g. cost, knowledge, market and regulation barriers).[5] Using data from the 2005 UK CIS, they show that the extent of engagement in innovative activities influence the degree of barriers perception, i.e. barriers are perceived as highly important when moving from the lowest to the

[2]For example, Frank, Cortimiglia, Ribeiro, and Oliveira (2016) using data of Brazilian firms show that market-oriented innovation strategies (e.g. product commercialization) matter more than technological oriented ones for innovative performance.

[3]Specifically, the dependent variable consists of 8 item based on managers' answers regarding firm's innovative behavior. These include, among the others, information about how often new product are introduced or existing product modified and on the amount of resources devoted to organizational changes. See Webster (2004) p. 738-739.

[4]These modes, obtained using clustering techniques, are product oriented (firms introduce only product innovations), process oriented (firms introduce mainly process innovations), organizational oriented (firms introduce organizational innovations) and complex (firms realize both technological and non-technological innovation).

[5]Specifically, they measure the extent of engagement in innovative activities ranking firms in four categories depending on the number of innovation activities carried out: 0 in case of no engagement; 1-2 if firms engage in one or two innovation activities; 3-4 if they engage in three or four innovation activities; 5-7 if they engage in more than four activities. This classification is then used as independent variable in a multivariate probit model for the four barriers to innovation.

highest categories of engagement in innovation.[6]

Building on this background, this chapter departs from these studies focusing on innovation "extensivity", as the main dependent variable, and investigating its relationship with investment intensity and absorptive capacity.

3.2.1 Environmental Innovations

The attention to environmental innovation is ancient (see, for example, Porter, 1991; Porter and Van der Linde, 1995; Lanjouw and Mody, 1996). However, only in recent years, in response to globalization and industrialization, the importance of concepts such as sustainable development, eco-innovations and environmental friendly technologies has increased exponentially. Many scholars have started to investigate the determinants of environmental innovation and the differences between eco-innovators and other innovators (see Brunnermeier and Cohen, 2003; Horbach, 2008; Triguero, Moreno-Mondéjar, and Davia, 2013; Cainelli, De Marchi, and Grandinetti, 2015); the environmental impact of these innovations, e.g. the reduction of energy and material usage, pollution and emissions (Horbach, Rammer, and Rennings, 2012); the role of regulations (*Porter Hypothesis*[7]) and policies (Van Leeuwen and Mohnen, 2017; Jiang, Wang, and Li, 2018; Liao, 2018); and, finally, the impact of obstacles, e.g. lack of funding or lack of qualified personnel, on their introduction (Souto and Rodriguez, 2015). This literature highlights that environmental innovators are slightly different. For example, barriers to innovation, cooperation with external partners and external sources of knowledge matter more for firms involved in environmental innovations than for other innovators (see De Marchi, 2012; Cainelli and Mazzanti, 2013; Souto and Rodriguez, 2015; Jakobsen and Clausen, 2016; Tumelero, Sbragia, and Evans, 2019). Moreover, environmental innovators are more affected by regulation, cost savings and policy instruments than general innovators (Horbach, Rammer and Rennings, 2012; Liao, 2018).

Following this stream of research, the chapter investigates the determinants of environmental innovations. In doing that, it adds to the existing literature linking environmental innovations to the concept of innovative "extensivity". Specifically, it investigates whether there is a linear and positive relation between them. Thus, whether firms in categories 3 and 4 are more likely than firms in categories 1 and 2 to introduce this kind of innovations.

[6]However, this effect differs slightly across type of innovative barriers: a non linear relationship exists for cost and market barriers underlying the existence of a deterring effect, that is not present in the case of knowledge and regulation factors.

[7]Strict environmental regulations may encourage the introduction of eco-innovations, bringing efficiency into production processes and product realization (see Porter, 1991).

3.3 Empirical Strategy

The analysis focuses on innovators and distinguishes them on the basis of their extent of engagement in innovative activities. To this end, similarly to Evangelista and Vezzani (2010), innovators are distinguished in four categories:

1 - if firms realize one innovative output;

2 - if firms realize two innovative outputs, either two technological ones or a technological one and a non-technological one;

3 - if firms realize three innovative outputs. In this case there are two possible combinations: two technological innovations, product and process, and one between organizational and marketing innovations; or organizational and marketing innovations and one among the technological ones;[8]

4 - if they realize four different innovative outputs, product, process, organizational and marketing innovations.

This classification is then used as dependent variable in the following ordered probit model:

$$\begin{gathered} y_i^* = \mathbf{x_i}'\beta + \varepsilon_i \\ y_i = j \qquad if \quad \mu_{j-1} < y_i^* \leq \mu_j \qquad with \quad j = 1,...,4 \end{gathered} \tag{3.1}$$

where, as usual, y_i^* is unobserved and what is observed is y_i.[9] The μ's and the β's are the unknown parameters to be estimated, while x is a vector of covariates that includes, among the others, the investments in R&D and absorptive capacity measures.[10]

To investigate the relationship between innovative "extensivity" and environmental innovations we run a probit model as follow:

$$Pr(Environmental\_Innovations = 1|z) = G(\beta_0 + \mathbf{z}\beta) \tag{3.2}$$

where *Environmental_Innovations* is a dummy variable equals to 1 if the firm realizes innovations with a positive environmental impact and 0 otherwise, while $\mathbf{z}$ is a vector of covariates which includes almost the same variables of equation 3.1 and, in addition, the categorical variable indicating the extent of engagement in innovation. With the aim to highlight the differentiating characteristics of firms realizing environmental innovations, they are distinguished in two groups depending on their extent of engagement in innovative activities: those belonging to

[8] Unfortunately, we cannot distinguish the specific cases.

[9] See Greene (2012).

[10] To check the parallel lines assumption a Brant test has been run after the ordered probit model. However, it rejects the null hypothesis indicating that the assumption was not violated, thus, it was sufficient to rely on the ordered probit model.

categories 1 and 2 labeled as "group 1", i.e. those realizing few types of innovative outcomes, mainly technological innovations; those belonging to categories 3 and 4 labeled as "group 2", i.e. those combining different innovative outcomes, both technological and non-technological. Two separate probit models are run to compare these two groups in a more compact framework.

3.4 Empirical Analysis

3.4.1 Data: Italian Community Innovation Survey (CIS2014)

The empirical strategy is performed using data of Italian firms from the 2014 Community Innovation Survey[11]. As seen in the previous chapter, this provides information about firms with at least 10 employees from different sectors of activity, mainly manufacturing, construction and wholesale and retail. However, the sample, that originally included 17,532 observations, is restricted to consider only innovative firms. Indeed, the survey is structured so that only firms that positively declare to have "realized innovation", either product or process, or that have tried or are still trying to realize innovations answer to the sections related to R&D activities, expenditures and cooperation for innovation. For the purposes of this chapter, the analysis specifically focuses on innovative firms, i.e. those firms that at least introduce product or process innovations, exploiting in this way the full set of information provided by the questionnaire[12]. Thus, the final sample consists of 6,185 firms with a different extent of engagement in innovative activities. As described above, firms are categorized in four groups depending on the extent of innovative outputs realized. In particular, the 21% and the 27% of the firms belong to categories one and two, respectively; the 27% realizes three innovative outputs and the 25% of the firms realizes and combines four innovative outputs, both technological and non-technological (see table 3.2). More than the 60 per cent of the interviewed entities introduces innovations with a positive environmental impact. The majority of the firms is small-size (the 44 per cent) and operate in the manufacturing (45%), wholesales and retail (16%) and construction sector (9%). These firms seem to rely more on intramural R&D and machinery investment as innovative input and on local (19%), national funding (10%) and cooperation (28%) as additional external

[11]The elaborations have been carried out at the Istat Data Analysis Laboratory of Palermo, in compliance with the legislation on the protection of statistical confidentiality and personal data protection. The results and opinions expressed are the sole responsibility of the authors, do not constitute official statistics and do not engage in any way the ISTAT. The reference period is 2012-2014 inclusive i.e. the three-year period from January 1st 2012 to December 31st 2014. See CIS Methodological Recommendations.

[12]Differently from the previous chapter, firms with an innovation status that is "abandoned/failed" or "still ongoing" are excluded from the analysis.

sources (see table 3.2). Moreover, the 63 per cent of these innovative firms also operates in international markets. This could be interpreted as a signal of the mutual reinforcing role of innovation and internationalization in driving firms competitiveness.

Variables

Following past studies, information about both firm's internal characteristics and external factors are added as explanatory variables. In particular, these include the expenditure in innovative inputs, i.e. intramural R&D, extramural R&D and machinery investment; measures of absorptive capacity, e.g. interaction terms between internal and external knowledge sources or the presence of highly educated employees (see, among the others, Cohen and Levinthal, 1989; 1990; Parisi, Schiantarelli, and Sembenelli, 2006; Crescenzi and Gagliardi, 2018); cooperation with external partners, that allows to internalize technological spillovers, make use of external resources otherwise unavailable for the firm, reduce uncertainty and share the costs associated with R&D and innovative output realization (see Kobarg, Stumpf-Wollersheim, and Welpe, 2018; Tumelero, Sbragia, and Evans, 2019; Kobarg, Stumpf-Wollersheim, and Welpe, 2019); information about firm's internationalization, indeed operating in foreign markets can help in gaining competitiveness thank to the exposure to knowledge spillovers and new and advanced technologies; and, finally, information about public support for innovative activities, that has been underlined as an important factors for innovation. Indeed, as discussed in the second chapter, R&D and innovation are characterized by market failures that make the full appropriability of innovative outcomes difficult for the firm, causing private under-investment. Thus, "additional" financial support could allow firms to bypass these market failures (see, among the others, Almus and Czarnitzki, 2003; Bérubé and Mohnen, 2009; Aristei, Sterlacchini, and Venturini, 2017; Czarnitzki and Hussinger, 2018).

Tables 3.1 and 3.2 report, respectively, the list of the explanatory variables and their summary statistics.

3.4.2 Innovative "extensivity" and investment intensity

The results of the ordered probit model in eq. 3.1 are shown in table 3.3. It reports the average marginal effects with the aim to disentangle the effect of variations in independent variables for single level of the outcome variable.

Results show that the relationship between investment intensity and innovative "extensivity" is non-linear (see, among the others, Berchicci, 2013 and Kim, 2018). The squared terms of the expenditures in intramural and extramural R&D and machinery investment are statistically significant, however, their effect differs across innovation categories. Indeed, the coefficients are positive for firms in categories 1 and 2, while they are negative for categories 3 and 4. This means that the probability of being a more or less combined innovator depends on the amount of investment in innovative inputs. In particular, large investments in innovative inputs increase the likelihood of being a combined innovator, however, this relation holds up to a certain threshold beyond which investing more in innovative inputs induces firms to concentrate their innovative activity on few types of outputs. Looking at absorptive capacity measures, they are distinguished into "internal" and "external". The "internal" absorptive capacity, measured by the interaction term between the expenditure in intramural R&D and machinery investment, positively affects the probability of being in categories 3 and 4. This means that internal R&D and machinery investment become two complementary sources of innovation as firms increase the combination of outputs realized. Similar results emerge for human capital that, as discussed in the previous chapter, can be seen as a measure potential absorptive capacity. The presence of graduate employees increases, in fact, the likelihood of being a more combined innovator. Different results emerge for the "external" absorptive capacity. The interaction term between intramural and extramural R&D inputs turns out to be negative and significant as the types of innovative outcomes combined increase. Thus, these two innovative inputs act as two substitutes sources of knowledge when firms combine different type of innovations. This may be interpreted in lights of the presence of economies of scope. It means that firms exploit cost advantages in using internal sources of knowledge as the extent of engagement in innovation increases. Indeed, as it has been argued in previous studies, relying on external knowledge sources is convenient but also increases the costs of monitoring and coordinating the different activities (Berchicci, 2013). These costs are more likely to become relevant when different innovative activities are combined. In line with the previous literature, results show that firm size, specifically being medium or large which in general indicate the presence of a greater availability of resources and knowledge, as well as, cooperating in innovative activities with external partners and receiving public local funding exert all a positive and statistically significant effect as the combination of innovative outputs increases (see McGuirk, Lenihan, and Hart, 2015; Crescenzi and Gagliardi,

2018; López-Bazo and Motellón, 2018). The same hold for international market outlet. Indeed, operating in international market exposes firms to strongly competitive environment and is, thus, positively correlated with realizing 3 or 4 innovative outcomes. Finally, there are not significant differences between geographical areas.

<Please insert Table 3.3 here>

3.4.3 Innovative "extensivity" and environmental innovation

Table 3.4 reports the average marginal effects for the probability of realizing environmental innovations. In particular, column 1 reports the results of the probit model in equation 3.2 on the full sample of innovators, column 2 and 3 provides, instead, the results of two separate probit models on group 1 (categories 1 and 2) and group 2 (categories 3 and 4), respectively. This allows us to exploit, in a more compact framework, the distinctive determinants of the likelihood of introducing environmental innovations distinguishing firms according to the combination of innovative outputs realized. Results show that extent of engagement in innovative activities is positively related to the realization of environmental innovations. The intensity of the coefficients is larger for firms in categories 3 and 4. These firms are those combining both technological (e.g. product and process) and non-technological (e.g. organizational and marketing) outputs, thus, may be more focused on the sustainability and environmental impacts of innovation in order to raise their reputation and consideration in consumers. Internal absorptive capacity plays a positive role for the likelihood of realizing environmental innovations for both innovator categories, as well as, being of medium and large size, and receiving public funding from local administration. Cooperating with external partners matters only for firms in group 2, while receiving public funding from the EU matters only for group 1 innovators. There are not relevant geographical differences, except for the North-West that has a positive and statistically significant coefficient in the case of group 1 innovators. Puzzling results emerge for human capital and international market outlet underlying the need of further investigations.

<Please insert Table 3.4 here>

3.5 Conclusions

Standard innovation literature has analysed the determinants of innovative activities, mainly comparing innovative and non-innovative firms or analysing the specific characteristics of possible innovative outcomes (e.g. product, process, organizational and marketing innovations). However, firms do not engage in innovative activities with the same extent. Only few contributions take this into account mainly using the different extent of engagement in innovation as independent variable into their models (see Webster, 2004; Evangelista and Vezzani, 2010; D'Este, Iammarino, Savona, and Tunzelmann, 2012). Differently from previous studies, this chapter focuses on innovative firms and classify them in four categories according to the extent of innovative outputs realized considering both technological (e.g. product and process) and non-technological innovations (e.g. organizational and marketing). This is done with the aim to empirically investigate the distinctive features of firms combining different innovative outcomes, especially in terms of investment intensity and absorptive capacity. This classification is then used to analyse whether the different innovative "extensivity" is correlated with a different propensity of realizing innovations with a positive environmental impact.

Results highlight interesting differences in innovative firms according to their engagement in innovative activities. Indeed, a great heterogeneity exists between firms with a different innovative "extensivity" both in terms of distinguishing characteristics and propensity to realize environmental innovations. In particular, a non linear relationship emerges between innovative "extensivity" and investment intensity. Indeed, investing more in innovative inputs reduces the diversification of innovative outputs. Thus, the higher the investments the more firms tend to concentrate on few types of innovative outputs. Heterogeneous effects also exist in terms of absorptive capacity. Specifically, firms in categories three and four seem to rely more on internal than external absorptive capacity. Indeed, intramural and extramural R&D turns out to be two substitute sources of knowledge. This could underline the presence of economies of scope, meaning that as the innovative activity complicates firms prefer to rely on internal sources of knowledge reducing, in this way, the costs of monitoring and coordinating the various activities. Finally, results show a positive relationship between innovative "extensivity" and environmental innovations. Indeed, the propensity to introduce innovations with a positive environmental impact increases with the combination of innovative outputs. Public funding and Cooperation emerge, instead, as the main distinctive features among firms combining 1 and 2 and those combining 3 and 4 innovations. In particular, public funding from local administration and Europe is highly relevant for firms realizing few types of innovative outcomes, and mainly technological innovations (group 1). Strongly combined innovators (group 2), instead, may fill the lack of private sources relying more on cooperation with external partners.

Our results, in line with previous arguments (OECD, 2011b), suggest that public policies aimed to address environmental issues promoting the realization of eco-innovations should have two main objectives. First, they should focus their financial support more on technological than combined innovators. Indeed, technological innovations (e.g. new production processes, new machines and so on) are those that may help in improving environmental quality and realizing sustainable development with low economic costs. Moreover, the introduction of these technologies may call for deep procedural and organizational changes that may require additional monetary sources and external incentives. Second, they should favor network relationships, for example, between firms and research institutions with the aim of improving internal competences and internal absorptive capacity.

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Table 3.1: Variables description

Variables	**Definition**
Innovative Output Extent	Categorical variable, taking values 1 to 4, indicating the combination of innovative outputs (product, process, organizational or marketing innovations) carried out by the firm.
Environmental Innovation	Dummy variable equals to 1 if the firm introduces a product (good or service), process, organizational or marketing innovation with any environmental benefits either for the enterprise or for the end user.
Intramural R&D	Expenditure in intramural R&D in 2014/ number of employees.
Extramural R&D	Expenditure in extramural R&D in 2014/ number of employees.
Machinery Investment	Expenditure in acquisition of machinery, equipment, and software in 2014/number of employees.
Intramural R&D^2	Square of the Expenditure in intramural R&D in 2014/ number of employees.
Extramural R&D^2	Square of the Expenditure in extramural R&D in 2014/ number of employees.
Machinery Investment^2	Square of the Expenditure in acquisition of machinery, equipment, and software in 2014/number of employees.
Size	Categorical variable indicating the number of employees in 2014: 0 - Small: 1-49 employees; 1 - Medium >49 employees; 2 Large: >250 employees.

Table 3.1: Continued

Variables	**Definition**
Funding Local	Public financial support for innovation activities by Local or regional authorities.
Funding National	Public financial support for innovation activities by Central government.
Funding EU	Public financial support for innovation activities by the European Union.
Group	Dummy variable equals to 1 whether the firm is part of a group and 0 otherwise.
Market	Firms selling their goods in European or international markets.
Cooperation	Cooperation with external partners in innovative activity
Human Capital	Categorical variable indicating the share of graduate employees: 1 - 0% 2 - 1-4% 3 - 5-9% 4 - 10-24% 5 - 25-49% 6 - 50-74% 7 - 75-100%
Sector	Dummy coding for the sector of activity.
Region dummy	Dummy coding for the region where the firm is located: North-West; North-East; Centre; South.

Table 3.2: Summary Statistics

Variables	**Mean**	**Std. Dev**	**%**	**Obs.**
Innovative Output Extent:				6,185
1			21%	1,303
2			27%	1,667
3			27%	1,658
4			25%	1,557
Environmental Innovation			61%	6,185
Intramural R&D	3.26	3.89		6,185
Extramural R&D	0.96	2.39		6,185
Machinery Investment	4.62	3.65		6,185
Intramural R&D^2	25.86	33.52		6,185
Extramural R&D^2	6.52	18.02		6,185
Machinery Investment^2	34.69	31.47		6,185
Funding Local			19%	6,185
Funding National			10%	6,185
Funding EU			7%	6,185
Group			62%	6,185
Market			63%	6,185
Cooperation			28%	6,185
Human Capital				6,185
0%			20%	1,331
1-4%			17%	1,087
5-9%			15%	931
10-24%			20%	1,256
25-49%			14%	920
50-74%			8%	526
75-100%			5%	342

Table 3.2: Continued

Variables	**Mean**	**Std. Dev**	**%**	**Obs.**
Size:				6,185
Small			44%	2,816
Medium			32%	2,049
Large			24%	1,528
Territorial Division:			6,185	
Centre			16%	1,043
North-East			37%	2,363
North-West			35%	2,215
South & Island			13%	772
Sector:			6,185	
Construction			9%	562
Manufacturing			45%	2,903
Wholesale and Retail			16%	992
Electricity, gas steam and air conditioning supply			2%	100
Water supply; sewerage, waste management and remediation activities			3%	212
Transportation and storage			4.74%	303
Information and communication			8%	505
Financial and insurance activities			6%	423
Mining and quarrying			0.59%	38
Other professional, scientific and technical activities			5%	355

Table 3.3: Innovative Output Extent

Variables	**Category 1** (1)	**Category 2** (2)	**Category 3** (3)	**Category 4** (4)
Intramural R&D	-0.038***	-0.014***	0.010***	0.041***
	(0.005)	(0.001)	(0.0014)	(0.005)
Extramural R&D	-0.028***	-0.010***	0.008***	0.031***
	(0.007)	(0.026)	(0.002)	(0.007)
Machinery Investment	-0.013***	-0.005***	0.003***	0.014***
	(0.004)	(0.001)	(0.001)	(0.004)
Intramural R&D^2	0.004***	0.0014***	-0.0011***	-0.0043***
	(0.0005)	(0.0002)	(0.0001)	(0.0006)
Extramural R&D ^2	0.002**	0.0008**	-0.0006**	-0.0024**
	(0.0008)	(0.0003)	(0.0002)	(0.0009)
Machinery Investment^2	0.0013***	0.0004***	-0.0003***	-0.0014***
	(0.0004)	(0.0001)	(0.0001)	(0.0004)
*Intramural R&D*Machinery Inv*	-0.0017***	-0.0006***	0.0005***	0.0018***
	(0.0002)	(0.00009)	(0.00007)	(0.0002)
*Intramural R&D*Extramural R&D*	0.0011***	0.0004***	-0.0003***	-0.0012***
	(0.0004)	(0.0001)	(0.0001)	(0.0004)
Human Capital:				
1-4%	-0.029**	-0.008**	0.009**	0.028**
	(0.013)	(0.004)	(0.004)	(0.013)
5-9%	-0.043***	-0.013***	0.014***	0.042***
	(0.014)	(0.004)	(0.004)	(0.014)
10-24%	-0.054***	-0.018***	0.017***	0.055***
	(0.013)	(0.004)	(0.004)	(0.013)
25-49%	-0.074***	-0.027***	0.021***	0.079***
	(0.014)	(0.005)	(0.004)	(0.016)
50-74%	-0.063***	-0.022***	0.019***	0.066***
	(0.017)	(0.007)	(0.005)	(0.019)
75-100%	-0.050**	-0.016**	0.016***	0.050**
	(0.014)	(0.007)	(0.006)	(0.022)
Size - Medium	-0.021**	-0.007**	0.006**	0.020**
	(0.009)	(0.003)	(0.003)	(0.010)
Size - Large	-0.091***	-0.042***	0.022***	0.111***
	(0.010)	(0.005)	(0.002)	(0.013)

Note: Dependent variable Innovative Output Extent.
Standard Errors in parentheses. *** p< 0.01, **p <0.05, *p<0.1.
Coefficients reported are average marginal effects.

Table 3.3: Continued

Variables	**Category 1**	**Category 2**	**Category 3**	**Category 4**
	(1)	(2)	(3)	(4)
Group	0.0007	0.0002	-0.0002	-0.0008
	(0.009)	(0.003)	(0.002)	(0.009)
Funding Local	-0.041***	-0.015***	0.011***	0.045***
	(0.009)	(0.003)	(0.002)	(0.010)
Funding National	-0.017	-0.006	0.004	0.018
	(0.013)	(0.005)	(0.003)	(0.014)
Funding EU	-0.004	-0.001	0.001	0.005
	(0.015)	(0.005)	(0.004)	(0.017)
Market	-0.0243**	-0.008**	0.006**	0.025**
	(0.009)	(0.003)	(0.002)	(0.010)
Cooperation	-0.044***	-0.016***	0.012***	0.047***
	(0.009)	(0.003)	(0.002)	(0.009)
Centre	0.002	0.0007	-0.0005	-0.002
	(0011)	(0.004)	(0.003)	(0.012)
North-West	-0.001	-0.0004	0.0003	0.001
	(0.009)	(0.003)	(0.002)	(0.009)
South	-0.004	-0.001	0.001	0.005
	(0.012)	(0.004)	(0.003)	(0.013)
Sector	Yes	Yes	Yes	Yes
Obs	6,185	6,185	6,185	6,185

Note: Dependent variable Innovative Output Extent.
Standard Errors in parentheses. *** p< 0.01, **p <0.05, *p<0.1.
Coefficients reported are average marginal effects.

Table 3.4: Environmental Innovation

Variables	**All innovators (1)**	**Group 1 (2)**	**Group 2 (3)**
Innovative Output Extent_2	0.102***		
	(0.017)		
Innovative Output Extent_3	0.188***		
	(0.017)		
Innovative Output Extent_4	0.281***		
	(0.017)		
*Intramural R&D*Machinery Inv*	0.001***	0.002***	0.001***
	(0.0002)	(0.0004)	(0.0003)
*Intramural R&D*Extramural R&D*	0.0002	0.0004	0.00002
	(0.0003)	(0.0005)	(0.0004)
Human Capital:			
1-4%	-0.037*	-0.020	-0.052*
	(0.019)	(0.027)	(0.027)
5-9%	-0.013	0.020	-0.038
	(0.020)	(0.030)	(0.028)
10-24%	-0.019	-0.019	-0.046*
	(0.019)	(0.029)	(0.026)
25-49%	-0.014	-0.021	-0.007
	(0.021)	(0.035)	(0.028)
50-74%	-0.098***	-0.128***	-0.080**
	(0.026)	(0.043)	(0.034)
75-100%	-0.081***	-0.088*	-0.069*
	(0.030)	(0.047)	(0.039)

Note: Dependent variable dummy for Environmental Innovation.
Standard Errors in parentheses. *** p< 0.01, **p <0.05, *p<0.1.
Coefficients reported are average marginal effects.

Table 3.4: Continued

Variables	**All innovators (1)**	**Group 1 (2)**	**Group 2 (3)**
Size - Medium	0.084***	0.092***	0.086***
	(0.015)	(0.021)	(0.021)
Size - Large	0.197***	0.181***	0.217***
	(0.017)	(0.027)	(0.020)
Group	0.006	-0.011	0.023
	(0.013)	(0.020)	(0.018)
Funding Local	0.045***	0.052**	0.044**
	(0.015)	(0.024)	(0.019)
Funding National	0.034	0.026	0.041
	(0.021)	(0.034)	(0.027)
Funding EU	0.059**	0.093**	0.037
	(0.025)	(0.041)	(0.031)
Market	-0.033**	-0.029	-0.040**
	(0.014)	(0.021)	(0.019)
Cooperation	0.034**	-0.001	0.067***
	(0.013)	(0.022)	(0.017)
Centre	0.012	0.041	-0.005
	(0.017)	(0.026)	(0.022)
North-West	0.018	0.049**	-0.0058
	(0.014)	(0.021)	(0.018)
South	0.025	0.046	0.013
	(0.019)	(0.028)	(0.026)
Sector	Yes	Yes	Yes
Obs	6,185	2,970	3,198

Note: Dependent variable dummy for Environmental Innovation.
Standard Errors in parentheses. *** p< 0.01, **p <0.05, *p<0.1.
Coefficients reported are average marginal effects.

Conclusions

Export and innovation are two key drivers of firm competitiveness and economic performance, as well as two important determinants of countries' national income, growth and development. Indeed, they both contribute to increase firm's knowledge, competencies and technologies making firms able to develop distinguishing characteristics and gain competitive advantage. This thesis develops three empirical analyses to investigate firm exporting and innovative activities, with the aim to provide additional evidence on the micro-economic mechanisms beyond these two phenomena. In doing that, it departs from existing literature in differing ways. First, it bypasses the traditional dichotomy between exporters and non-exporters, fulfilling standard international trade literature with international business and international entrepreneurship. This allows to investigate the determinants of exporting firms following different internationalization strategies. Specifically, using qualitative data models on data of firms from less developed and developing countries collected by the World Bank, it compares in a unique framework domestic, born local and born global firms. Second, it looks at the role of the regional environment on firm innovative performance and on the capacity of firms to exploit internal knowledge and absorb external knowledge in both potential and realized terms. To this end, the analysis adopts a micro-founded approach in line with a recent stream of regional innovation literature. In this case, we focus on the Italian case in order to fill a gap in the empirical literature. Indeed, little attention has been given to a micro-founded approach of regional innovation in this country. Finally, it analyses the characteristics of firms with different innovative "extensivity", i.e. the ability of the firm to combine different innovative outputs and, moreover, links this concept with that of environmental innovation. In this way, it contributes to the existing literature that has largely neglected that innovative companies do not engage in innovation with the same extent. Indeed, only few studies look at the innovative "extensivity", but consider it as a determinant of innovative performance. Moreover, it considers the determinants of environmental innovation which, in line with the recent discussion on climate change, is acquiring increasing attention.

Some interesting results emerge from the analysis. Distinctive characteristics emerge from the comparison between domestic firms, born locals and born globals. In particular, while born local are able to bypass domestic market's inefficiencies, e.g. the lack of public infrastructures and the presence of corruption, entering foreign markets they may still be prevented to be committed or born globals if they lack strong linkages with foreign entities, proxied by the presence of foreign ownership and the use of foreign technologies, and quality certifications. Thus, the policy maker could facilitate and encourage network relationships, foreign direct investments and linkages with foreign companies to favor the quick inclusion of these firms in international market platforms. This clearly translates in an easier inclusion of less developed and developing countries in the world economy. This evidence confirms the nature of internationalization as a complex and heterogeneous phenomenon and shows that when it comes to exporting not all SMEs are born equal.

High heterogeneity emerges also looking at innovation. Indeed, results highlight the presence of different regional innovative profiles, with great heterogeneity especially between core and peripheral areas. The North is characterized, in general, by a good innovative profile, while the South results as the less innovative area both in terms of input investment and absorptive capacity. Some relevant differences emerge, however, also between the North-West and the North-East especially in terms of potential and realized absorptive capacity. Finally, heterogeneous characteristics emerge also looking at firms with different innovative "extensivity". Specifically, results provide evidence of a non-linear relationship between investment "intensity" and innovation "extensivity", with relevant distinguishing features among categories of innovators. In particular, combined innovators, i.e. firms combining both technological and non-technological innovations, rely more on potential and realized absorptive capacity than those realizing few types of innovative outcomes. Moreover, public funding from the national government and the EU and cooperation seem to be the main distinctive characteristics of firms realizing environmental sustainable innovations. These results offer new insights on the importance to adopt innovation policies that are aware not only of firm specific characteristics but also of regional specific factors, with the aim to stimulate the absorptive capacity of firms, especially in the lagging geographical areas. Moreover, results highlight the determining role of public intervention on the development of environmental innovations with funding at both national and European level playing a major role. Indeed, since the introduction of these innovations requires very often, high technological improvements and investments, public policies play a fundamental role to incentivize and enhance their application and diffusion.

Limitations and directions for further research

The essays developed in this thesis provide additional evidence to the existing literature on firm exporting and innovative behavior. However, the analysis is subject to limitations and further research is needed to overcome them. Specifically, the first study is limited by the cross-sectional nature of data which do not allow to fully observe the firm internationalization dynamics. Exploiting panel data may be useful, for example, to investigate whether born locals follow a gradual internationalization process entering the different stages sequentially or "opportunistically", jumping from being experimental to committed exporters just in response to an increase in foreign demand. In the second chapter, exploiting data at different level of regional aggregation, e.g. NUTS 2, would allow a more accurate analysis of the influence of the regional environment on firm's innovative behavior. We are currently working on that point. In this respect, we are trying to bypass the fact that many regions at the NUTS 2 level present few observations aggregating them according to some criteria such as, for example, geographical proximity. Finally, in the third chapter exploiting detailed information on the specific types of innovative outputs combined by the firm (for example, comparing pure technological with respect to pure non-technological or combined innovators), may allow to better understand the nature of innovative "extensivity". The main idea would be to investigate whether firms innovate in "related" or "unrelated" fields and whether this differs according to the sector of activity. Regarding environmental innovations the aim would be to investigate what are the factors preventing their realization and their differences across high-tech and low-tech industries. Moreover, it would be interesting to analyse the impact of these innovations on firm performance.

Moreover, further investigation will be aimed at understanding the direction of causality between innovation and internationalization. The present essays analyse them as two separated phenomena, just controlling for the firm participation in foreign markets in chapter two and three. However, they are strictly interconnected. Indeed, a large literature has investigated the relationship between them trying to identify whether it is innovation that induces export (i.e. the introduction of new products or processes increases foreign demand and firm's competitiveness pushing firms towards international markets) or vice versa (i.e. it is operating in international markets that induces innovation thanks to the exposure to advanced knowledge and technologies not available in the home market*, learning by exporting* mechanism). However, there is not unique *consensus* on whether the relationship goes from innovation to export or the other way around, thus, this represents a challenge for further research.