Exploring European Firms' Heterogeneity: Perspectives on Finance, Export, and R&D

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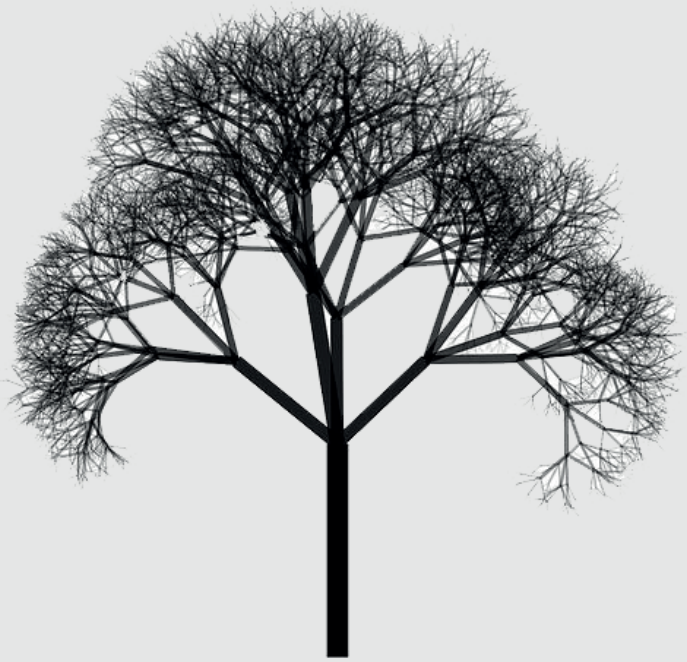

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Supervised by

Agustí Segarra-Blasco

Mercedes Teruel

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FAIG CONSTAR que aquest treball, titulat **"Exploring European Firms' Heterogeneity: perspectives on Finance, Export and R&D"**, que presenta **Sebastiano Cattaruzzo** per a l'obtenció del títol de Doctor, ha estat realitzat sota la meva direcció al Departament **de Economia** d'aquesta universitat.

HAGO CONSTAR que el presente trabajo, titulado "**Exploring European Firms' Heterogeneity: perspectives on Finance, Export and R&D**", que presenta **Sebastiano Cattaruzzo** para la obtención del título de Doctor, ha sido realizado bajo mi dirección en el Departamento **de Economia** de esta universidad.

I STATE that the present study, entitled "**Exploring European Firms' Heterogeneity: perspectives on Finance, Export and R&D**", presented by **Sebastiano Cattaruzzo** for the award of the degree of Doctor, has been carried out under my supervision at the Department **of Economics** of this university.

Reus, 2/11/2020

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"The difficulty lies, not in the new ideas, but in escaping from the old ones, which ramify, for those brought up as most of us have been, into every corner of our minds"

J. M. Keynes - Preface of The General Theory of Employment, Interest and Money (1936)

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Contents

Introduction

The primary objective of this thesis is to explore of European firms' heterogeneity with a special attention to some of the most relevant aspects of firm growth, and to the recent time dynamics. Both the empirical and theoretical literatures now agree upon the fact that rather than the average firms, others are those who actually move and shape aggregate dynamics. On the contrary, at the macro-level, industrial performances are often driven by relatively small group of firms, usually characterized by high degrees of innovative contents, export propensity, or simply, just size (e.g. the granularity debate). For this reason, the empirical exercises contained in this work strive to include methodologies and datasets that allow to disentangle the high degree of heterogeneity in European firms' characteristics, across a large set of dimensions.

Given the turbulent times that the world is experiencing, the inclusion of a time dimension has now become almost a tenet in recent empirical works. Indeed, business cycle fluctuations and not so rare

economic downfall are characterizing the first two decades of the century and firms are obvious candidates in suffering, or participating to these dynamics. Also, each country and the associated industrial structures are likely to evolve in different manner and shall be taken into account. Due to this variability, empirical and policy implications can vary greatly across time periods and countries, requiring scholars to be extremely careful in their analyses.

If the aim is following this route, it becomes mandatory to work at strict contact with data. The reasons are multiple and articulated. First, as a disclaimer, this shall not be considered as a call to pursue empirical work at the detriment of theoretical one. On the contrary, their continuous and possibly virtuous interaction is a key evolving factor for economics as a social science. Indeed, if on the one hand, it would be hard to envision any empirical exercise without some theory to drive it, also the contrary would risk to be unrealistic. Second, as anticipated, world economies are experiencing turbulent times from at least two perspectives: the speed of change, which seems to steadily increase with technology, and the frequency of peaks and downs in business performances. Third, data allows to explore the reality in all its features and aspects. Once scarce, data has become a characterizing paradigm of this new era of information and what once may have been an obstacle, now it is mostly a matter of finding the right ideas.

The relevance of such work stems from the need of firms, and policymakers, to flourish and be in a position that can foster their com-

petitive advantages. This obviously comes with some costs. It is hard to envision a market where each and every firms is endowed with factors that bring it to perennial success. Rather, despite the asymmetry of firm growth distribution, there is a considerable number of firms whose performances is far from desirable and probably, will never be. The role of empirical work for a well-functioning economy is also to develop techniques and tools that can identify firms with high growth prospectuses and opportunities and isolate the characteristics that puts them in this position. Similar objectives shall not only be pursued by entrepreneurs and firms' managers, but it also constitutes a desirable outcome for society, which can only benefit from a well-regulated and productive economy.

Nevertheless, firms' heterogeneity is both part of the title of this works and starting point of the analyses that will follow. This omnipresent feature in industrial studies have been successfully recapped in Dosi, Lechevalier, and Secchi (2010), whose second section title is quite self-explaining: "Heterogeneity wherever one looks". Indeed, industrial dynamics, at any aggregation level, are distinguished by a substantial degree of complexities, which rarely transforms into empirical regularities. Despite the stylized facts that more than 40 years of work on firms and organizations have produced, there is still much to understand. In this direction, the multi-dimensionality of firm growth is an obvious challenge. Even the interaction among apparently simple and key growth variables, such as profitability, size or turnover, is

a complex matter, which cascading makes the establishment of firm growth determinants quite complicated.

Luckily, in these decades, the information technology revolution, the research advancements of statisticians and the attention of policy-makers have eased some of the constraints that prevented industrial scholars from advancing their understanding. In particular, the information technology revolution had a positive, but articulated impact on economic research. Firstly, it implied the development of computers with increasingly bigger computational powers. In turn, this allowed for key advancements on two sides: econometrics and data. On the one hand, the formulation and testing of new estimation techniques, or the amendment of existing ones, has been pushed by the increases in computational powers. Techniques that once took time and effort to be estimated, now became a simple matter of execution. On the other hand, this evolution allowed research to handle continuously bigger datasets, whose production and maintenance has started to become also a policy objective, at least for "enlightened" policies. The combined provision of these gave a considerable extra edge to empirical research in economics, which may finally become able to solve some of its downsides.

Despite all this, limitations are obviously still present, but by acknowledging and considering them in the discussion and interpretation of the results is the way to alleviate their presence. In the present work, some are more relevant than others. First and foremost, probably the

biggest pitfall consists in neglecting entry and exit dynamics. Indeed, they are events that have considerable strength in shaping industrial evolution. However, the focus on incumbent firms only is to focus on a possibly positive analysis, where the interest is rather in the identification of selection mechanisms that bring some firms to grow more than their counterparts. Further, when talking about growth, this thesis refers exclusively to organic growth, as opposed to inorganic growth that takes place through mergers or acquisitions. The two growth modes are completely different and the decision to focus on the first is mostly due to its generation mechanisms, such as innovation and internal organizational adjustments. Finally, a caveat lies in the lack of consideration dedicated in this work to micro firms, which turn out to be frequently excluded from datasets for several reasons, data consistency and reliability first. However, this is likely not to constitute a source of bias, as these micro firms impact on the overall economy is very low.

Realizing and acknowledging firms' heterogeneity is of key importance also for escaping from the risk of understanding only the growth mode of average firms, whose path is rarely relevant or interesting for the aggregate economic performance. Thus, overcoming the limitations posed by research based on the notion of representative agents or firms becomes essential. This impacts also the framework of analysis, which instead of estimating an average effect for the average firm in a quite uninformative way, it shall be more comprehensive and atten-

tive to differences. These considerations become even more significant when introducing aspects related to the economics of innovation into the analysis. Indeed, one more than stylized fact about innovation is the inner uncertainty on the many phases that compose it. As a consequence, it becomes paramount to be aware and take into careful consideration all these sources of noise.

As it will emerge from the literature review, interest in industries and firms has quite distant roots and a great deal of both theoretical and empirical work has been produced in both the economics and management disciplines. For example, the understanding of how firms grow and try to flourish advanced considerably if compared to embryonic attempts, such as the one by Gibrat (1931). However, a complete understanding is still far away, especially of the complex interactive forces that shape firm growth, considered to be at least quasi-random from an empirical perspective. In this framework, the current thesis aims to transform heterogeneity into a perk by attempting to fill research gaps relatively to the interaction between relevant growth determinants and specifically-growing firms.

When talking about specifically-growing firms, the objective is to individuate firms that contribute to aggregate dynamics according to specific criteria, among which their ab-normal growth. Doing this implies focusing on firms that in different time and countries have been pursued by policy efforts for long time. Namely, this thesis dedicate a special attention to some classes of firms that here are put under

the umbrella of "gazelle in the Savannah", but that is formed of firms like high-growth firms and young innovative companies. Among others, these enterprises are major contributors of industrial evolution *in primis*, and of societal advancements, through job and innovation creation. In particular, the analysis evolves around the interaction of these peculiar firms with environments such as finance, export and R&D. Despite apparently far, these are very relevant aspects in the current world. Although globalization started centuries ago, competition becomes every day more global and demanding for firms willing to export, which if they succeed, may constitute a new type of industrial champions. Also, the non-infrequent economic downturns and credit unavailability pose the financial aspects of firms as key enabling factor to pursue growth-enhancing processes. And finally, research and development is a costly and pro-cyclical activity, which if not stimulated, may stagnate.

Structure of the thesis. Chapter 1 strives to offer a reasonably comprehensive literature review on the relevant aspects that shall allow readers to contextualize the contribution. The review attempts to provide a short, but significant recap of the analyses that precedes the present one. Being firm growth so multifaceted and the topics under consideration so articulated, the potential number of works to be included is enormous. On the contrary, the effort was directed to the selection of studies that bring the most relevance to comprehend and contextualize the methodological choices contained in this thesis. An

extensive preliminary part is dedicated to firm growth and its multiple characteristics. Then, building upon this, it develops on the implications of these peculiar characteristics, fat-tailedness above all. Further, it reviews the major firm-level studies on exporting, finance and R&D in the attempt of making the reader familiar with the current status of research in each field, and moreover, with the way scholars have gotten to it. Nevertheless, each research chapter contains also a narrower literature review that directly applies to the empirical exercises in question. Finally, it contains a data section, which briefly introduces the firm-level data panorama in Europe, lists the data sources utilized for the present work, and the illustrate the reasons motivating their choice.

Chapter 2 starts from analyzing the finance-growth nexus. This research question have been largely investigated both in corporate finance and in growth studies. However, the two fields typically showed rare interactions and the results are often hindered either by lack of appropriate data or by approaches with low explanatory power. In order to amend these aspects, the chapter contains an augmented growth model, which balances simplicity in interpretation and empirical validity. Particularly, the research is aimed at estimating how a particular measure of firms' finance, long-term leverage, interacts with firm growth, across the whole distribution. This is done applying dynamic panel quantile regression to a comprehensive panel of firm-level data relative Spain, France and Italy in the period following the economic

crisis, 2010-2016. The possibility to differentiate the results for unconditional growth quantiles show relevant results for specific classes of firms.

Chapter 3 advances the analysis of firms' financing by narrowing down the focus on high-growth firms and extending the analysis of determinants also to export and partially, innovation. First, a self-selection framework in finance is tested against one, where firms would dynamically gain from their participation in export markets and improve their financial health. More than one of the collected pieces of evidence point at a self-selection environment at play for high-growth firms, where already financially healthy firms jump abroad. The analysis is then complemented by a persistence perspective aimed at evaluating how finance, export and innovation contribute to the probability of a firm to experience high-growth phenomena. Also this part shows interesting results as past-persistence turns out a significant and positive determinant, contrary to common knowledge.

Finally, Chapter 4 addresses more in detail an innovation-related aspect of firm growth: research and development. Particularly, the exercise is an empirical decomposition of the internal R&D distribution of a country, Spain in this case. The decomposition is carried out along three main dimensions: distributional quantiles, firm-level determinants and time. In terms of distributional quantiles, the estimation is intentionally detailed at this level to provide a complete picture of the different impact that firm-level determinants have on differently

performing firms. These determinants are selected in a way to accommodate the vast literature on them and thus not neglecting relevant factors, but also in a strive to keep interpretability manageable. Finally, the time dimension allows to repeat the analysis for two key periods in European economy: an expansionary, pre-crisis period, and a contractionary, post-crisis one. Results show how contributions from the tail to the R&D distribution is indeed decreasing, and also that the business cycle have strong and asymmetric effects on the distribution.

Chapter 1

Firm-level theories and evidences on finance, export and R&D

Synopsis. This first chapter serves as literature review of the relevant contributions that help the contextualization of the present thesis. Each chapter contains a more specific and narrow review, but a general framework mixed with the motivations leading to specific choices in the compilation of the thesis is proposed here. Starting with an extremely synthetic overview of the main contributions on firm growth, we then develop on them focusing particularly on their implications in terms of the present research. Heterogeneity is put at the center of a long discussion, which shall provide readers with a unifying framework that

runs across each chapter. Topics like finance, export, and research and development are briefly introduced with their essentials and then, we elaborate on the specific features of interest for this empirical work. Finally, a data section overviews the candidate databases for this kind of exercise and puts forward motivations for the final selection.

1.1 Theories of firm growth

Before entering in the culprit of the present research, this part offers an overview of the existing theoretical frameworks that have been developed by scholars to analyze and investigate firm growth. Although these theories may be subject to different classifications, here they are grouped in three main streams of research: 1) the neoclassical approach, 2) the "Penrosian" approach, and 3) the evolutionary one.

In this, the so-called neoclassical approach is centered around the notions, and the subsequent mathematical derivations, of optimality, and of optimal firm size, in industrial organization. The approach by Penrose is characterized by a dynamic vision, which also entails learning phenomena. While, finally, evolutionary economics envisions the economy as a complex, evolving system, whose engine relies basically on innovation that allows firms to grow.

1.1.1 Size and optimality: a neoclassical approach

This section's title has the precise aim of introducing just a tiny part of the theoretical contributions that generally fall under the vast "neoclassical" umbrella. Precisely, the focus is on the theoretical prescriptions that derive from the standard, Marshallian microeconomic theory. According to this production theory, firm sizes[1] shall generically fluctuate around an optimal size. In order to grasp the main features of these

[1]More precisely, their empirical size distributions.

approaches, hereby two somehow seminal articles are analyzed: Viner (1932) and Lucas (1978).

The first is simply a formalization of the optimal size concept. The author predicts a unique size distribution for each industry, at which firms minimize their costs and variations in demand are taken care of by entry/exit dynamics. This was an interesting solution to the allocative problem, but definitively not sensible to many real-world observations, where firms have very different sizes, diversify in products, and variations in demand are mostly associated to size variations.

Inspired but not convinced by this idea, Lucas (1978) proposes a related way to explain the actual empirical distribution as explained in Ijiri and Simon (1977). Particularly, the idea was to amend Viner's model where it failed the most, the firm size distribution, and to make it reconcile with the empirical observation by Ijiri and Simon. In his formulation, the size distribution simply emerges as a consequence of an exogenously defined distribution of managerial abilities that are (efficiently) allocated across firms. Thus, the author envisions a process of growth that is simply dominated by managerial impetus, which make good managerial decisions happen where they are more lucrative, to the expense of smaller economic activities.

1.1.2 Edith Penrose on firm theory

In her book, the author puts forward what she identified as clear and fundamental features of firm growth. Precisely, the complex process of firm growth relies on three main organizational aspects. First, the process was seen as intrinsically dynamic and cumulative. This cumulativeness shows particularly through learning-by-doing phenomena that trough time, allow the continuous improvement of knowledge, internal routines and heuristics, also of Simonian memory (Simon, 1956). Such processes require time and often reach a *plateau* at which managers will focus excessively on expansionary moves, inducing higher operating costs if compared to less growing firms of the same sector.

Secondly, the above concept of learning-by-doing bring also a fundamental consequence for the way firms are seen, which in Penrose's approach are collection of resources. This resource-based view of the firm considers that the knowledge accumulated within the firm is intrinsically valuable, rare, tacit and non-substitutable. Thus, it does not only characterizes the nature of the firm, but it also consists of its value. Examples of this may range from human capital, to trademarks, passing by machineries and best practices.

Finally, contrary to what above has been characterized as the neoclassical view, in Penrose's approach, firms increase their size simply as a natural consequence of past growth episodes, which carry on by-products sustaining other growth spells. Rather than constrained

toward an optimal size, the growth of a firm is in her view, dynamically constrained by the multiple administrative and organizational restraints that firms have.

1.1.3 The evolutionary approach and a principle of growth of the fitter

Although largely influenced by classics such as John Maynard Keynes and Joseph Schumpeter, the formalization of evolutionary economics is relatively recent and it goes back to Nelson and Winter's seminal book (1982). A rather stylized but effective conception consists of the idea of a turbulent world characterized by rapid technical change that through processes of "creative destruction" makes the economy evolve. In this context, firms to strive have two options, they either innovate through cost-reduction processes, or by imitation of more successful competitors. In doing this, some "fitter" firms will adapt its organizational routines better and evolve, while some others will struggle and lose to this selective mechanism.

This simple, but powerful systematization of reality bears many advantages. First, the abandonment of the unrealistic notion of one, or many, optimal sizes, in favor of performance-based selection mechanisms at industry-level. Second, the possibility to model this environment through "replicator dynamics" and to obtain empirical predictions very close to actual data. And most of all, it puts innovation

at the very heart of economies and industries, in particular. This also led to a tremendous effort in studying and formalizing innovation practices (Dosi, 1988; Pavitt, 1982, 1984), establishing industrial regularities (Bottazzi & Secchi, 2003; Dosi, 2005), and understanding of sectoral features (Bottazzi, Dosi, Lippi, Pammolli, & Riccaboni, 2001; Malerba, 2002, 2005).

In the narrower context of firm growth, the idea some "fitter" firms evolve and grow better than other is indeed very appealing. For instance, two straight forward measures of fitness may be productivity and profitability. Nevertheless, as shown in Coad (2009), this is not the case in the tested empirical world, where there are no signs that more productive firms grow significantly faster than others. Indeed, one *caveat* of evolutionary theory is that empirical support for the growth of the fitter concept is still lacking and weak. The main reason for this is clearly the multi-dimensionality that characterizes firm growth and which makes it very hard to grasp with one or more measures of fitness.

1.1.4 Conclusion

This brief review presented the salient features of three relevant and possibly not exclusive, ways to approach the matter of firm growth. Despite apparently far, these streams shall interact and build on each other established evidences. Also, the degree of heterogeneity that

characterizes the topic of firm growth, and that will be evident in the next pages, calls for a multi-disciplinary and multi-perspective approach.

The focus of this thesis is mostly empirical and it does not rely on structural, theoretical models. However, their importance in the way they are framed, and in the transmission channels that they hypothesize is of utmost relevance for the conception of each research question that will be pursued. This thesis is the attempt of putting the above into practice. Although a general evolutionary inspiration is present in the motives behind the work, the final objective is to give a comprehensive and possibly unbiased picture of firms' growth heterogeneity in Europe.

1.2 Firm growth and its determinants

In order to contextualize the analysis developed in this thesis, we pose as starting point the research conducted on firm growth, from which stemmed many sub-fields connected to it. Thus, it becomes fundamental to consider the vast amount of work that has been produced in decades of research on firm growth. This first section strives to offer a comprehensive, synthetic and contemporaneous literature review that serves this purpose. Although the literature has seen a rotation of growth indicators, according to the most suited framework, this chapter considers it in its original formulation, employment growth, and in

a minor way, in the immediately subsequent measure, sales growth.

Starting from some basic, stylized facts over the firm growth distribution, its determinants and the methodologies allowing researchers to capture them, the aim is to put the basis for the empirical works that will follow in the next chapters. Particularly, the understanding of how the study of firm growth evolved over the years is a necessary information to thoroughly grasp the choice of research objects and methodologies in the subsequent chapters.

1.2.1 The underlying distribution and its implications

Despite being centered on firm sizes rather than growth rates, a relevant starting point for the empirical study of firm-level industrial structure and dynamics is undoubtedly Gibrat (1931). In his book, the author proposed the so-called "Law of Proportionate Effect", also known as "Gibrat's law". Looking at a sample of French manufacturing firms, Robert Gibrat was convinced that modeling the empirical employment distribution as a log-normal was a correct approximation. Although many successive authors proposed their own similar, candidate distributions (Ijiri & Simon, 1977; Simon, 1955; Steindl, 1965), the relevant point here is the realization that this distribution is non-normal and rather skewed.

Relatedly, when analyzing the growth rate distribution, another

characteristic emerges: fat-tailedness. If somebody thinks at the multitude of existing firms, among which the majority does not grow or grows very little, there is another, non-negligible group of firms which is subject to relatively frequent and substantial episodes of expansion and contraction. This intuition can emerge conceptually from simple anecdotal evidence or from empirical data, and goes significantly back in time (Ashton, 1926; Little, 1962). However, the formalization of this concept required the establishment of some candidate distributions and explanations for the phenomenon.

Disappointed with the poor empirical performance[2] of models based on Gibrat's law (Dunne, Roberts, & Samuelson, 1989; Evans, 1987; Hall, 1986; Singh & Whittington, 1975), Stanley et al. (1996, 1995) studied in depth data regarding US manufacturing companies over 15 years and proposed a model that reconcile empirical and theoretical observations on the firms' size and growth distributions. This specification entailed an exponential form, meaning that the spread among growth rates diminishes with increasing sizes. Also, the model allowed for the current growth rate of a firm to depend on its past growth values and on present volumes (or, levels). By doing so, both the past growth performance, in terms of rate, and the absolute value of it, in terms of level, were taken into consideration.

[2]It shall be noticed that at the time, Gibrat's law was the best existing candidate, and also that the "law", in its weak version, is not consistently rejected under all circumstances and specifications, an example is Bottazzi and Secchi (2011).

The above exponential distribution belongs to the Laplace family and fits the empirical data remarkably well. This intuition led to subsequent developments and application of the concept (Amaral et al., 1997; Amaral, Gopikrishnan, Plerou, & Stanley, 2001; Bottazzi, Cefis, & Dosi, 2002; Bottazzi et al., 2001; Lee, Amaral, Canning, Meyer, & Stanley, 1998). As time passed by, characterizing the growth distribution as an exponential became quickly a stylized fact in industrial economics, which tend to hold across different industries, countries, aggregation levels and growth indicators.

Among the implications of this formalization, there are at least two that deserve to be analyzed properly. The first is the connection between firm growth rate variance and firm sizes. Although already noticed in previous empirical work, the negative relationship between firm size and growth rate variance has key economic (and econometric) implications. Economically,

Indeed, econometrically, it constitutes a source of heteroskedasticity in firm growth rates that shall be taken into account for unbiased estimations. While economically, it suggests that looking at firms as a collection of units, the more units a firm has, the less variant shall be its growth rate. If statistically this can be easily explained through the Central Limit Theorem, a potential economic explanation of the phenomenon relates to the participation of firms in different, and independent, sub-markets.

The other relevant implication of a fat-tailed growth distribution

regards the auto-correlation of growth rates. Despite the lack of consensus on the specific auto-correlation patterns, it is empirically evident that firm growth rates exhibit some form of serial correlation (Boeri & Cramer, 1992; Bottazzi et al., 2001; Bottazzi & Secchi, 2011; Chesher, 1979; Wagner, 1992). The heterogeneity of the results depends on the different lag structures, industries and timings of previous research. Also, Segarra-Blasco and Teruel (2012) found that characteristics like the sample size and selection of the different datasets under consideration constitute a considerable, additional source of bias. A likely explanation of this diversity of approaches relies in the general disinterest of scholars in this feature, which was rather considered as a possible source of statistical bias. Other elements will be added in Section 1.3 and 1.2.3 , when taking into account the methodological implication of this aspect.

A candidate economic explanation of the finding is the one given by Bottazzi et al. (2002). The authors compare a purely stochastic benchmark with the actual distribution of estimated autocorrelation coefficients from firm-level data. Finding that the two distributions are significantly different, they conclude that firms follow growth trajectories that are idiosyncratic and that they show some hysteresis. Nevertheless, despite the finding, they also state that there exist strong asymmetries among firms' growth patterns. Coad (2007) makes two additional steps toward explaining this phenomenon. On the one hand, it shows that small firms are often subject to negative autocorrelation,

while large ones to positive[3]. On the other hand, it shows how the farther a growth rate is from the distribution average (where auto-correlation is almost zero), the more negative auto-correlation will be present[4].

1.2.2 Features known to affect firm growth

Despite the quasi-randomness of firm growth patterns, decades of research on the topics have led to the isolation of variables that are surely linked to these patterns and whose exerted influence has been mostly understood. On this, a standalone chapter would not be enough to collect and correctly explain all the empirical results produced. For this reason, the present section shall be exclusively considered as an extreme synthesis of the most accepted firm growth determinants.

Innovation

Innovation has been known for long to positively contribute to firm growth[5] (Dosi, 1988). However, the magnitudes of this contribution are subject to several conditionals. The first and biggest of these con-

[3]This supports the hypothesis that small and large firms tend to have different time horizons in their operations, with larger firms operating on farther horizons, if compared to small firms.

[4]In turn, this has additional implications on the growth patterns of firms experiencing extreme growth events, among which there are the so-called high-growth firms (HGF) and whose patterns result often erratic.

[5]This sentence shall not be regarded as absolute, but as a general tendency. Exceptions to this exist.

ditional is that the impact depends strongly on the growth indicator of choice. In terms of sales growth, it is quite trivial to observe how the development of new products, or processes, can lead to an increase in the volume of sales. On the contrary, looking at employment growth, there is much ambiguity on the net effect of innovation, which depends on decisions and processes both internal and external to the firm (Calvino & Virgillito, 2018).

The differentiation between product and process innovation is theoretically relevant in helping out of the above ambiguity[6]. Product development tend to be associated positively with employment growth, as they usually create additional demand for the firm. Contrarily, when looking at process innovation, these tend to decrease the requirement of labor for a given manufacturing process. However, despite this direct effect, there is a multitude of indirect effects that may confuse the net impact[7].

Another important dualism in terms of innovation studies is the one between innovation input and output. Given the extremely uncertain and complex nature of innovation, elaborating more than one measure of it, possibly tracking different time steps of the (long) overall process, became essential. In terms of inputs, the most accepted and common is research and development expenditure, whose characteris-

[6] A finer and more recent classification have been proposed by Gault (2018).

[7] For instance, a process innovation for a firm may require the purchase of new machines, thus increasing other firms' demand.

tics will be analyzed extensively in Section 1.6. In terms of outputs, the most studied measures are usually either actual innovations *per-se*, or patents[8] (Kleinknecht, Montfort, & Brouwer, 2002).

Finance

Often believed to be a central factor for firms' expansion, studying the financial behavior and performance of a firm have always been problematic. Indeed, these aspects and their relation with firm growth conflict with the notions of information asymmetry (Akerlof, 1978; Stiglitz & Weiss, 1981) and of financial constraints (Fazzari, Hubbard, Petersen, Blinder, & Poterba, 1988). Despite many theories, such as q-based theories (Blundell, Bond, Devereux, & Schiantarelli, 1992; Tobin & Brainard, 1976) and Euler equations (Bond, Elston, Mairesse, & Mulkay, 2003), the empirical performance of the research in this subject is quite inconclusive and their strong reliance on a multiplicity of assumptions is an additional source of invalidity.

An alternative and quite undeveloped stream of research on this is the evolutionary one. Considering firms' heterogeneity in all its dimensions, evolutionary economics proposes a more agnostic and less mathematical framework, which is built upon Simon's bounded rationality (Simon, 1956) and the concept of "growth of the fitter" (Coad, 2010b). In this framework, firms' would be always financially-constrained, as

[8]Departing from these simple indicators, a wide range of more complex and narrow measures have been developed to face specific cases or obstacles.

they naturally want to grow, and their financial performances depend strongly on the firms' performance itself, making this relation largely idiosyncratic. Section 1.4 and Chapter 2 continue the discussion and elaborate more on the relationship between finance and growth at firm-level.

Age

The age variable has been a component of firm growth model for long, often as a proxy of firm size, especially in theoretical models. Indeed, the two variables are somehow related and this holds particularly well when considering models of organizational change such as Greiner (1989). Following Coad, Segarra-Blasco, and Teruel (2013), a possible grouping of the effects induced by age is the following: selection effects, learning-by-doing effects and inertia ones. Selection, as modeled in Jovanovic (1982), is a mechanism through which only highly productive firms stay in business, and as a firms' cohort ages, it is expectable that more productive firms are in place. Learning, originally developed in Arrow (1962), is a cumulative process that allows firms to become more productive as age goes by, also through the incorporation or development of more efficient routines. This can be also stimulated by activities such as innovating, which brings both direct and indirect effects to the firm (Geroski, Machin, & Van Reenen, 1993). Finally, inertia is a negative concept, which postulates that as firms grow old,

they may become less flexible, less productive and less apt for change (Barron, West, & Hannan, 1994).

Given the interactions of multiple effects on this relationship, only the empirics can be helpful to piece together the puzzle. Despite years of restrictions due to data limitations, in more recent times scholars have come up with different approaches such as sub-sampling on surviving firms only (Garnsey, Stam, & Heffernan, 2006; Stam & Wennberg, 2009), focusing on the functional form of the age distribution (Angelini & Generale, 2008; Cabral & Mata, 2003; Calvino, Giachini, & Guerini, 2020; Cirillo, 2010; Coad, 2010a), studying the age-productivity relationship (Haltiwanger, Lane, & Spletzer, 1999), or delving into the financial structure in aging firms (Beck, Demirgüç-Kunt, & Maksimovic, 2005; Beck & Demirguc-Kunt, 2006; Oliveira & Fortunato, 2008). In general terms, age and growth are quite robustly negatively related. An exception to this regularity is likely to take place i) in young and turbulent industries, where on the contrary, age plays a fundamental role among relatively young competitors (Das, 1995), and ii) for particular types of young firms (i.e. Young Innovative Companies, which will be presented in Section 1.3).

Firm, industry and macroeconomic specific factors

Briefly mentioned in the above sub-section, productivity plays a key role for organizations. The measurement of this determinant has attracted considerable debate and it shows scholars preferring to estimate it as Total Factor Productivity (or, TFP) and others who rather use what is usually called Labor Productivity, computed as the value added of a firm divided by the number of its employees. Nevertheless, other than the absolute measures, which by the way are strongly correlated, considering relative productivity is a much safer concept, which can also take into consideration industry- or country-specific factors.

Empirical results on the productivity-growth nexus are not all aligned. On the one hand, low productive firms seem to be the ones more subject to exit markets (Griliches & Regev, 1995; Haltiwanger, Foster, & Krizan, 2001). On the other hand, few studies have been able to connect firm productivity to growth and use it as a predictor (Bottazzi et al., 2002). A possible interpretation of the latter result is the lack of adequate competition in certain industries, which lack the selection mechanism through which more growth opportunities are attributed to more productive firms.

It shall be noted that despite the lack of robust evidence on the productivity-growth nexus, productivity is still a very relevant measure of output at firm-level. Also, it constitutes an important threshold in trade models (Melitz, 2003) and it definitely is desirable to have

industrial policies in place aimed at stimulating productivity at firm-level.

Finally, there exist less relevant, but still impactful factors that play their roles either at the firm, industry or macroeconomic level. Starting from the firm boundaries, economic and managerial research have highlighted how the ownership structure influences growth perspectives (Dunne et al., 1989; Fagiolo & Luzzi, 2006; Harhoff, Stahl, & Woywode, 1998). This holds especially for larger firms that have the discretion to choose between multi- and single-plant structures, for example. Other firm-level factors can be the management characteristics, whose abilities can foster growth-enhancing activities or not, the product-line diversification and exporting. The latter will be analyzed more in depth in Section 1.5.

Industries constitute a *meso*-level of aggregation between firms (the individual level of industrial economics) and countries (the aggregate level of macroeconomics). Although the majority of the stylized facts listed above holds across industries, there are also significant peculiarities that can influence firm growth prospects (Segarra & Callejón, 2002). Age has already been mentioned to be relevant, as the opportunities of mature industries are likely to have already been exploited.

Technological levels and innovation regimes (Bogliacino & Pianta, 2016; Pavitt, 1984) tend to vary consistently across industries and trivially, impact firm growth opportunities. In relation to this, also Audretsch (1995) stresses how scale economies and technology shape in-

dustrial sectors, sometimes as revolving doors while at times as forests. Finally, industrial organization studies have investigated for long the role of market concentration. Focusing on its relation with firm growth, market concentration seems to push at least the top firms to grow more (Geroski & Toker, 1996).

1.2.3 Methodologically relevant advancements

The majority of the findings reported above have accumulated over time and with it, they also became more narrow and precise. Indeed, at the beginning, theoretical models were the capstone in industrial economics.[9] Also because of the need to analytically solve these models, they were often coupled with multiple and sometimes unrealistic assumptions. Advancements in the understanding of industrial systems, in the collection of firm-level data and in the development of statistical tools made many findings possible.

Methodologically, this thesis focuses on the detection of possibly heterogeneous regularities for firms in different growth statuses (Chapters 2 and 3), or showing different technological intensities (Chapter 4). This is done applying modern techniques, which instead of focusing on the average firm, estimate the required specifications over the whole firm growth distribution (or, for specific parts of it, for instance, the upper-tail). Trivially, this approach enables the scholar to gain more

[9] Certainly not due to *mala fides*, but rather to the scarcity of data and computational power to analyze it.

insights on the relationship between the variable under consideration and potentially, to reduce the bias derived from other noises.

In particular, the two most relevant techniques applied in the present work are: quantile regression for dynamic panel data and distribution decomposition methods. The first was developed in Koenker and Bassett (1978) and it is formulated as a minimization of the sum of the absolute deviances. Then, this technique has become widespread among industrial and innovation scholars, also thanks to the application by Coad and Rao (2006). Overall, the technique is not biased by departure from normality, as it is not by the presence of outliers. On the same line of working along whole distributions, there is Chernozhukov, Fernández-Val, and Melly (2013), who proposed an estimator for decomposing conditional distributions into separate contributors. This is done through the estimation of a counter-factual for the distribution(s) of interest and it can be seen as an amendment of well-known methods such as the Oaxaca-Blinder decomposition (Blinder, 1973; Oaxaca, 1973) or the Juhn-Murphy-Pierce (JMP) decomposition (Juhn, Murphy, & Pierce, 1993). More technical details are present in the Econometric section of each chapter.

1.2.4 Conclusion

This section contains a selected literature review of studies on firm growth. Starting from the Gibrat Law and the subsequent develop-

ments in the understanding of firm growth, the presence of only a minor number of robust stylized facts shall be clear. Among these, the fat-tailedness and tent-shaped form of firm growth distribution are probably the most relevant. Especially, these observations are relevant in shaping the methodological approaches chosen to answer to specific research questions. The need to estimate coefficients for the whole growth distribution[10] emerges from here, and from the fact that firms occupying the center of it tend not to grow, or grow very little.

Also, the paragraphs above highlighted how factors such as innovation, age, finance and export interact constantly and strongly with firm growth by shaping the opportunities that each firm has. The aim of the next sections and chapters is to center the discussion around these thematics and present possible advancements in the comprehension of the undergoing phenomena.

1.3 Facing heterogeneity and identifying gazelles

Due to the already mentioned paucity of data that characterized the first 50-60 years of the 20^{th} century, business and industrial research was mostly focused on large firms. This started to change in the 70s and 80s, when also small firms started to receive attention, and a

[10] Or, to put it differently, for firms growing at different paces.

particular subset of them was classified as made up of gazelles. The following paragraphs explain how this happened and developed.

1.3.1 Targeting across the distribution

As anticipated below, two obstacles strongly limited research in industrial economics: the lack of data for small companies and the general tendency to focus on average firms of the existing techniques. This conundrum centered most of the industry studies around large firms (Hart, 1962; Prais, 1974; Samuels, 1965). The overcoming of these problems allowed scholar to start investigating firms standing in different parts of the firm growth distribution, as well as small and medium firms.

Quantile regression constituted a small-scale revolution in the context of firm growth and innovation studies. Removing biases derived from typical regression and/or theoretical assumptions has been very relevant. Also, the facts that the firm size and the firm growth distributions are far from being Gaussian made standard regression techniques subject to possible errors (Coad & Rao, 2006). Non-Gaussianity is not only an obstacle for unbiased estimates, but also a conceptual motif that poses more interest and relevance to the firms occupying the tales of the distribution, the right one in particular.

A final distinction in this context is the difference between conditional and unconditional distributions. Despite apparently trivial, this

difference drives the interpretation of results in a unequivocal manner. Typical quantile regression techniques, such as Koenker and Bassett (1978), are formulated to obtain estimators relative to the conditional distribution. This can become a problem as firms that would be on the right-tail in absolute terms, could move anywhere once the distribution is estimated conditionally on other, relevant variables. Only few quantile estimators are able to bypass this problem and instead, to estimate on the basis of the unconditional distribution (e.g. Powell, 2016).

1.3.2 *An ab-normal contribution!*

Modern techniques transformed a complex analysis in a much easier one, but targeting special classes, or types, of firms is not a modern novelty. The seminal works in this field, whose author is also responsible for coining the term "gazelle", are Birch (1979, 1981). Analyzing the US industry, the author was able to put together two concepts developed above, size and age, to notice that a particular group of firms was contributing substantially to the job creation process in the United States.

Particularly, in Birch (1981), he realized that

> "Of all the net new jobs created in our sample of 5.6 million businesses between 1969 and 1976, two-thirds were created by firms with 20 or fewer employees."

and, that

> "Another distinguishing characteristic of job replacers is their youth. About 80 percent of the replacement jobs are created by establishments four years old or younger."

These two sentences are likely the author's intuition of the heterogeneity hidden by the firm size and growth distributions. Despite being criticized for possible measurement issues authors like Davis, Haltiwanger, and Schuh (1996) and Haltiwanger and Krizan (1999), the publication fostered a huge deal of investigation on small business that still carries on today.[11]

Further and more recent work took into account the imprecisions of Birch and the constructive critiques of the colleagues, and narrowed down the concept of gazelles to better identified class of firms, namely High-Growth Firms (HGFs). A huge deal of investigation followed and was successfully recapped in Henrekson and Johansson (2010). The authors revealed the salient points in the body of research under examination. First, the definition of HGFs was far from being consistent across papers (Section 3.3.2 analyzes the issue more in depth). Second, age is a powerful indicator for HGFs, more than size. Third, HGFs are present in all industries (and not over-represented in high-tech sectors, as initially believed) and they are more resilient to economic down-

[11] It is important to stress that the majority of small business does not grow or grow very little, thus making size itself a poor candidate for the identification of these "super" firms.

turns, or recessions.

In a similar fashion, it is possible to isolate another class of firms, whose contribution to the aggregate economy is still considerably more than average, namely Young Innovative Companies, or YICs (Schneider & Veugelers, 2010; Veugelers & Cincera, 2015). These firms are conceptually related to what was called New Technology-Based Firms, as defined in the late 70s by the consulting agency Arthur D. Little. Definitions have been varying over time, but the distinguishing characteristics are two: the youth and the innovative approach. Nevertheless, as noted by Czarnitzki and Delanote (2012), empirically, a few more restrictive criteria are necessary for a correct identification of these "super-firms". In particular, selecting on young, less than 6 years, small, less than 250 employees and R&D intensity, higher than 15%, the authors show how these firm indeed grow consistently more than the average, while also offering highly skilled jobs and innovative outputs.

1.3.3 Policy and the pursuit of HGFs and YICs

Given the perks listed above, it is easy to understand how institutions have developed policy supporting the creation and the presence of gazelle firms in the economy. Focusing exclusively on the European Union for a moment, this effort can be divided toward two classes of firms: high-growth firms and young innovative companies. On the one

hand, the support of high-growth firms is undoubtedly a challenging task. Even if it would be desirable to avoid the typical wide-scope start-ups financing, it is almost impossible to know *a-priori*, which firms will experience high-growing episodes on a somehow regular basis. On the other hand, young innovative companies may be easier to identify, but pushing their growth potential might not be as easy. Indeed, standard R&D subsidies seem not to contribute particularly (Schneider & Veugelers, 2010), while they may be more in need of different innovation and industrial systems, of more competition and/or cooperation with other, established companies.

Despite these apparent obstacles, these firms are in the position of offering a big number of highly-skilled jobs to the society and through this, also to contribute to the scientific and technical progress. Thus, it is not surprising that policy attempts to foster their presence, performance and persistence. Doing this for high-growth firms implies some decisive steps. The first consists of homogenizing its definition, and in this sense, the European Commission attempt took place in 2007 by imposing strict criteria on HGFs identification.[12] This definition solved some of the problems involved with the excessive multiplicity of the previous empirical results, but made very difficult to identify firms who were able to stay high-growth for long periods of time. Sec-

[12]Precisely, the Eurostat-OECD definition requires HGFs to experience an average annualized growth of either employment or turnover of at least 20% over a three year period and to start the period with more than 10 employees.

ondly, after identifying these firms, appropriate policy supports shall be given. Typical forms involve financial support, but as posed by Mason and Brown (2013), this is far from being a panacea, and on the contrary, more active support shall be engaged (i.e. providing means for successful and profitable internationalization).

On the YICs side, the situation is somehow different, as the YIC concept itself was formalized by the European Commission to precisely target potential radical innovators in 2009. As highlighted by Schneider and Veugelers (2010), typical tools such as R&D subsidies are effective for the firms' population, but not if we focus on these already, over-performing firms. Other tools, more focused on the commercialization and marketing strategy of innovation may involve more centrality of these firms and by it, also more spillover effects on the rest of the economy. Generally, policy effort have been concentrated in easing the possible financial constraints of these candidate super-firms, or gazelles. What shall have emerged in these two decades, also thanks to the empirical contributions by the academia, is that this type of financial support is not enough per-se and more importantly, is not enough to stimulate more presence of firms in the right-tail of the distribution.

1.3.4 One-hit wonders and other conceptions of persistence

This section deals with the idea put forward in Daunfeldt and Halvarsson (2015) and more generally, with the concept of persistence in firm growth rates. Basically, the question regards understanding whether these rates show some temporal correlation at firm-level. Such type of studies started a long time ago and through the analysis of auto-correlations, they could establish that some positive and significant correlation was present for US and UK firms (Ijiri & Simon, 1967; Singh & Whittington, 1975). The subsequent availability of better data, especially including an annual time dimension, led to a great deal of research on the topic, but results are quite mixed.[13] In the context of high-growth firms, the question becomes whether and for how long firms are able to sustain given performances of interest, typically high growth. Also here, very few evidences are in favor of the existence of some temporal correlations for firms in the right-tail of the growth distribution, which also cast doubt on the economic sense of pursuing these evanescent star firms.

More precisely, conditioning on firm size and applying non-linear regression techniques, Bottazzi, Coad, Jacoby, and Secchi (2011) find

[13]Examples of positive observed auto-correlations are Bottazzi et al. (2001); Bottazzi and Secchi (2003); Chesher (1979); Wagner (1992), while negative findings are in Boeri and Cramer (1992); Bottazzi, Cefis, Dosi, and Secchi (2007); Lotti, Santarelli, and Vivarelli (2003)

some regularities holding mostly for large firms. However, the same is not true when looking at small, high-growing firms, whose patterns tend to be erratic. Apparently, this is another sub-field where heterogeneity takes over. Nevertheless, most of the above-cited studies also involve methodological choices that may strongly hinder the comparability of the results, like the choice of relevant lags to consider. One possible way out of this complicated approach is to change techniques and switch from the current regression-based approaches to counting models.

This is the route taken in Chapter 3. There, instead of focusing on annual auto-correlation coefficients, which apparently are not very informative in this sense, a Poisson-based model is estimated. Precisely, a period of 14 years is divided in two, with seven years each. Then, the number of high-growth events are counted, between 0 and 7, for each firm in the sample. Regressing this variable for period 2 on the same variable, containing the data for period 1, yields interesting and relevant results, indeed.

1.3.5 Conclusion

One of the major implications of the firm growth distribution functional form, an asymmetric exponential power law, is indeed the existence of firms contributing consistently more than average to the aggregate output. This intuition is not new and it was formalized the

first time in Birch (1979). Despite some methodological drawback, the article paved the way to focus more on these firms, rather than the average ones. In the same decades, significant statistical advancements, such as quantile regressions, and the availability of progressively better data, with longer time horizons, allowed scholars to develop a significant body of research on firm growth.

Being the average firms of little impact, in this thesis, the objective is rather to assess the dynamics of super-firms, or gazelles, as compared to those closer to the center or to the other tail of the distribution. Policymakers have attempted for long to foster presence and duration of these firms in the tails, but the majority of these attempts have been centered around loosening possible financial constraint. Another objective of this thesis is to take this, and other, interactions under considerations in order to propose some possibly, more comprehensive strategy.

1.4 Firms' sources of financing

Quite trivially, firms require financing to complement their internal resources. Sometimes, they need it for working capital needs, but in the most desirable scenario, the necessity is to enable investments aimed at further growth.[14] In this section, we review how scholars approached

[14]The situation tends to vary considerably across the growth distribution, see Figure 3.3 for an exemplification.

the financial problem related to firm growth, analyze some of the possible downsides and propose some amendments and complementary views.

1.4.1 Financial constraints and the need of financing

When dealing with firm financing, the typical approach consists in analyzing the dynamics of financial constraints and their impact on firm growth. Nevertheless, this approach is hindered by a fundamental underlying issue: typical datasets do not give the possibility to observe or estimate the credit demand and supply relations going on between firms and financial intermediaries. In general, researchers lack information on the amount demanded and received, on the actual interest rate, and on the nature and emergence of firms' borrowing decisions (Farre-Mensa & Ljungqvist, 2016).

The literature have seen an alternation of candidate proxies that have tried to deal with the above problem. Examples vary from cash-flow sensitivity (Fazzari et al., 1988) and surveys to multivariate indexes (Hadlock & Pierce, 2010; Lamont, Polk, & Saaá-Requejo, 2001; Whited & Wu, 2006) and credit ratings, or lack thereof (Faulkender & Petersen, 2006; Whited, 1992). Each of the above solution came with a pitfall as any of those would either have endogeneity problems or focus on just one of the two sides of the relationship. From this, it shall be

clear how the topic is extremely empirically challenging, and for this reason, the current thesis attempts to approach it from an unusual perspective.

Particularly, the aim is to explore firms' sensitivity to different financial variables and indicators in order to understand how these behave and are empirically related to firm growth measures and investment. In Chapter 2, the focus is exclusively on long-term debt, which it is considered because of its predominance among debt instruments used by firms. Then, in Chapter 3, the analysis is extended to a whole variety of financial indicators, namely cash-flow, current and non-current liabilities, liquidity and leverage ratios. This choice is to pursue a comprehensive approach, which shall be able to highlights the financial characteristics that make high-growth, exporting firms financially-healthier than other counterparts. Finally, in Chapter 4, the indicator analyzed consists of the above introduced financial constraint, which is among the few available indicators in the database of use, but it also has a relevant nexus with research and development investment.

1.4.2 The pecking-order theory

A quite accepted and empirically based notion: the pecking-order theory, whose roots can be found in Donaldson (1961), and then developed more formally by Myers (1984) and Myers and Majluf (1984). In both

articles, the authors detected and supposed the existence of an imperfect substitutability among sources of finance, both internal and external. In particular, he supposed there is some type of decreasing willingness to invest as the sources to sustain it become more and more external to the firm.

The theory subsequently received both theoretical and empirical support, making it an almost stylized fact in the literature. Particularly, Vanacker and Manigart (2010) obtained results that are indeed very relevant for this thesis, as they focus on differently growing firms. The authors, after acknowledging the reliability of this hierarchical approach, study a comprehensive longitudinal dataset including many high-growth firms. The results are very much in line with the theory also for this particular category of firms.

In this framework, a firm would first try to invest using their internal funds, then it would switch to incurring into debt and only as a last resort, it would issue equity. This prioritizing approach embodies the notion of asymmetric information, as the above order is basically induced by the different levels of information that are in play internally and externally. It is relevant to notice that, firms can be seen always as financially-constrained (Coad, 2010b), as increasing their size is the ultimate objective to strengthen their positions in the market. This not only contrasts the neoclassical view of "optimal size", but it has strong empirical and theoretical foundations (Nelson & Winter, 1982), but poses an argument against the concept of financial constraint.

1.4.3 Debt and its maturity

Instead of asking how firms' growth can be considered as financially-constrained or not, another possibility (pursued in Chapter 2 and 3) is to analyze directly how financial variable empirically relate to measures of firm growth. In this sense, the most commonly used financial tool is debt. This debt is usually provided by banks, either through firm's or state guarantees. Also, it is a financial tool with a duration (or, maturity), which in other words requires to be honored within an agreed time framework. It is according to this duration that debts are usually classified in firm-level datasets.

This thesis and particularly Chapter 2 focus on long-term debt for several reasons. First, it is the largest debt component in firms' balance sheet, regardless of the sector, once controlled for age and size (Giannetti, 2016). Further, being long-term, it incorporates a certain stability that in the context of empirical, longitudinal studies is certainly a perk for reliable estimates and conclusions. This feature is relevant also because the long-term nature involves the presence of some type of strategic planning to be implemented behind; while, short-term debt is not a good candidate for this ends. Finally, the pecking order puts debt in a position that is very compelling for the current research framework. Indeed, not only it is the last resort before the issuance of new equity, but also it is a considerably relevant commitment for firms, especially smaller and medium ones, and at the same time, it embod-

ies institutional contexts that are certainly relevant and interesting to study in Europe.

1.4.4 Conclusion

Most of the empirical, firm-level financial literature has applied the fragile concept of financial constraint to study how the possible lack of finance may affect firm growth. However, this choice came at some cost, as the concept itself is subject to many unobserved forces. Despite many attempts to amend the fragile aspects of it, there are some biases that empirically are almost impossible to correct.

Through theories like the pecking order, but also from simple empirical observation, it is possible to select one, or many, financial variables that are suspected to play a relevant role in firms' growth opportunities. This allows a more "positive" approach to the finance-growth nexus at firm-level, whereby the observation becomes whether a firm is able to obtain the needed finance and to exploit it in a way that favors its growth.

1.5 The relation between exporting and firms' characteristics

The nexus, and the associated causality, between exporting and some specific firms' characteristics, productivity in particular, have been analyzed more than extensively by trade economists. Starting with the seminal paper by Bernard, Jensen, and Lawrence (1995), it has become progressively clear that exporting firms on average, perform better than non-exporting counterparts. This can be the result of self-selection mechanisms that induce only the better firms to enter exporting markets, or of learning mechanisms that improve the performance of exporting firms.[15] The next sub-sections offer an explanation of these concepts and elaborate on exporting in relation to finance and high-growth statuses.

1.5.1 A brief outline on firms and export

Although trade theories have been around for long, it is only in more recent decades that scholars have started to formalize and analyze the factors affecting the export propensity at firm-level. Empirical evidences stress an already proposed concept: firms are heterogeneous at any aggregation level, only a small percentage of the firms universe sell

[15] On this, Wagner (2007) systematically reviewed the existing evidences and underlines how 1) exporters tend to be more productive even before joining foreign markets, 2) their productivity tends to reduce once they exit these markets, and 3) learning-by-exporting is not unequivocally present in current analysis.

abroad, and exporting firms produce more efficiently than their counterparts (Aw & Hwang, 1995; Tybout & Westbrook, 1995). Building on the foundations laid out by Jovanovic (1982) and Hopenhayn (1992), authors such as Melitz (2003) or Bernard, Eaton, Jensen, and Kortum (2003) attempted to provide a theoretical model of explanation of firm-level trade patterns. Their specifications entailed a self-selection process through which only a small group of highly productive firms export.

Following up this research, a parallel literature began to explore a complementary approach, which takes into consideration how export activity may affect innovation performance with cascade effects over subsequent evolutions of productivity (De Loecker, 2007). Under this approach, exporting firms experience a learning-by-exporting process affecting their R&D investments, innovative capacity and productivity (Wagner, 2007). This view implies that the causality between productivity and export is probably cyclical and not unidirectional as implied by threshold models.

Without entering the causality debate, it is possible to observe that independently of the underlying mechanism, a considerable amount of resources is required to export. International markets are challenging and both the entrance and subsequent survival are not to be taken for granted (Bridges & Guariglia, 2008; Esteve-Pérez & Mañez-Castillejo, 2008; Sui & Baum, 2014; Wagner, 2012). Thus, it is easy to imagine how above average productivity trends are needed for firms desiring to

join foreign markets. In this, finance plays a fundamental role. Indeed, for productivity to increase, firms normally invest in machines, equipment or process improvements, which require financial resources. Also for achieving innovations, firms invest resources in R&D, human capital and subsequent commercialization of the innovative items (Segarra-Blasco, Teruel, & Cattaruzzo, 2020). For these reasons, financial resources come into play and often, their use has important connections with the internationalization process and its impact on subsequent growth performances.

1.5.2 SS versus LBE hypotheses, an application to finance

In a similar fashion of the debate between self-selection and learning-by-exporting explained above, the literature has analyzed whether financial fundamentals are subject to either one of these processes.

Typical findings on the relationship between financial resources and export participation highlights the existence of a significant ex-ante advantage for exporting firms in terms of financial health and resource availability. Further, this advantage seems not to increase significantly after starting to export (Bellone, Musso, Nesta, & Schiavo, 2010). However, this finding contrasts what highlighted by Greenaway, Guariglia, and Kneller (2007), who found that financial health improves significantly thanks to exporting. These results are probably due to the

high degree of heterogeneity of exporting firms in global markets, but also due to the strong endogeneity and reverse causality of the relation under consideration, which make it very hard to estimate unbiasedly.

Despite the existing evidences, as noted by Wagner (2014), the topic still lacks of robust stylized facts in the matter. Generally, it is possible to say that financial health improves the probability to start exporting, but this result is quite trivial by itself alone. Also, we believe that it is not financial health by itself that allows firms to successfully enter foreign markets, but rather a wise use of their financial resources that facilitate the expansion abroad.

1.5.3 HGFs in exporting markets

Despite the large amount of literature produced in the last decades on high-growth firms, there exist very few studies dealing explicitly with the export and internationalization modes of these firms. A very relevant analysis in this matter is the article by Brown and Mawson (2016), which tries to fill this gap by surveying the few instances in the literature and at the same time, investigating the internationalization mode of high-growth firms from Scotland.

The few existing evidences underline that high-growth firms tend to be significantly internationalized (Burgel, Fier, Licht, & Murray, 2000). Other evidences come from Hölzl (2014) that highlighted a strong correlation between exporting and being an high-growth firm.

As noted by Moreno and Coad (2015), in general terms, export and high-growth episodes are positively correlated; however, the magnitude and modes of this effect seem to depend significantly on the state of international market and the resources of the firm to reach markets away from home. This stylized fact is in line with Berman, Rebeyrol, and Vicard (2018) who analyze the demand learning in international markets on firm growth. Their results confirm that sales growth is positively affected by the entrance in external markets. However, sales growth decreases with the age of the firm in the market.

1.5.4 Conclusion

Exporting is a process that has been studied under a myriad of different perspectives. However, if from a macro perspective, data and studies are prominent, from a microeconomic one, analysis are still somehow behind. Focusing only on the firm-level evidences and theories, it is clear how firms joining international markets are yet another, possibly overlapping, class of super-firms. These firms show productivity levels bigger than they non-exporting counterparts. In order to achieve these levels, other than the development of the relevant, internal organizational routines, exporting firms also keep their dominant position thanks to continuous investment and innovation. On this, high-growth firms come in play because of their strong tendency to internationalize and to invest in R&D for innovation purposes, but empirical evidences

on them in an exporting context are still scarce.

1.6 Characterizing firms' R&D effort

Thanks to economic research and to the advent of endogenous growth models, technical and technological innovations were recognized to have a fundamental role in growth and development (Neef, 1998). Thus, firms and countries have started devoting attention to how this could be stimulated.

1.6.1 R&D as a measure of innovative input

The accounting item to which these investments refer is namely, research and development. At the beginning of the 1960s, starting from a document by Christopher Freeman and with the idea of standardizing definitions and data on research expenses, the OECD (Organization for Economic Development) has proposed the commonly-named "Frascati manual". Subject to frequent updates the last version was issued in 2015, and we find that "Research and Experimental Development comprise creative and systematic work in order to increase the stock of knowledge - including knowledge of humankind, culture and society - and to devise new applications of available knowledge". Further, the authors establish five core criteria for an activity to be an R&D one: 1) novel, 2) creative, 3) uncertain, 4) systematic, and 5) transferable.

One stylized fact about research and development is the high degree of concentration of its activities and investments. This is especially true for private business enterprises, where a relatively small number of firms compose the almost entirety of global expenditure in R&D. Following the Frascati manual, R&D activity is mainly measured by two factors: 1) the amount of money dedicated to it (R&D investment, henceforth), and 2) the number of employee dedicated to it (R&D personnel).

Table 1.1: Global Gross Expenditure on R&D by sector of performance (OECD, 2018)

2010				2015			
		in mln $	%			in mln $	%
Public	Government	179,349.6	14.0%	Public	Government	206,599.2	13.0%
	Higher Education	215,054.7	16.8%		Higher Education	234,468.3	14.7%
Private	Business enterprises	858,047.4	**67.1%**	Private	Business enterprises	1,122,228.3	**70.6%**
	Other	26,586.0	2.1%		Other	26,866.5	1.7%
Total		1,279,037.5	100.0%	Total		1,590,162.3	100.0%

All amounts are expressed in 2010, millions of US Dollars.

Finally, it is worth noticing the two main axes along which R&D can be classified. On the one hand, a possible dimension is the one shown in Table 1.1, which reports where the R&D money is spent, with a considerable dominance of the private sector. On the other hand, it is possible to split research and development expenditure between internal and external. Here, the major component, by far, is

obviously internal expenditure, which will also be the subject of analysis in Chapter 4. Still, external R&D is a non-negligible component as it measures also the extent of collaborations that innovative firms have in place.

1.6.2 R&D intensity determinants

Standard approaches would suggest managers and entrepreneurs to calibrate the R&D intensity of their firms according to an expected rate of return (Grabowski & Vernon, 1990; Griliches, 1980, 1985). Nevertheless, the intrinsic uncertainty and novelty of the research process make calculations based on returns on investment rarely true (Hall, Mairesse, & Mohnen, 2010). Consequently, how would profit-motivated agents decide how much resources allocate to this process? According to Dosi (1988), their commitment must be based upon two elements: the perception of opportunities, and the existing incentives (appropriability mechanisms, relative prices, market and broader socio-economic conditions).

Since clearly it is impossible to precisely account for this large degree of uncertainty and routinely assign it some value, firms are likely to work with quite general and event-independent rules, such as spending some given percentages of sales on research and development. Also, occasionally firms may come up with meta-rules that could react to unanticipated shocks on interest or profit rates by cutting specific ar-

eas of research (Dosi, 1988). This elaboration by the author is based upon both managerial evidence and findings of Griliches, Pakes, and Hall (1986), where the authors find evidences for representing firm-level R&D investment as a "martingale with a relative low variance".

If the above theorization holds as a general rule of thumb, then, on the margins also other, more precise factors come into play. For example, R&D subsidies are a tool largely applied by policymakers all around the globe, and that consists of offering financial support strictly aimed at fostering investment in the field of research. Nevertheless, such a policy instruments spurred a vigorous stream of debate between scholars hypothesizing crowding-in effects, as opposed to those trying to demonstrate the presence of crowding-out consequences due to these policies. The literature review in Chapter 4 analyzes the issue more specifically.

1.6.3 Conclusion

Measuring innovation inputs and outputs has been the main challenge for innovation scholars over the years. However, given the prominence of this aspect over the industrial and firm life cycle, the attempts to model it have never be abandoned and on the contrary, research on this is very active and flourishes. Identifying the sources of variation in R&D intensity is of key importance to appropriately design policies that are capable of stimulating this type of investment where

opportunities are high and for firms with the potential to contribute consistently.

1.7 Data-sources

Although only tangentially, both the introduction and this literature review have touched the topic of data, and their improvement over the years. Indeed, the quality and type of available data have been key driving criteria in building the research frameworks on which the next three chapters are built. This section presents what were the candidate sources of data for the current work and briefly elaborates on the reasons leading to the final choice.

1.7.1 Micro-aggregated databases

A small scale revolution in industrial studies was brought from micro-aggregated databases or more technically, distributed micro-data analysis. The meaning of the definition refers to the fact that this data is indeed derived from micro-level data, but for several reasons, it gets aggregated at sectoral level. The resulting output consists of each variable's distribution at sectoral level, leaving also the possibility to condition among variables.

The reasons behind aggregation are mostly two. On the one hand, the standardization of the cleaning and aggregation procedures allows

data to be perfectly comparable and harmonized across countries and time. On the other hand, the quality of this data derives from the fact that instead of being top-down and relying on several, often unspecified, procedures, it follows a bottom-up approach. By this, we mean that statistics are collected at the census level from each country's business register and to avoid direct identification, they clearly need to be grouped and become unidentifiable.

Once this is done, these data consist of a collection of all relevant variables' distributions and the associated moments, like means, variances, kurtosis and so on. Despite not being as flexible as micro data are, this approach is undoubtedly valid and can bring to interesting observations, as the ones in Bartelsman, Hagsten, and Polder (2018).

1.7.2 Firm-level data

Amadeus and derivations

Amadeus is a database developed by Bureau van Dijk containing detailed information about the whole universe of corporations in Europe. It is the European version of ORBIS, which has the target coverage of the whole world. There exist different versions of Amadeus that grant access to diverse numbers of firms, the one used here is the most comprehensive available.

The database comes with high cost of access and a debatable quality of both export procedure and outputs. Exporting data from Amadeus

is very cumbersome, as it imposes a maximum number of downloadable observations dependent on the number of requested variables. Thus, excluding the possibility of batch download, the researcher has to get the single files and then append everything.

Despite the above considerations, Amadeus has considerable potential for academic research that expresses itself particularly in terms of coverage, number of observations and inter-country comparability. For these and other reasons, it has been used in other peer-reviewed articles in economics. For instance, several authors have used it for analyzing the impact of different institutional environments on leverage or corporate performance from a micro-perspective (Brouthers, 2002; Weill, 2008). Other studies focused on the complex interplay between investment decisions and internal finance (Konings, Rizov, & Vandenbussche, 2003); while, still in the context of firm performances, but focusing on the impact of the Emission Trading Scheme, there is the work by Anger and Oberndorfer (2008). Finally, two compelling working papers by the National Bureau of Economic Research (Desai, Gompers, & Lerner, 2003; Klapper, Laeven, & Rajan, 2004) use this data to study in detail firm dynamics, capital constraints and institutions.

More recently, the database has been used as an "augmenting tool" for existing, usually cross-sectional database. An example of this practice is the EFIGE database, on which the analysis of Chapter 3 relies. The concept consists of collecting at firm-level either data or surveys

and then, using the firms' names or identification numbers, of expanding the information collected with standard, time-varying accounting data. Although more technical details will be given in the associated chapter, this procedure leads to quasi-panels, where a part of the data is longitudinal, while another part is cross-sectional. Based on the same data, we published an article in *Economics of Innovation and New Technologies* that investigates export-based learning mechanisms at European level (Segarra-Blasco et al., 2020).

CIS-based approaches, and PITEC

The other side of the coin are databases that follow the Community Innovation Survey (CIS) approach. Rather than the other side, these have been the first choice for many researchers and they have been driving European innovative studies for decades. Despite being almost all its versions exclusively in cross-sectional form, this survey has many perks that led scholars to relevant scientific findings.

Rather than an actual dataset, the Community Innovation Survey shall be seen more as a template to collect harmonizable data on industries and innovation. The project started in the early 1990s and then, it evolved in the largest innovation survey in the world on the basis of participating countries and number of enterprises (Arundel & Smith, 2013). In these three decades, CIS underwent many and significant changes. Being the first version, CIS1, very limited in both the

response rate and the contained variables, efforts were put to amend it. Particularly, confrontation with all the stakeholders (firms, scholars and policymakers) was pursued and led to a continuous renewal of the survey contents trying to amend previous drawbacks and to follow the new technological trends, while keeping the basic structure constant to allow for comparative analyses.

Despite the European breadth of the project, the CIS was not carried out in a centralized way, but it constituted the template for National Statistical Offices to be followed for their data collection regarding industries and innovations. The idea is simple, but very efficient. One prominent, national version of the CIS is the Spanish one, named Panel de Innovación Tecnológica (PITEC). While sharing all the perks coming from the standardization and the shared development of the survey items, this version has the notable perks of being longitudinal. This is also the source serving for Chapter 4.

1.7.3 Conclusion

A diversity of approaches characterizes data sources and careful considerations have to be made before selecting a database for an empirical exercise. For the sake of comparability, the use of the same data source across different exercises shall be favored. Nevertheless, this thesis adopts a different approach. First, some criteria were set as unavoidable. The firm, as unit of observation, was mandatory as

Table 1.2: The main advantages and disadvantages of the datasets under consideration

Dataset	Pros	Cons
Amadeus	numerousness of observations and international harmonization	reliability and accessibility
EFIGE	150+ survey questions on firms' internal organization	only a quasi-panel
PITEC	representativeness and time dimension	terminated
MMD	representativeness and geographical coverage	semi-aggregated

Source: own elaboration.

micro-aggregated data do not offer the same flexibility and richness in terms of modeling choices. The presence of the time dimension felt as a fundamental one, as largely explained in the above sections. Also, the possibility to focus on more than one country was pursued. On the one hand, this may have been problematic as bundling together firms from very different contexts may constitute a source of bias. However, on the other hand, this source of bias, once controlled for, constituted an additional source of variation, which could only make the empirical findings more sound and robust.

Table 1.2 recaps the main advantages and disadvantages that each of the datasets under consideration has. In this thesis, the aim is to strike a balance between representativeness, time-dimension and relevance of the data. For this reason, the choice to exclude the MMD database from the candidates, and to carry out the analyses on the remaining three, firm-level datasets. Finally, what we believe to be

the biggest obstacle that concerns our work, is the non-tracking of entry-exit dynamics. Indeed, exiting firms do not always disappear from the databases, but rather they are removed from it after some years of inactivity, making exits only imprecisely detectable.

Chapter 2

The long-term leverage-growth nexus: A quantile regression analysis of European manufacturing firms

Synopsis. Firm dynamics and financial constraints have been extensively studied; however, the relationship between firm leverage and its impact on growth remains still dusky. The aim of this chapter is to build on a comprehensive survey of the literature on the leverage-growth nexus at firm-level and bring its several implications to trial. Current theories and evidences would suggest a selection framework, where higher growing firms benefit more from long-term leverage, since

they are supposedly better equipped. The analysis considers manufacturing firms from France, Italy and Spain, observed from 2010 to 2016. The comparative perspective allows for the establishment of some common patterns in the way long-term leverage is related to firm growth. However, the main result is a negative one. Meaning that the hypothetical framework built on the literature is not reflected in our dynamic panel estimations. On the contrary, the only consistently positive effects emerge for the lowest-growing decile of the growth distribution.

2.1 Introduction

The interest for the finance–growth nexus has raised during the last decades. In general, the studies have analyzed the relationship between leverage regardless their maturity. However, the maturity of debt is a strategic characteristic that determines the investment pattern of firms (Dang, 2011). In particular, the recent economic crisis has raised the attention on a long-standing problem of European firms: access to external finance.[1] Consequently, rollover risk has increased after the crisis and firms have tended to counterbalance it by shortening their debt maturity (Choi, Hackbarth, & Zechner, 2018). However, this may erode the ability to invest and achieve the projected strategic plans (Almeida, Campello, Laranjeira, & Weisbenner, 2012; Faulkender & Petersen, 2006; Pál & Ferrando, 2010).

The global crisis also brought consequences on firms' growth. For instance, Bottazzi, Secchi, and Tamagni (2014) observed an asymmetric impact of financial constraints over the firm growth distribution. The authors point out the existence of a potential "loss effect" for low-growing firms, as opposed to a "pinioning effect" for high-growth firms.

[1] The incidence of the crisis is multiple on the financial and investment capacity of firms. First, financial institutions restricted the financial leeks to the productive system during the crisis (D'Aurizio, Oliviero, & Romano, 2015; di Patti & Sette, 2016). Second, the demand crisis caused an asymmetric decrease of the expected profits of firms which decrease firms' investments projects and their financial needs (Claessens, Tong, & Wei, 2012; Makkonen, Pohjola, Olkkonen, & Koponen, 2014; Pradhan, 2011). Third, differences of financial institutions and restrictions during the last financial crisis have generated credit rationing stemming from a more caution behavior of banks (Gaiotti, 2013; Kremp & Sevestre, 2013).

Additionally, this heterogeneous behavior depends also on the institutional framework at country level (Bravo-Biosca, Criscuolo, & Menon, 2016) and the different incidence of economic crises at country level. Therefore, it is relevant to analyze the relationship between long-term leverage and firm growth after the crisis since the financial crisis has affected the access of firms to financial resources and also their capacity to convert them into growth.

This paper characterizes the relationship between long-term leverage (henceforth LTleverage) and firm growth of manufacturing companies across France, Italy and Spain. Based on a comprehensive survey of the literature, we hypothesize the existence of a selection mechanism that may explain the firm growth and leverage nexus, and that may act with monotonically increasing benefit to high-growing firms. The data is harmonized and retrieved from BvD-Amadeus database for the period 2010-2016.

Applying Powell (2016) quantile panel estimator, we establish robust associational links between our leverage variable and firm growth, as proxied by sales or labor productivity growth. The empirical findings show that this nexus is subject to many non-linearities across the growth distributions. Only few stable trends could be detected. Undoubtedly, low-growth firms' profile shows considerable reliance on LTleverage, which contributes positively to growth. Further, in the majority of estimations, this positive effect is present for some central deciles of the growth distributions, and vanishes or become negative

for the right-tails.

The contributions are several and of different nature. First, the attempt is to systematize the existing knowledge on the leverage-growth nexus at firm-level. Indeed, the effort on this narrow topic has been large and also are the associated theories and evidences. Second, building on this, we bring at trial an hypothetical framework, where the relation across quantile is increasing, meaning that high-growing firms have a stronger positive association to long-term leverage. On this, the result is a negative one, in the sense that our findings do not show evidences of the selection effect, and if anything, they point to an opposite scenario. Finally, we emphasize the lack of study characterizing this nexus for different firm growth classes.

Although unexpected, the results can be interpreted insightfully from an economic standpoint. Indeed, low-growth firms are intrinsically in need of growth-enhancing resources to broaden their strategic moves, and they find it in LTleverage. However, this strategy seems not to work equally for high-growth firms, whose projects and financial needs are likely to be more complex and diversified. Further, we stress that the comparative perspective does not chase explanation, but rather the mere establishment of common associative patterns across different countries. The heterogeneity of the results is itself a relevant contribution, as it highlights the complexity of the studied relationship and the inapplicability of one-fits-all explanations.

The structure of the chapter is the following. The second section

reviews the literature on leverage and firm growth. The third section presents our dataset and a preliminary exploration of the available data. The fourth section our econometric methodology. The fifth section discusses the main empirical results. The final section highlights the main conclusions and suggests further research.

2.2 Literature Review

The aim of the section is to present the existing theories and evidences on the LTleverage-growth nexus at firm-level. On the one hand, it is clear that access to finance affects firm growth and profitability by facilitating capital accumulation Lee (2014). On the other hand, these processes may be highly non-linear and largely depending on the growth performance itself.

2.2.1 The disjunction between long-term and short-term debt

The vast literature on the decision of the financial structure has pointed out the access to external funds as a key determinant of firms' ability to invest and differentiate their funding sources for expansion (Almeida et al., 2012; Faulkender & Petersen, 2006; Pál & Ferrando, 2010). In this process, firms face a disjunction between financing with short-term or long-term funds (Johnson, 2003).

On the one hand, the access to long-term debt may allow existing firms to grow faster due to a larger capacity to finance productive investments. First, long-term debt is more desirable as it diminishes the refinancing risk and the firm-level economic volatility (Demirgüç-Kunt, Horváth, & Huizinga, 2017)[2] since firms are likely to plan better their investment opportunities. Second, long-term debt has lower flotation (Lee, Lochhead, Ritter, & Zhao, 1996) and illiquidity costs (Longstaff, Mithal, & Neis, 2005). Finally, the type of debt shapes managers' incentives and affects the expansion patterns of firms (Jensen, 1986; Molinari, 2013; Molinari, Giannangeli, & Fagiolo, 2016). Under these arguments, short-term debt is a relatively "blind" and volatile strategy for firms (Diamond & He, 2014; Schiantarelli & Sembenelli, 1997).

On the other hand, Lang, Ofek, and Stulz (1996) found that long-term debt affects negatively to firms whose growth opportunities are either not recognized by the capital markets due to informational asymmetries or to those firms that do not have good investment opportunities, but might want to grow anyway. Additionally, firms may prefer having many short-term debts with small amounts in order to avoid rollover risk (Johnson, 2003). This point is particularly interesting in a period of time where financial markets are reluctant to borrow long-term debt which increases the rollover risk (Choi et al., 2018). Finally, firms show a certain persistence since the maturity of newly issued

[2]Demirgüç-Kunt et al. (2017) find that limited access to long-term debt induces avoidance of investment in long-term projects, resulting in volatile firm growth.

debt is influenced by pre-existing maturity profiles (Choi et al., 2018) and their cash-flow realizations (DeMarzo & Fishman, 2007).

In order to account for the level of the indebtedness of the company, the literature has used the ratio of long-term debt over total assets (see for instance, Guariglia, Liu, and Song (2011); Huynh and Petrunia (2010); Lang et al. (1996); Molinari (2013); Oliveira and Fortunato (2008). The relation between long-term debt and assets reflects the equilibrium between financial and investment decisions. This is an important point since the interaction between the evolution of the long-term debt and the value of the assets may generate different impacts. For instance, Dang (2011) investigates the effects of growth opportunities on leverage and debt maturity as well as the effects of these financing decisions on firm investment. His results show complex interactions, where UK high-growth firms react to underinvestment incentives by reducing leverage but not by shortening debt maturity.

2.2.2 The effect on productivity and sales growth

The relationship between long-term leverage and firm growth may be difficult to determine given the multidimensional nature of both variables. When appraising the nexus between leverage and firm growth, most of the literature focuses on financial growth indicators (e.g. market versus book value, profitability or Tobin's q), instead, to maintain the link with the firm growth literature, we choose the following.

The growth indicators under analysis are sales and labor productivity growth. On the one hand, this ensures comparability with the majority of the existing results. On the other hand, these two measurements are often targets in firms' management. Further, as pointed out by Cooley and Quadrini (2001) referring to firms' debt dynamics, "more debt allows them to expand the production scale and increase their expected profits".

Concerning sales growth, financial structures characterized by long-term leverage can ensure the accomplishment of the desired expansion plans (Almeida et al., 2012; Faulkender & Petersen, 2006; Pál & Ferrando, 2010). Therefore, long-term leverage may induce managers and shareholders to pursue empire building tendencies which will foster subsequent sales growth. Previous evidence on the sales growth association to leverage are found in Huynh and Petrunia (2010). The authors also show that the sensitivity is higher for firms with low or intermediate levels of leverage.

However, a higher long-term leverage may also lower sales growth. First, one potential reason under this behavior is that managers will limit their expansionary ambitions. Second, Singh and Faircloth (2005) find a negative impact of debt on future growth opportunities because of the negative effect that it has on investment in R&D. The justification under this behavior is that R&D is a process starred with uncertainty, and fueling it with long-term leverage is not the wisest of the ideas. Therefore, those projects with a certain high-risk will not

be carried out by the companies. However, Billett, King, and Mauer (2007) find that leverage and growth opportunities are significantly attenuated by covenant protection, suggesting that covenants can mitigate the agency costs of debt for high growth firms. Further, the majority of existing empirical evidences suggest a positive impact of LTleverage on sales growth (Honjo & Harada, 2006; Molinari, 2013; Rahaman, 2011).

Concerning productivity growth, firms that invest in R&D projects, characterized by high potential productivity growth, are more prone to suffer from financial barriers than their counterparts (García-Quevedo, Segarra-Blasco, & Teruel, 2018; Hottenrott & Peters, 2011; Mina, Lahr, & Hughes, 2013) and particularly long-term debt (Jensen & Meckling, 1976; Myers, 1984). Because R&D is positively related to productivity, then the relationship between productivity and long-term leverage is expected to be negative. Fear of liquidation may induce firms not to choose investment projects characterized by greater returns in the long-term. Similarly, more productive equipment, machineries and technologies might not be acquired and adopted, unless they provide an immediate payoff. Consequently, firms will overcome the shortening of the investment horizon by having access to leverage with longer maturity. Finally, firms' leverage is likely to bring further growth phenomena via the financial pressure channel. Nickell et al. (1997) and Nickell and Nicolitsas (1999) showed that leveraged positions can be positively associated with productivity growth, suggesting that lever-

Table 2.1: Summary of the literature review on the leverage-growth nexus

Reference	Methodological choices	Sign of the estimated relation
Leverage impact on sales growth		
Honjo and Harada (2006)	Long-term debt ratio to total assets	(+)
Huynh and Petrunia (2010)	Debt-to-asset ratio	(+)
Rahaman (2011)	Long-term debt ratio to total assets	(+)
Molinari (2013)	Leverage modeled with a quadratic term	non-linear
Leverage impact on productivity growth		
Nickell, Nicolitsas, and Dryden (1997)	Interest paid over labor productivity	(+)
Nickell and Nicolitsas (1999)	Interest paid over labor productivity	(+)
Nunes, Sequeira, and Serrasqueiro (2007)	Total liabilities ratio over labor productivity	(-)
Weill (2008)	Total liabilities ratio over cost efficiency	country-dependent
Coricelli, Driffield, Pal, and Roland (2012)	Total debt ratio impact on TFP growth	non-linear
Avarmaa, Hazak, and Männasoo (2013)	Long-term leverage and total debt over labor productivity	(-)

Source: own elaboration

age can lead to a quasi-competition effect.

Conversely, in line with Demirgüç-Kunt et al. (2017), a lower long-term leverage could also be associated with a negative impact on productivity growth. The main argument is that long-term debt is associated with an increase of the inefficiency because of the increase in wasteful activities by managers. This is also in line with the evidences by Coricelli et al. (2012) and Avarmaa et al. (2013), who find that excessive leverage hurts productivity growth.

This positive association between lack of access to long-term debt and firm performance is supported by authors such as Dinlersoz, Kalemli-Ozcan, Hyatt, and Penciakova (2018) who find that more productive firms have higher short-term leverage. Finally, Nunes et al. (2007) show for Portuguese firms a generally negative impact of leverage on labor productivity, but positive for higher productivity firms.

Concluding this review section, summarized in Table 2.1, it shall be clear that the current evidences point at sometimes contrasting results, which are probably due to differences in sample composition and to estimation choices focusing on specific points of the growth distributions. In contrast, our research question is the following:

RQ1: The LTleverage-growth nexus is highly heterogeneous on the firm growth distribution, independently of growth indicator.

2.2.3 The heterogeneous impact of long-term leverage on firm growth

At theoretical level, the "selection effect" through which the fitter firms are in a better position to successfully expand their operations (Nelson & Winter, 1982) is an approximation of the fact that firms may not be able to overcome certain pressure and rigidities derived from their strategy and their external restrictions. The theory of fitter firms would imply that poorly-performing firms are unlikely to recognize highly profitable investment opportunities, while successful firms are in a better position to recognize and appropriate them. Furthermore, presumably, low-performing firms are supposed to lack the cognitive and managerial abilities to point at high returns from investment (Dosi, Faillo, & Marengo, 2008).

Following the "selection effect" concept, firms have heterogeneous "leverage capacities" depending on their idiosyncratic firms' abilities. The argument is based on the different capacity that firms have to obtain economic returns from their leverage. For instance, Aivazian, Ge, and Qiu (2005) found that Canadian firms with lower growth opportunities are more negatively affected by leverage than the "fitter" others. Similarly, Bottazzi et al. (2014) point out the existence of a potential "loss effect" for low-growing firms, as opposed to a "pinioning effect" for high-growth firms. This positive association between leverage and firm growth has been also analyzed by Guariglia et al. (2011) for Chi-

nese firms. More recently, Molinari et al. (2016) find that the relation amongst financial variables and growth is not constant across the firm growth distribution. In particular, high-growth firms heavily rely on external debt. Their results are in line with Fazzari, Hubbard, and Petersen (1996), who acknowledge that high-growth firms will have a greater demand for finance.[3]

In this framework, fitter firms may be in advantage since they will use long-term financial resources on firm growth by investing in more productive projects or in niche markets with higher potential growth. Therefore, our second hypothesis is the following:

RQ2: High-growth firms are able to benefit more from long-term leverage, if compared to less growing firms.

[3]A final point to be stand out is that commonly, high-growth firms has been associated with technological firms. However, it is well-known (see the survey of Brown, Mawson, and Mason (2017)), high-growth firms are present in all sectors. In fact firms, in technological sectors may suffer of more information asymmetries and as a result their risk increases and their financial constraints (Beck et al., 2005; Beck & Demirguc-Kunt, 2006; Binks & Ennew, 1996; Nitani & Riding, 2013). Colla, Ippolito, and Li (2013) find that firms with high growth opportunities and R&D expenses specialize in few types of debt, while profitable firms with more tangible assets, high leverage, and use multiple sources.

2.3 Data and statistics

2.3.1 Data Source

The data comes from the Amadeus database, a pan-European dataset compiled by Bureau van Dijk and it provides data on financial and productive activities for public or private and domestic and international companies. One advantage of focusing on European countries is that company reporting is regulatory (Gopinath, Kalemli-Özcan, Karabarbounis, & Villegas-Sanchez, 2017). Hence, this data source provides information about financial accounting from detailed harmonized balance sheets, income statements, profits or taxes obtained by the companies. Moreover, this data source offers complementary information on the headquarters location and year foundation of the companies.

Unfortunately, the data requires considerable attention when dealing with it. The main weakness is the incompleteness of some variables. These are not always reported consistently throughout time (see Kalemli-Ozcan, Sorensen, Volosovych, and Yesiltas (2015)). Further, the nature of the data does not allow to track the life-cycle of firms; for this reason and to avoid possible biases, we only consider incumbent firms that are stably present across the period under consideration[4].

Following previous peer-reviewed studies using the same data (Brouthers,

[4]Ideally, one would have also information on firms' death in order to clean the results from the so-called survivorship bias. However, being this information unreliable in the Amadeus repository, we preferred to focus only on incumbent firms, keeping in mind the reduced external validity induced by the choice.

2002; Desai et al., 2003; Klapper et al., 2004; Konings et al., 2003; Weill, 2008), we apply several refinements. First, we remove the observations reporting equal sales and employment growth rates for the same year, given the unlikelihood of these two events (Duschl, 2016). Second, we remove observations that report a year of birth earlier than 1800 and later than 2016. Third, we considered winsoring for the triplet sector, year, country at the 5-th percentile level on the extrema in order to avoid considering possible episodes of inorganic growth[5]. Additionally, to avoid the bias that the often erratic growth path of micro-firms would induce, we put a minimum threshold on three employees [6] (Coad, 2009; Duschl, 2016). To ensure the arbitrarity of this choice does not affect our results, we move the threshold without seeing our results significantly affected. Finally, in order to enlarge the range of possible techniques used and in line with the exclusion of life-cycle properties of the firms as mentioned above, we balance the panel. This operation entailed a moderate loss of observations, while improving the quality of our estimates considerably.

[5]At the expense of sacrificing possible truly extreme growth performances, the exclusion of inorganic growth events is key to avoid possible biases in our estimation framework.

[6]In addition, this criterion gets rid of phantom companies, mostly existing for tax purposes.

2.3.2 Countries and period

We select firms from France, Italy and Spain between 2010 and 2016. The main reason why we chose these three countries and this time period is by nature multi-dimensional. Being the objective the establishment of empirical regularities, the diverse nature of these countries has been a pushing factor. The non-symmetric reaction to the crisis would make possible cross-country, robust findings even stronger. Finally, from a preliminary exploration of the data, it is undeniable that for these three countries, there exists significantly better quality firm-level reports.

A comparison of the banking systems under consideration fortifies the motivations for the countries' choice. Spain and Italy represent the so-called "stressed" economies in the European Union, while France is the benchmark economy. Indeed, differently from German and French banks, Spanish and Italian banks are heavily exposed to the traditional intermediation business, albeit with a substantial loan-to-deposit gap (Sola & Ruiz, 2015). Indeed, the majority of the Spanish and Italian banks appear very similar. They tend to be strongly biased towards financial intermediation, they share similar risk profiles and are marked by a gap between loans and deposits. In contrast, this traditional intermediation approach holds much less weight in France and Germany, where banks' strategies are more heavily dominated by capital markets and investment banking activities.

Further, as financing constraints would inevitably hinder an estimation exercise as the present one, we needed to have that the countries under consideration do not show substantial differences in the level of financially-constrained firms. Although subject to regional specificities, this does not seem to be a problem for the countries under consideration (Bank, 2016).

Finally, the time window follows the 2007 financial crisis. During this period, financial constraints have largely increased for firms (especially for smaller ones) and we suppose that this put pressure on firms in selecting and putting at use their leverage resources. Also, although we expect to see emerging similar patterns in the shape of the leverage impact, this empirical setting allows to take a glimpse at the different ways the country dimension influenced the response to the crisis.

2.3.3 Coverage analysis

In Table 2.2 and 2.3, with the aim of appraising the external validity of our study, we analyze the coverage of our data with the respect to the population of reference. In order to do so, we recover data for all European manufacturing firms at country-level from the Office for Structural Business Statistics. Then, we compare the sample and the population in terms of key variables such as turnover and number of enterprises both at the beginning and at the end of our period of observation (2009-2015), classifying firms according to the number of

employees.

Table 2.2: Coverage analysis for the first year in the sample - 2009

		Relative number of firms			Relative turnover		
	Size class	FR	IT	ES	FR	IT	ES
Amadeus	4-19	33.86%	41.62%	63.25%	0.49%	4.32%	3.10%
	20-249	56.18%	53.41%	33.40%	6.96%	27.18%	22.76%
	250+	9.97%	4.97%	3.35%	92.33%	68.51%	74.14%
SBS	1-19	91.52%	92.67%	90.82%	11.3%	21.0%	13.7%
	20-249	7.76%	7.02%	8.75%	28.0%	40.1%	36.4%
	250+	0.72%	0.31%	0.44%	60.7%	38.9%	49.9%

Source: own elaboration of data from Amadeus and SBS.

From the comparison, it emerges a decent coverage, especially if compared to the vast majority of the studies on these topics. The sample distribution inevitably shows some differences, as in the cleaning process of our data a minimum threshold of more than three employees for a firm was imposed.

Table 2.3: Coverage analysis for the last year in the sample - 2016

		Relative number of firms			Relative turnover		
	Size class	FR	IT	ES	FR	IT	ES
Amadeus	4-19	27.25%	42.28%	52.91%	0.46%	4.57%	2.58%
	20-249	59.21%	54.04%	42.64%	7.04%	35.79%	26.78%
	250+	13.55%	3.68%	4.46%	92.50%	59.64%	70.64%
SBS	1-19	92.45%	92.54%	90.64%	9.58%	10.49%	11.61%
	20-249	6.92%	7.14%	8.88%	25.99%	45.69%	36.50%
	250+	0.63%	0.32%	0.48%	64.44%	43.82%	51.89%

Source: own elaboration of data from Amadeus and SBS.

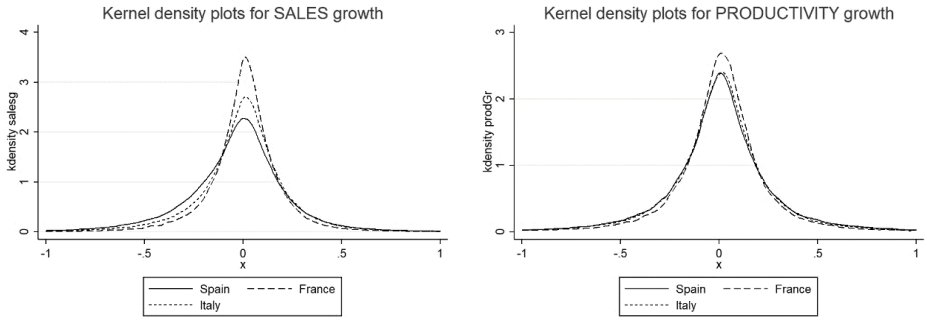
Consequently, the class of micro and small firms is relatively under-represented with respect to the real population. This could hinder the validity of our estimates in standard estimation settings, but quantile regression alleviates this bias. Following the refinements outlined in the previous section, we obtain a sample of manufacturing firms for France, Italy and Spain containing respectively, 11,443, 103,503, and 54,161 observations for the period 2010-2016.

2.3.4 Descriptive statistics

With the final aim of keeping this analysis the most agnostic and clear possible, we isolated a limited set of variables whose interactions have shown empirically to most strongly influence firms' performance. In particular, we include the following variables: total assets, long-term debt, employment, sales, age, and added value. From this, we compute labor productivity as the ratio between value added and the number of employees in the firm, and the long-term leverage (LTleverage) computed as long-term debt over total assets.

In line with Bottazzi and Secchi (2006), the distributions appears fat-tailed and following an asymmetric exponential distribution. Specifically, Spanish and Italian sales growth distributions are more skewed on the left-tail, in line with the actual industrial trend of the three countries under consideration. Still confirming the existing stylized facts, we observe that the growth rate distributions are 'tent-shaped',

Figure 2.1: Kernel density estimates for the firm growth distribution (FGD) of Spanish, Italian and French manufacturing firms.



Note: The kernel density is estimated with an Epanenchnikov kernel bandwidth equal to 0.5. Source: own elaboration from Amadeus database

indicating that most firms have growth rates close to zero while a non-negligible proportion of firms experience rapid growth or decline.

Table 2.4 presents the descriptive statistics for all the variables included. As we can see, at aggregate level, Spanish firms are smaller and more leveraged than their counterparts. It also emerges how the French sample likely includes some considerably big firms, which biases the mean levels of sales and assets, but not their median. Finally, the LTholders ratio, corresponding to the percentage of firms holding LTleverage, is not characterized by excessive zeroes and quite homogeneous across countries. As a preliminary step, we analyze first the shape of the firm growth distribution for productivity and sales overlaid by country (Figure 2.1).

To analyze the degree of heterogeneity in the use of long-term debt across the firm growth distributions we provide more fine-grained statistics relating our main variables of interest. Particularly, Table 2.5

Table 2.4: Descriptive Statistics (2010-2016)

	Country								
	Spain			France			Italy		
	mean	median	sd	mean	median	sd	mean	median	sd
Sales growth	0.01	0.02	0.25	0.03	0.03	0.18	0.03	0.03	0.24
Sales level	29728	1828	432237	193435	6859	3036783	34133	5654	888266
Productivity level	55.98	40.16	239.37	67.61	55.27	77.25	69.17	56.52	310.94
Productivity growth	0.02	0.01	0.36	0.02	0.02	0.34	0.02	0.02	0.35
Long-term debt	6511	193	104877	58361	159	1436712	5267	430	185131
Assets	31881	1674	400324	351878	4586	7814629	40555	6168	1204361
LTleverage	0.19	0.13	0.19	0.08	0.04	0.16	0.11	0.08	0.10
LTholders	0.95	1.00	0.23	0.89	1.00	0.31	0.88	1.00	0.32
Age	34.51	32.00	12.33	41.97	38.00	15.77	39.79	38.00	14.55

Note: the variables Sales, LTD and Total Assets are expressed in thousands Euros, Age in years, and Labor productivity in thousand Euros per employee. LTholders corresponds to the percentage of firms holding a value of LTleverage different from zero. Source: own elaboration from Amadeus

below reports the value of long-term leverage for firms across deciles of both the productivity and the sales growth distributions.

Table 2.5: The heterogeneity of LTleverage across the growth distributions

	LTleverage					
	across sales growth deciles			across productivity growth deciles		
Decile	mean	median	s.d.	mean	median	s.d.
0.1	0.156	0.101	0.176	0.147	0.095	0.168
0.2	0.137	0.091	0.155	0.134	0.090	0.149
0.3	0.130	0.090	0.142	0.129	0.090	0.137
0.4	0.126	0.089	0.135	0.129	0.091	0.137
0.5	0.125	0.087	0.133	0.125	0.091	0.128
0.6	0.126	0.088	0.138	0.124	0.089	0.129
0.7	0.124	0.088	0.167	0.125	0.088	0.131
0.8	0.126	0.088	0.135	0.127	0.087	0.172
0.9	0.129	0.088	0.141	0.128	0.086	0.148
1	0.133	0.088	0.148	0.143	0.088	0.169

Source: own elaboration from Amadeus database.

From this table, two facts emerge. First, the difference between mean and median values points at a considerably skewed nature of LTleverage, across all deciles. Secondly, the relationship is weakly U-shaped, signaling that independently of size, firms in the tails of the growth distributions tend to be more leveraged than central ones. Finally, the lowest growing firms, according to both indicator, are significantly more leveraged than the rest of the distribution. This hints at major needs of low-growth firms, or at least, at the fact that these firms prefer LTleverage as a way to raise finance.

2.4 Econometric approach

Also for the sake of comparability, we strive to keep the model as simple as possible. In order to estimate the impact of leverage on productivity and sales growth, we estimate the following base growth models:

$$\Delta log(Sales)_{i,t} = \beta_{10} + \beta_{11}\Delta log(Sales)_{i,t-1} + \beta_{12} log(Sales)_{i,t-1} + \\ + \beta_{13} log(Age)_{i,t} + \beta_{14} log(Age)^2_{i,t} + \beta_{15} log(LTleverage)_{i,t-1} + \varepsilon_{1,it} \tag{2.1}$$

$$\Delta log(Prod)_{i,t} = \beta_{10} + \beta_{11}\Delta log(Prod)_{i,t-1} + \beta_{12} log(Prod)_{i,t-1} + \\ + \beta_{13} log(Age)_{i,t} + \beta_{14} log(Age)^2_{i,t} + \beta_{15} log(LTleverage)_{i,t-1} + \varepsilon_{1,it} \tag{2.2}$$

Where β_i are the coefficients and $\epsilon_(it)$ is the usual error term of firm i at time t. In this analysis, the two dependent variables are the growth of sales ($\Delta log(Sales)$) and of productivity ($\Delta log(Prod)$). Annual firm growth rates are calculated in the usual way by taking log-differences of size (e.g. Coad and Hölzl (2009); Törnqvist, Vartia, and Vartia (1985)). Our key explanatory variable is leverage, or $log(LTleverage)_{t-1}$, that captures the use of long-term debt and its relation with firm performance controlling for the magnitude of firms' assets. The remaining explanatory variables follow from previous work

on the determinants of firm growth (see Coad (2009) for a survey) and of capital structure (Coleman (2006); Giannetti (2016), hence we include the lagged value of the firm sales (*log(Sales)*) or firm productivity (*log(Prod)*), the logarithmic firm age and its squared value, *log(Age)* and $log(Age)^2$. Controlling for firm past performance and age allows us to obtain cleaner estimates, as these two variables have proven to be very influencing for firm growth itself, but also for their relation with leverage.

Given the nature of our research questions and the econometric specification, we apply Powell (2016) quantile panel data estimator.[7] The author proposed a fixed-effect, non-additive panel estimator that through an alternative way to model the disturbance term is proved to be more consistent for small T and more accommodating with heterogeneous samples. This alternative estimator exploits GMM-type of estimation trying to overcome a possible problem in the derivation of fixed effects in typical quantile, panel fixed effects framework. If with the typical estimation procedure, we obtain estimates of the distribution $Y_{it} - \alpha_{it}|D$; following Powell (2016), we estimate for $Y_{it}|D_{it}$, where D is the set of explanatory variables, while α is the typical fixed effect.

Quantile regression has been frequently applied to analyze issues related to the distribution of firm growth (Bartelsman, Dobbelaere,

[7]The quantile regression estimator was originally designed for the analysis of cross-sectional datasets (Koenker & Bassett, 1978), but it has seen many developments.

& Peters, 2014; Capasso, Treibich, & Verspagen, 2015; Coad & Rao, 2006, 2008; Coad, Segarra-Blasco, & Teruel, 2016; Falk, 2012; Hölzl, 2009; Kaiser, 2009; Mata & Woerter, 2013; Mazzucato & Parris, 2015; Segarra-Blasco & Teruel, 2011).

The reasons why we apply quantile regression and why it is preferable to the more usual regression methods are both conceptual and technical. Conceptually, we are not interested in the behavior of the average firms, which tend to either do not grow or grow very little, but rather in the heterogeneous behavior of firms alongside the major points of the growth distribution. Technically, there is a number of reasons why in the field of firm growth studies, results estimated with quantile regression techniques are more informative. For instance, as shown in Figure 2.1, the firm growth distribution shows heavy tails and instead of being Gaussian, it is closer to an exponential distribution. On the same wave, deviating from normality also impacts the optimal properties of standard regressions, while quantile ones are robust to both outliers and heavy-tails (Buchinsky, 1994).

Consequently, the estimator of choice shall tackle the so-called Nickell's bias (1981), proper of dynamic models, and at the same time give the possibility to unbiasedly estimate effects across the distribution. Two natural solutions would be following either the GMM approach (Arellano & Bond, 1991) or the IV approach (pioneered by Anderson and Hsiao (1982) and expanded to this context by Galvao Jr (2011)). Our estimator of choice, Powell (2016), is on the line of the second

approach. Powell's method has several perks in this context. First, it is one of the few quantile panel data estimator that allows the use of instrumental variables. Also, it permits the instruments to be correlated with the estimated fixed effects and at the same time, it outputs estimates that can be interpreted as cross-sectional results, contrary to other quantile panel data estimators.

Finally, we want to address at least partially, the possible endogeneity concern that may arise from this estimation. Although it cannot be ruled out completely, we deal with it using many precautions and post-estimation checks. In terms of precaution, we include time lagged variables that are particularly helpful in this kind of estimation (Galvao Jr, 2011) and thanks to the fixed effect estimation, we control for potentially, time-invariant confounding variables. For robustness sake, we run also the same estimations as in Equations 2.1 and 2.2, but instrumenting either for lagged growth or lagged levels with an additional lag.

Concluding, endogeneity between firm growth and leverage is something to bear in mind, and it does not allow us to make any casual claim, but instead we merely want to identify the associative relationship between these two important variables for industrial dynamics.

2.5 Results

Tables 2.6 and 2.7 report the estimations of the base model for two different performance indicators: sales and productivity growth. For the sake of brevity, we only focus on our main variable of study: LTleverage.

Table 2.6: LTleverage coefficients estimates on sales growth – Base model – no instruments

Decile	France	Italy	Spain
0.1	0.0233 (0.0198)	0.244*** (0.0255)	0.0699*** (0.0064)
0.2	0.0061 (0.0061)	-0.0309*** (0.0023)	0.0487*** (0.0038)
0.3	-0.0044** (0.0020)	-0.0109*** (0.0010)	-0.145*** (0.012)
0.4	0.0084*** (0.0032)	-0.0018** (0.0009)	-0.0020 (0.0050)
0.5	0.0107*** (0.0016)	0.0443*** (0.0035)	0.0614*** (0.0041)
0.6	-0.0204 (0.0152)	0.0119** (0.0050)	0.0086*** (0.0027)
0.7	-0.0152 (0.130)	-0.0169** (0.0071)	-0.0037* (0.0021)
0.8	-0.0220*** (0.0074)	-0.117*** (0.0072)	0.0086*** (0.0020)
0.9	-0.0043 (0.0046)	0.0003 (0.0026)	0.0036 (0.0035)

Number of observations: France (2,348), Italy (17,955) and Spain (8,626) observed over seven years. Significance levels corresponding to * $p<0.1$, ** $p<0.05$, *** $p<0.01$. A constant term and other variables, such as age and age squared, and lagged sales are included in each regression but not reported here. Standard errors in parentheses.

In particular, the vast majority of the results emerges as a consequence of the chosen estimation technique, quantile regression, and thanks to the introduction of non-additive fixed effects, we obtain directly interpretable estimations.

Table 2.7: LTleverage coefficients estimates on productivity growth – Base model – no instruments

Decile	France	Italy	Spain
0.1	0.0089 (0.0145)	0.270*** (0.0238)	0.202*** (0.0328)
0.2	0.0060 (0.0075)	0.183*** (0.0171)	0.462*** (0.0393)
0.3	0.0002 (0.0032)	-0.0472*** (0.0050)	-0.0087*** (0.0017)
0.4	-0.0306*** (0.0054)	-0.0278*** (0.0012)	-0.0239*** (0.0017)
0.5	0.0049 (0.0033)	0.0544*** (0.0025)	0.0257 (0.0221)
0.6	-0.0328*** (0.0046)	0.0204*** (0.0033)	0.0881*** (0.0080)
0.7	-0.0153*** (0.0056)	0.0189*** (0.0017)	0.0326*** (0.0031)
0.8	-0.0372 (0.0318)	-0.0546*** (0.0032)	-0.0641*** (0.0055)
0.9	0.0190 (0.0750)	-0.0008 (0.0031)	0.0026 (0.0050)

Note: see above the note for Table 2.6.

2.5.1 Leverage and its conditional impact on growth

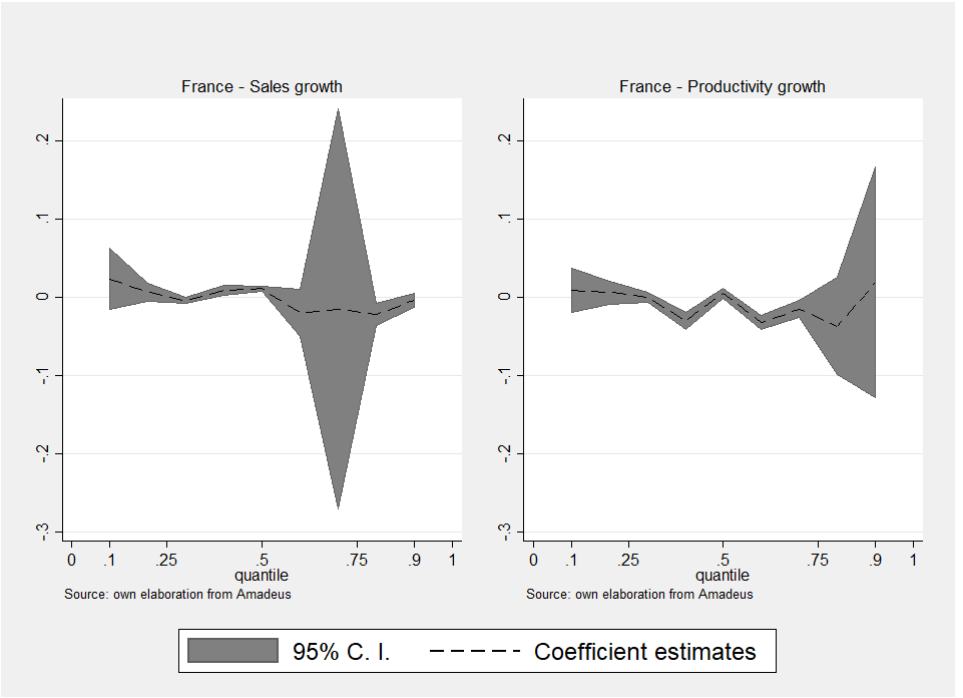
Graph 2.6 in the Appendix compares all the coefficient estimates obtained. It highlights a high degree of heterogeneity of the LTleverage-growth nexus across quantiles and countries. Despite coefficients for Spain and Italy showing some similarities, non-linear behavior characterizes strongly this relation.

Before starting, we clarify that the country dimension is introduced with the aim of establishing empirical regularities for the LTleverage-growth nexus. Thus, we do not seek explanations of each emerging difference, which would be impossible with this limited set of variables. Contrarily, the study focuses on detecting similarities, as candidate stylized facts. Below, we interpret the results country-by-country.

The French case is the least insightful of the three cases under con-

sideration. As it emerges from Figure 2.2, most of the estimated coefficients are very close to zero, subject to considerable variability, and rarely significant, especially for the sales growth distribution. When significant, LTleverage has a mixed impact on sales growth, while it is negative impact for productivity growth.

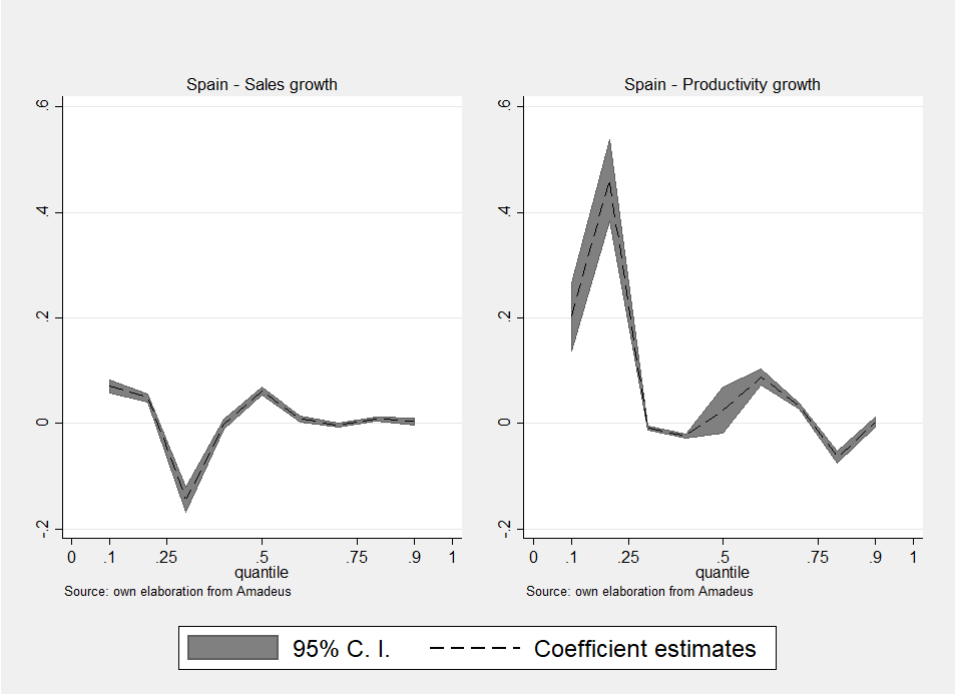
Figure 2.2: Plots of LTleverage coefficients for France, both growth indicators.



However, the impact on sales growth follows a reverse U-shape, centered on the median, while for productivity the effects are concentrated in the right-half of the distribution. These first evidences already question the existence of a clear-cut relationship between LTleverage and

any of our two growth indicators of choice. In terms of magnitude, the elasticities vary in a limited range, between 0.0044 and 0.0328 in absolute values, showing limited impact for the French firms sample.

Figure 2.3: Plots of LTleverage coefficients for Spain, both growth indicators.

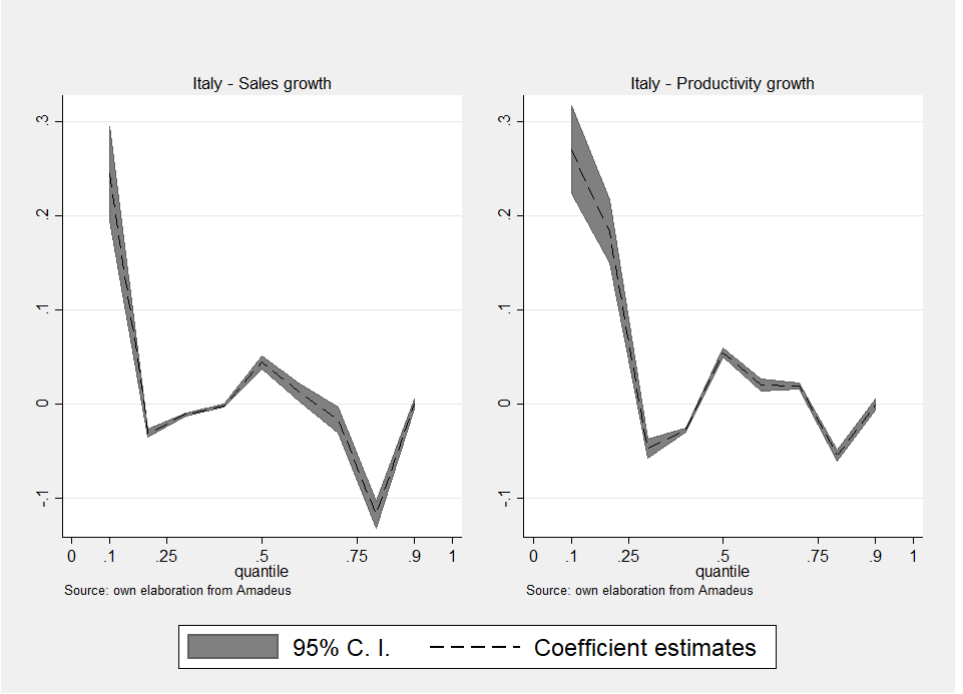


The situation regarding Spanish firms is richer in terms of shape and quite different across growth indicator. For sales growth, the relationship is strongly U-shaped, with a minimum of -0.145, for firms in the third decile of the sales growth distribution. This is proof of a strong adverse effect for firms adopting LTleverage in that group. Nevertheless, the remaining effects on the sales distribution are posi-

tive and start to vanish on the right-tail.

For productivity, strong positive effects are evident in the left-tail of the distribution, but they diminish strongly in magnitude and show more uncertainty until becoming negative on the high-growth tail. Again, if anything, the Spanish case puts even more complexity to the interpretability aspect of this relationship.

Figure 2.4: Plots of LTleverage coefficients for Italy, both growth indicators.



To conclude, the Italian case is quite peculiar. As for Spanish firms, the coefficients estimated for the left-tail of the distributions is of considerable magnitude and strongly positive. Then, similarly to

the effects found on the Spanish productivity growth distribution, the trend is fluctuating, showing some positive effects in the center of the distribution, which then become negative and vanish for high-growth firms.

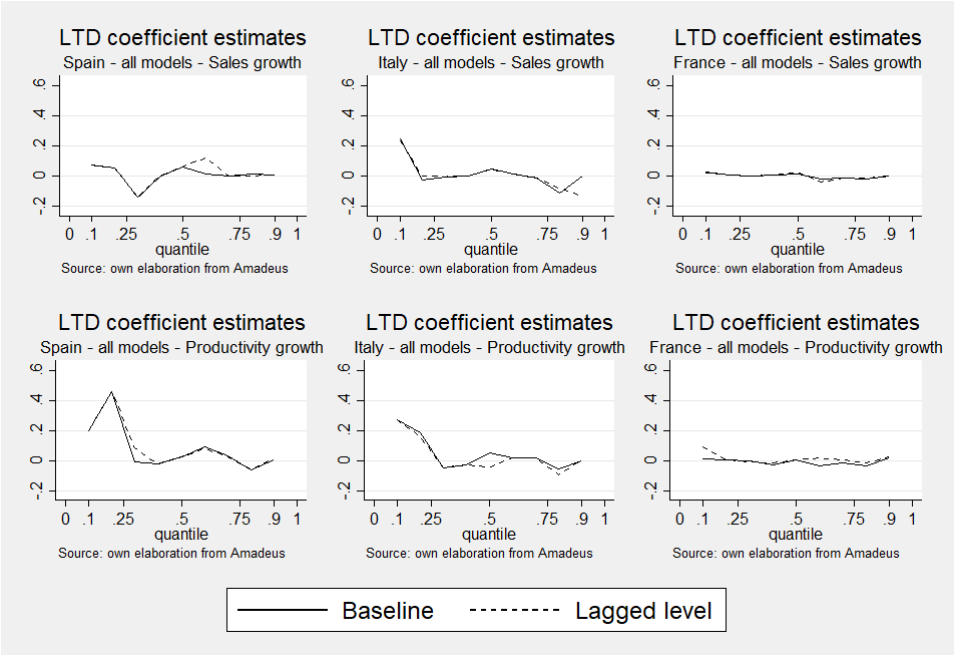
Despite the conspicuous degree of non-linearities and irregularities detected, some common pattern emerges and contribute to the understanding of the LTleverage-growth nexus. First, the very low-growth firms decile is one which consistently benefit from increasing their long-term leverage position. In line with Molinari (2013), this makes sense as leverage can have a growth-enhancing effect for these firms by providing additional resources and enlarging opportunities.

Second, also firms occupying the central part of the growth distributions, the "boring", barely growing firms, seems to benefit from the same effect and their LTleverage coefficients are consistently positive. Finally, the right-tails of the distribution exhibit either negative or non-significant coefficients. This can be interpreted as an evidence that truly growth-enhancing projects, such as innovative efforts, require resources non-compatible with the nature of long-term leverage. Such an interpretation is also in line with the findings by Singh and Faircloth (2005), who found a negative relationship ongoing between financial leverage and R&D investment.

2.5.2 Robustness checks

With the aim of reducing likely endogeneity biases, we also estimate the models outlined in Equations 2.10 and 2.11 instrumenting the lagged values with an additional lag (Galvao Jr., 2011). This procedure does not affect the estimations in any significant manner, as the path and the magnitudes across quantiles follow common shapes for each country and performance indicator. The estimated coefficients can be found in Tables 2.1 and 2.1 of the Appendix, but they are graphically represented below.

Figure 2.5: Coefficients of LTleverage for each country, comparing instrumented and non-instrumented models.



2.6 Conclusion

This study deeply explores the LTleverage-growth relation and establishes the presence of numerous non-linearities, together with some characteristics in common across countries and growth indicator. First, it collects existing theoretical and empirical evidences on the topic. Then, with the use of advanced techniques, such as dynamic panel quantile regression with non-additive fixed effects, we estimate this relation for France, Italy and Spain, along two growth indicators, sales and productivity. The extended literature review on the subject highlights substantial modeling efforts, both empirical and theoretical. These models come with implications that contributed to the construction of our hypothetical framework, whose prescriptions were mainly two. The first one consisted of the existence of a selection effect, inducing some kind of increasing across growth quantile for LTleverage impact. While, considering the nature of our data, the second was that this impact is obviously different according to the growth indicator of choice and it is country-dependent.

Besides striving to provide a comprehensive literature review on a far-than-settled subject, we contribute to economic understanding in other ways. Particularly, we do not find support for the hypothesis that more growing firms embodies better capabilities to exploit long-term leveraged situation. On the contrary, our findings show the opposite. A stable, positive relationship has been established only for the lowest

growing decile, and for some cases of centrally-located firms. The nexus becomes duskier and fluctuating as we move toward the right-tail of the growth distributions.

Despite the negativity of the result, a candidate explanation is the fact that low-growing firms are in intrinsically needy positions, and the obtainment of LTleverage broadens their struggling strategic portfolio. This growth-enhancing effect may apply also for firms in the central part of the distribution, which are usually far from being the virtuous, innovative and disruptive ones. On the contrary, as we move toward the highest-growing decile, the effects are negative or insignificant, probably hinting at the fact that truly growth-enhancing activities rely on a more complex network of financial tools and arrangements.

Further, in line with the pecking-order theory (Berger & Udell, 1998; Gregory, Rutherford, Oswald, & Gardiner, 2005), highly profitable firms will prefer to finance their investments via internal resources. Indeed, Vanacker and Manigart (2010) show that internal finance and financial debt are the most frequently used financing alternatives for high-growth firms. In parallel, long-term leverage may be beneficial also for non-fitter firms as it creates value by disciplining managers in companies with no or very scarce growth opportunities (Jensen, 1986).

An emerging result is also the diffused heterogeneity in the way the LTleverage relationship is framed at firm-level, and more effort shall be put in the understanding of the underlying mechanisms both

at theoretical and empirical level. Particularly, from an applied perspective, the use of more insightful datasets, which track the possible channels of propagation from leverage issuing to actual growth, are needed. An important prescription stemming from the present study is that these channels of propagation are likely to differ considerably for firms growing following different paths.

Indeed, some of the limitations arise from the nature of our dataset. Amadeus data has no reliable information regarding the death of firms, and consequently, our analysis focuses only on incumbent firms, avoiding any consideration of life-cycle properties of firms. It is clear that focusing exclusively on incumbent firms can indeed over-estimate the impact of leverage on performance on the whole universe of firms, as we miss the impact of leverage on "dying" firms. However, being aware of this, results still have a strong validity for the sub-universe of incumbent firms, that contribute in a major way to the economy.

2.7 Appendix

Table 2.8: Variables definition

Variable of interest	Definition
Age	2018 minus the age of birth
Total assets	Total assets (Fixed assets + Current assets)
Long term debt	Long term financial debts (e.g. to credit institutions (loans and credits), bonds)
Number of employees	Total number of employees included in the company's payroll
Sales	Net sales
Added value	Profit for period + Depreciation + Taxation + Interests paid + Cost of employees
Labor productivity	Added value over number of employees
LTD ratio	Long term debt over total assets

Source: AMADEUS user guide.

Table 2.9: Pairwise correlation matrix – Pooled sample

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
(1) Sales growth	1.00							
(2) Sales level	0.01	1.00						
(3) Productivity growth	0.27*	0.00	1.00					
(4) Productivity level	0.02*	0.02*	0.13*	1.00				
(5) Long-term debt	0.00	0.81*	0.00	0.01*	1.00			
(6) Total assets	0.00	0.85*	0.00	0.01*	0.98*	1.00		
(7) LTleverage	-0.04*	0.00	-0.01*	0.00	0.02*	0.00	1.00	
(8) Age	-0.01*	0.04*	0.00	0.01*	0.03*	0.03*	-0.11*	1.00

Significance stars corresponding to the 5% significance levels or more.

Figure 2.6: Plots of LTleverage coefficients by country and growth indicator.

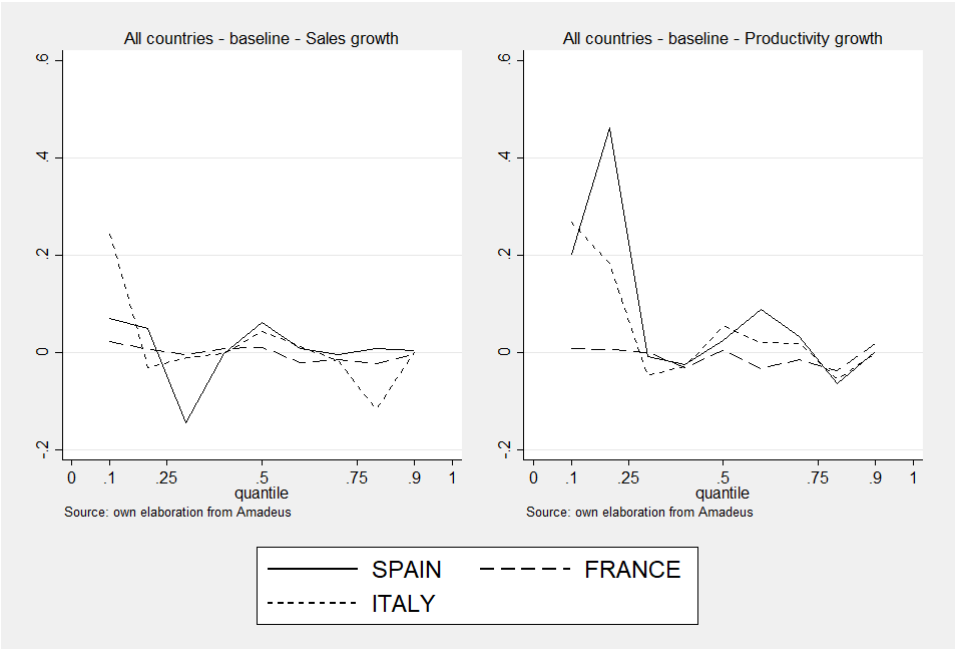


Table 2.10: LTleverage coefficients estimates on sales growth – Instrumented model with additional lag on sales level

Decile	France	Italy	Spain
0.1	0.0204 (0.0147)	0.235*** (0.0324)	0.0701*** (0.0078)
0.2	0.0061 (0.0061)	-0.0011 (0.0011)	0.0517*** (0.0069)
0.3	-0.0022 (0.0027)	-0.0057*** (0.0009)	-0.144*** (0.012)
0.4	0.0084*** (0.0033)	-0.0003 (0.0011)	0.0025 (0.0034)
0.5	0.0212*** (0.0040)	0.0449*** (0.0016)	0.0616*** (0.0040)
0.6	-0.0408*** (0.0090)	0.0117*** (0.0024)	0.122*** (0.0079)
0.7	-0.0151*** (0.0039)	-0.0121 (0.0122)	-0.0037* (0.0021)
0.8	-0.0148*** (0.0044)	-0.0843*** (0.0044)	0.0011 (0.0025)
0.9	-0.0017 (0.132)	-0.134*** (0.0294)	0.0030 (0.0039)

Number of observations: France (2,348), Italy (17,955) and Spain (8,626) observed over seven years. Significance levels corresponding to * $p<0.1$, ** $p<0.05$, *** $p<0.01$. A constant term and other variables, such as age and age squared, and lagged sales are included in each regression but not reported here. Standard errors in parentheses.

Table 2.11: LTleverage coefficients estimates on productivity growth – Instrumented model with additional lag on productivity level

Decile	France	Italy	Spain
0.1	0.0914** (0.0460)	0.270*** (0.0238)	0.202*** (0.0328)
0.2	0.0066 (0.0072)	0.159*** (0.0076)	0.462*** (0.0393)
0.3	-0.0081 (0.0178)	-0.0472*** (0.0049)	0.0832*** (0.0049)
0.4	-0.0166*** (0.0044)	-0.0278*** (0.0012)	-0.0239*** (0.0017)
0.5	0.0043 (0.0072)	-0.0435*** (0.0085)	0.0255*** (0.0036)
0.6	0.0159 (0.0361)	0.0204*** (0.0033)	0.0786*** (0.0037)
0.7	0.0053 (0.0032)	0.0190*** (0.0013)	0.0262*** (0.0041)
0.8	-0.0160** (0.0076)	-0.0933*** (0.0044)	-0.0607*** (0.0058)
0.9	0.0214** (0.0099)	0.0023 (0.0031)	0.0143*** (0.0041)

Number of observations: France (2,348), Italy (17,955) and Spain (8,626) observed over seven years. Significance levels corresponding to * p<0.1, ** p<0.05, *** p<0.01. A constant term and other variables, such as age and age squared, and lagged sales are included in each regression but not reported here. Standard errors in parentheses.

Chapter 3

On the role of exporting and finance in high-growth firms

Synopsis. Both, finance and export have never been considered in their complex system of relationship in the context of high-growth firms. The scope of this article is two-fold. First, we analyze the relation between exporting status and financial variables, with a particular attention to high-growth firms. Second, using these determinants, we apply a counting model to explore the persistence of HGFs. The study fills a gap that is due to the lack of adequate information and observations in the typical datasets. Instead, we use a representative sample of European firms and for which there is panel data relative to the accounting variables augmented by a cross-sectional questionnaire with strategic information. The emerging evidences point at a

self-selection framework, where already financially-healthy firms enter exporting markets. This holds quasi uniformly for all classes of firms. From a persistence perspective in high-growth quantiles, we identify cash-flow and exporting as key features, liquidity exhibits asymmetric trends when looking at either employment or sales, while there are strong signs of path-dependency.

3.1 Introduction

Looking at high-growth firms (henceforth, HGFs or HG firms), finance and export have never been considered in their complex system of relationship. The main reason for this lack of attention is likely to be the rarity of suitable and appropriate databases, which seldom offer enough observations and information. Indeed, if already exporting and HG firms are minorities in the firms' universe, their intersection is even smaller. Nevertheless, financial health is a key features for willing to export, high-growth firms for at least two reasons: the need to overcome export sunk costs and the asymmetric impact that financial constraints have on the firm growth distribution.

From a policy point of view, it is important to establish if guaranteeing financial access is key to foster not only high-growth firms' presence and duration, but also their participation to foreign markets. Not only they tend to rely strongly on R&D, which is an unpredictable and expensive activity, but also their often errand nature may increase their risk profile (Daunfeldt & Halvarsson, 2015; Hölzl, 2014). Further, appropriate capital structures can be key to face the sunk cost implied in foreign market participation. From a theoretical perspective, the nature of the relationship between finance, firm growth and exports is not straightforward, as these variables may interact by showing complementarity. The decision of exporting is likely to induce internal organizational changes, which in turn may affect productivity and fi-

nancial health of firms.

Finally, firms will be more willing to pay the sunk cost for entering into a new market depending on the macroeconomic context. During a domestic recession firms will be able to allocate more resources to exports and they will try to compensate for the decline in domestic sales through increased efforts to export while in boom periods production can be mainly sold on the domestic market (Belke, Oeking, & Setzer, 2015; Bobeica, Esteves, Rua, & Staehr, 2016). Hence, firms will decide to invest part of their financial resources into the export activity in order to ensure the economic viability during a recession, the so-called survival-driven exports (see Belke et al. (2015)).

Thus, the scope of this paper is two-fold. On the one hand, we estimate the relation among financial health, exporting and high-growth status with the aim of establishing the signs of the contributions and some criteria of temporal precedence. On the other hand, we continue the analysis by putting into relation these factors with persistence in the higher growing quantiles. While the analysis of the interactions between finance and export may be important and policy-relevant, understanding their incidences on the capacity to be and remain a high-growth firm is crucial.

For the aim, we exploit the comprehensive dataset called EFIGE, European FIrms in the Global Economy. Elaborated by the Bruegel think tank, it combines measures of firms' accounting situation data with quantitative and qualitative information derived from a 150 ques-

tions survey. For the estimations, we apply a range of different techniques ranging from simple, linear regressions to counting models, passing through the application of simple causal concepts derived from information theory.

The following section contains the literature review that merges the various aspects that we will take into consideration, ranging from regularities in the high-growth firms literature to their peculiar relationships with finance and exporting. Section 3 presents the data employed in this study and descriptive statistics that motivates us to pursue this road. Section 4 introduces the research questions that we aim to address and the relative estimation approaches we will use. Section 5 reports and comments the results, while section 6 concludes, providing both strength and weaknesses of the approach.

3.2 Literature Review

3.2.1 Empirical regularities for high-growth firms

Despite the large body of empirical studies conducted on high-growth firms (Acs & Mueller, 2008; Birch & Medoff, 1994; Coad, Daunfeldt, Hölzl, Johansson, & Nightingale, 2014; Coad, Daunfeldt, Johansson, & Wennberg, 2014; Davidsson & Henrekson, 2002; Fritsch, 2013; Henrekson & Johansson, 2009, 2010; Schreyer, 2000), the research community has been able to establish only a relatively, minor set of stylized facts.

Geographically, it is possible to find high-growth firms quite globally (Schreyer, 2000). As reported by Moreno and Coad (2015), HGFs seem to be quite uniformly present across all manufacturing sectors, with a slightly major representation in the service sector. However, knowledge, as human capital, appears to be one very strong discriminant that is relevant in fostering the presence of HGFs in the firms' population (Daunfeldt, Elert, & Johansson, 2013). If in the United States, HGFs tend to be old (Acs & Mueller, 2008), the same is not true in Canada, Spain, Germany, Netherlands and Sweden (Schreyer, 2000). Also, in general, tendencies to agglomerate according to the industrial technological density have been identified (Costa Campi, Blasco, & Marsal, 2004).

Innovation input and output are strong determinants of ab-normal growth events (Coad & Rao, 2008). Focusing only on the input side, Segarra-Blasco and Teruel (2014) find that R&D investment is an important determinant of the probability to become a high-growth firm. Finally, important differences in the impact of innovation-related investment exist across countries when taking into account the distance from the technological frontier (Hölzl, 2009; Segarra-Blasco, Teruel, & Jové-Llopis, 2018).

An additional branch of studies relative to high-growth firms focused on determining the factors associated to more persistence in growth. This work stemmed from analyses attempting to validate Gibrat's Law (1931) and initially focused only on auto-correlation co-

efficients (Wagner, 1992). Then, it developed a whole range of tools ranging from Markovian transition to autoregressive models, and probabilistic exercises (Moschella, Tamagni, & Yu, 2019). Nevertheless, the vast majority of the results failed to individuate precise characteristics that are associated with persistence in being high-growing firms. Concluding, several studies (Acs & Mueller, 2008; Bianchini, Bottazzi, & Tamagni, 2017; Delmar, Davidsson, & Gartner, 2003; Garnsey et al., 2006) pointed out that also for this type of firms, the patterns of growth are quasi-random and are very rarely sustained.

3.2.2 On HGFs and financing

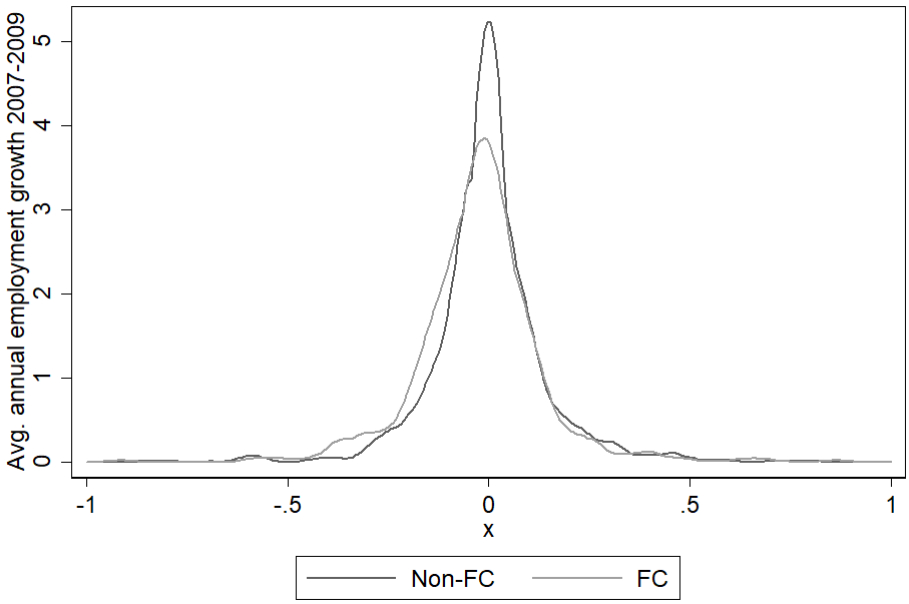
Typical works on financing follow the financial constraint concept and try to understand whether and to what extent the lack of (desired) financing is an impactful obstacle for firms' growth. Brown and Lee (2019) find that high-growth firms are by any means more impacted by financial constraints than their counterparts.

Bottazzi et al. (2014) find a situation strongly characterized by heterogeneous behaviors, non-linearities and low (high-) growth persistence. One possible reason of this outcome is the numerous weaknesses that the financial constraint concept bears with itself (Farre-Mensa & Ljungqvist, 2016). Nevertheless, by studying the asymmetric impact of financial constraints[1] on firm growth distribution (see Figure 3.1 for

[1]In the EFIGE questionnaire, firms are asked: "During last year, did the firm apply for more credit?", and they can answer either "Yes, and successfully", "Yes,

a visual representation), they suppose the existence of a "loss effect" for the lower performing firms, as opposed to a "pinioning effect" that applies to the rightmost part of the distribution.

Figure 3.1: Asymmetric distributional effects of financial constraints (FC) over the employment growth distribution.



Note: The kernel density is estimated with an Epanenchnikov kernel bandwidth equal to 0.5. Source: own elaboration from EFIGE database

An alternative route that may amend at least some of the weaknesses explained above is focusing on firms' variables that represent the actual use of either debt capacity (e.g. long-term leverage issues,

but unsuccessfully", or "No". For the sake of the graph, we define as financially-constrained firms answering "Yes, but unsuccessfully".

see Chapter 2) or other cash-flows/liquidity ratios (Megaravalli & Sampagnaro, 2018; Máñez, Rochina-Barrachina, Sanchis-Llopis, & Vicente, 2014). In particular, using quantile regression, Megaravalli and Sampagnaro (2018) found that the high liquidity ratios benefit more HGFs if compared to the average firms. This is contrary to what found in Chapter 2 for long-term leverage, but it would be in line with the findings by Nunes et al. (2007).

3.2.3 On HGFs and exporting

High-growth firms tend to be significantly internationalized (Burgel et al., 2000). In particular, this "going-abroad" phase is often associated to rapid employment expansion in the destination market with the purpose of serving directly foreign customer. This hints at the fact that HGFs may be more prone to have spatially extensive employment patterns when compared to non-HGFs (Brown & Mawson, 2016).

Hölzl (2014) highlighted a strong correlation between exporting and being a high-growth firm. This relation supposedly propagates through the innovation channel that allows firms to enter other markets with innovative products or processes. Finally, a recent study by Ben Slimane and Baghdadi (2019) with unique data for the Middle East and Northern African region shows that particularly for high-growth firms rather than the export intensity, it is the status to foster ab-normal employment growth.

3.2.4 The interplay between export and finance

Internationalization requires a considerable amount of resources (Roberts & Tybout, 1997). Indeed, to increase productivity firms normally invest in machines, equipment or process improvements; also for achieving innovations that can be attractive on a global basis, firms invest resources in R&D, human capital and subsequent commercialization of the innovative items. For the above reasons, financial resources come into play and often, their use has important connections with the internationalization process and its impact on subsequent performance.

A debate on the nexus between export and finance is what spurred from the articles of Greenaway et al. (2007) and of Bellone et al. (2010). The authors confront empirical evidences related to possible self-selection or increasing finance by exporting frameworks. However, the outcomes of these two empirical analysis are in contrast between each other. Moreover, these studies focused on what in this thesis have been referred as the average firm, which is of little relevance for our purpose.

Another relevant feature regards the "export phase" that each firm is experiencing. Not controlling for this could imply an important bias in every analysis. The study by Görg and Spaliara (2014) shows that firm survival and financial variables depend on the export stage. Particularly (and quite trivially), starters and exiters seem to be the groups that experience the most negative effects in presence of financial

hardship. Applying an Heckman-type framework (1976), Secchi, Tamagni, and Tomasi (2016) find that, relatedly to financial constraints, only firms with excellent financial health enter exporting markets.

Given the available data and the state of knowledge in the fields under consideration, our research questions deal with the peculiar growth patterns that high-growth firms undertake in an exporting context, and how financial factors influence these patterns. First, we study the mutual influences between export and finance for HGFs. Particularly, we exploit the available data with the aim of disentangling level advantages and dynamic gains relative to entrance in export markets.

RQ1: Does exporting activity improve the financial situation of high-growth firms? Or, there exist significant differences in financial levels?

The first research question looks at the relation between the exporting activities and the financial structure of firms. With this in mind, our estimations look for the presence of a level advantage or growth premia separately, then adding some causal consideration to the analysis. Subsequently, under a persistence perspective, we analyze whether there exist significant differences among the growth-enhancing factors relative to innovation, export and finance modes. In particular, we propose an alternative method to study persistence of high-growth episodes and their determinants.

RQ2: How does persistence in high-growth quantiles is related to

export, innovation and financial situation? Is there any form of path-dependency in persistence?

Instead of typical analyses of persistence, we count the number of non-consecutive years in which a firm qualifies for the high-growth status within a given time-frame. We apply a counting model to our data and estimate how the characteristics of firms in antecedent period affect the number of years during which this firm will be in the top performing quantiles for the subsequent period. A more specific explanation of the approach is contained in Section 3.4.2.

The analysis is the use of two concurring groups of high-growth firms: 1) identified as the best performing 10% of firms in terms of employment growth, and 2) the same quantiles, but in terms of sales growth.

3.3 Data and descriptive analysis

3.3.1 Data

The dataset employed in this exercise is the EFIGE survey, which thanks to its international and dual nature is a perfect candidate. By dual nature, we mean that the dataset is constructed merging a cross-sectional questionnaire consisting of approximately 150 items on both firms' internal qualitative and quantitative information with panel data coming from the Bureau van Dijk's Amadeus database, which contains

the standard accounting data. The resulting database comprises a representative sample of nearly 15,000 manufacturing firms, with more than 10 employees and coming from seven European countries (Italy, France, Spain, United Kingdom, Germany, Hungary and Austria).

Further, the dataset reports information on both firms' locations and industry. Geographically, it applies the NUTS2 classification, while for the industrial sectors, it groups firms in 11 industries following the NACE-CLIO categories. These variables have been used both for the stratification of the sample and for the anonymization process. For this reason, the available variables allow us to include these fixed effects in the estimations, but they are not directly interpretable (Altomonte & Aquilante, 2012).

Concerning the temporal window, the survey data refers to the period 2007-2009, while the information coming from the BvD-Amadeus database covers the period 2001-2014. Thus, this database combines rich data concerning the innovation activity, the organizational composition of the workforce and the international activity of the firms, with the standard accounting information that we usually use to study firms' performance.[2]

One possible concern about the period under study regards the 2007 economic downturn, which impacted globally all the economies.

[2]For a complete list of the survey items, a thorough representativeness analysis and a detailed description of the survey procedure, please refer to Altomonte and Aquilante (2012).

On the one hand, the selection mechanisms governing access to export markets may have become more stringent, reducing the number of high-growth and exporting firms. On the other hand, the crisis may have also affected persistence in the high-growth quantiles by reducing it (Collier, Haughwout, Kunreuther, & Michel-Kerjan, 2020). However, the long term perspective (14 years), the use of multi-year averages, the application of fixed effects, and the division of the panel in two periods, a pre- and a post-crisis one, guarantee the cleanest possible estimates.

3.3.2 HGFs definition

The alternative use of different definitions in the high-growth studies has been largely debated (Delmar et al., 2003). In this work, given the nature of the firms in our sample, instead of the Eurostat-OECD definition[3] (2007), we apply the quantile definition and with the aim of alleviating some of its weaknesses, we will dedicate a part of the study to the persistence of single firms in the high-growth group. This methodological choice also allows to gain several insights on the temporal persistence perspective. Finally, in terms of performance indicator, we carry out the exercise both for employment and sales growth.

[3]This definition is based upon an absolute growth threshold (20% over a 3-year period) and it excludes firms with more than ten employees; however, this definition is very restrictive in most of the settings (Daunfeldt, Johansson, & Halvarsson, 2015).

3.3.3 Descriptive analysis

We now explore some of the preliminary evidences that pose the relationships under consideration as very relevant for high-growth firms.[4] First, Table 3.1 shows the composition of firms' capital structure. In this case, we do not observe significant differences according with growth quantiles (see Tables 3.16 and 3.17 in the Appendix), thus implying that the firms in our sample share similar characteristics in terms of financial structure.

Table 3.1: Capital structure composition averaged over the whole period

	Debt		Securities		
	STD	MTD/LTD	STS	MTS/LTS	Other
mean	33.02%	48.59%	1.62%	2.05%	13.64%
standard deviation	35.99	38.74	9.44	11.16	29.93
observations	6848	6849	6804	6807	6808

The first two letters of the acronyms stand for short, medium and long term. Source: own elaboration from Amadeus database.

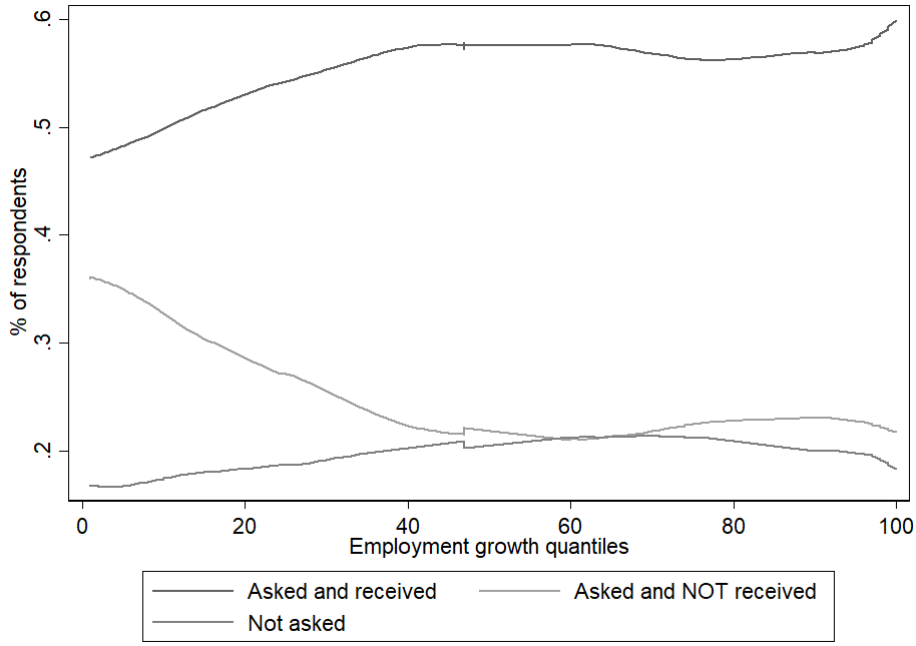
From the table it is clear how firms tend not to rely on securities, while preferring typical debt instruments, particularly medium and long-term ones. This also acts in partial confirmation of what theories and evidences on the pecking order prescribe (Donaldson, 1961; Myers, 1984; Myers & Majluf, 1984).

Next, we propose some plots of how the responses to a selected set

[4] We report the main descriptive statistics for the variables under consideration and the relative correlation matrix in Table 3.8 and 3.9.

of survey questions vary across the unconditional growth distribution. The first plot, Graph 3.2 regards what the managers of firms report regarding their applications for further credit made by firms and their outcome across the distribution. In particular, we observe a positive relationship between the growth quantiles and the successful application for credit. This holds for both sales and employment growth as performance indicators (see Graphs 3.9 and 3.10 in the Appendix).

Figure 3.2: Credit applications outcome and employment growth quantiles.

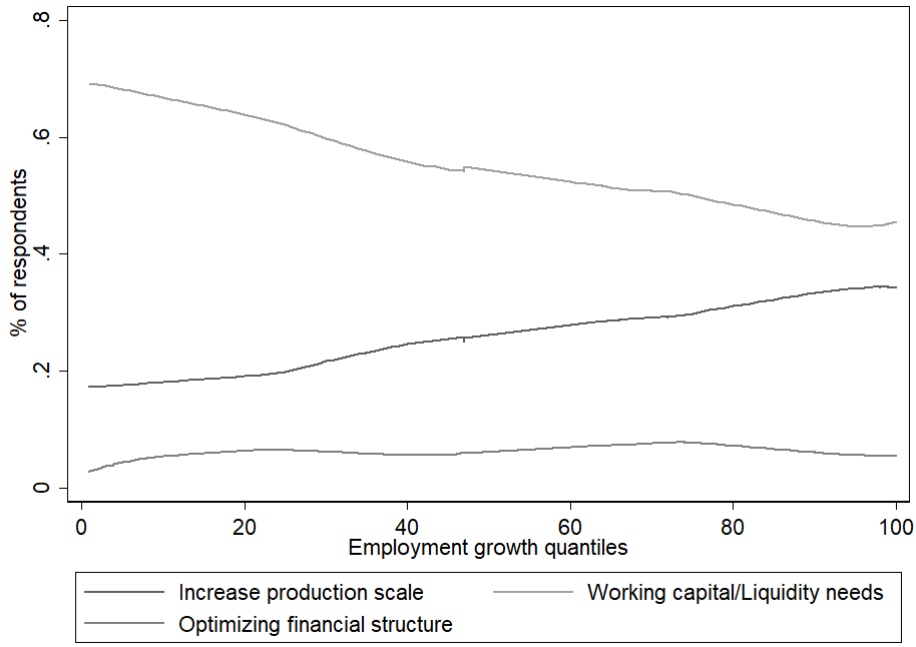


Source: own elaboration from EFIGE database

Another interesting evidence is the scope for which firms in different

growing situations ask for external credit. Graph 3.3 shows the main purposes that push firms to demand credit. Particularly, less growing firms borrow money in order to satisfy immediate liquidity needs or to raise working capital required to continue production. On the contrary, HGFs have more expansionary plans, as they borrow money for increasing liquidity and pursuing increases in production scale through investment (which needs liquidity, indeed).

Figure 3.3: Main purpose of external finance and employment growth quantiles.



Source: own elaboration from EFIGE database.

To conclude this section, we introduce the exporting dimension. Ta-

ble 3.2, compares the basic accounting information relative to the period 2007-2009 between four groups of firms: high-growing and exporting firms, high-growing and non-exporting firms, all exporting firms, and all non-exporting firms. With the aim of avoiding misleading size effects, the statistics proposed are computed per employee.

First, when we identify HGFs using the associated sales growth quantiles, the accounting profile does not differ significantly between exporters and non-exporters. Instead, for HGFs in employment, assets and liabilities among exporters appear to be "more constrained", if compared to non-exporters. Finally, focusing on the whole sample, we see that the effect is reversed and follows more what the literature would prescribe, meaning that exporting firms are more equipped under almost all the aspects.

This counterintuitive finding is very interesting and constitutes a considerable part of the motivation for this analysis. Indeed, despite exporting firms employ considerably more people, HGF exporting firms seem to struggle more than non-exporting ones. Similarly to Table 3.2, Table 3.3 describes some organizational variables coming from the EFIGE questionnaire.

Table 3.3 shows that the differences in the firms' profiles emerged in Table 3.2, are much less evident on the organizational profile.

Table 3.2: Accounting situation of HGFs and whole sample by exporting position (2007-2009) - mean values controlling for size (employment)

Exporter	Sales	Employees	Assets	Tangible assets	Intangibles assets	Cash-flow	Liquidity ratio	Current liabilities	Noncurr. liabilities
	90th employment growth quantiles								
No	1.050	1878.66	1.446	1.472	1.402	0.955	0.916	1.198	1.231
Yes	1.063	5046.58	1.087	1.039	1.017	0.992	0.954	1.055	1.022
	90th sales growth quantiles								
No	1.061	1754.37	1.001	0.953	0.933	0.964	0.912	1.020	0.985
Yes	1.048	7269.11	1.047	0.998	0.974	0.955	0.917	1.021	0.992
	Whole sample								
No	1.047	1819.53	1.475	1.404	1.349	0.943	1.001	1.405	1.291
Yes	1.058	6420.66	4.034	3.584	3.247	0.961	0.932	4.566	3.050

All the monetary values are expressed in thousand euros per employee. Source: own elaboration.

Table 3.3: Organizational profile of HGFs and whole sample by exporting position

Exporter	R&D	Product innovation	Process innovation	Marketing innovation	Organiz. innovation	Human capital
	90th employment growth quantiles					
No	41.1%	35.1%	42.2%	18.9%	31.5%	19.5%
Yes	67.3%	61.3%	53.7%	41.3%	41.8%	32.0%
	90th sales growth quantiles					
No	42.0%	33.5%	40.8%	18.6%	30.0%	24.8%
Yes	71.1%	59.7%	50.9%	40.8%	42.8%	37.2%
	Whole sample					
No	42.8%	32.8%	35.1%	17.3%	25.4%	21.6%
Yes	68.4%	57.2%	48.4%	38.6%	35.0%	30.8%

All the monetary values are expressed in thousands euros per employee. Source: own elaboration.

3.4 Estimation procedure

3.4.1 Variables selection

When identifying financial health among firms, given the extremely complex nature of financing it is impossible to focus on only one measure. We start from the approach proposed in Greenaway et al. (2007), and extend it to cover also a few, other features. Namely, we analyze possible differences in the time horizon of liabilities (short v. long term obligations). Two other indicators are the liquidity ratio and the long-term debt ratio. These are variables that point directly at a firm's financial health. Then, we also check for cash-flow, a very rele-

vant variable as it proxies for the quantity of money that firms gain as profits and that can mobilize (Almeida, Campello, & Weisbach, 2004).

Finally, other than these financial indicators, we utilize a selection of firm-level variables that cover the most impacting aspects of companies' dynamics. To do so, we include productivity, defined as value added over employees; size, defined as number of employees; exporting and innovation statuses. Particularly, innovation is introduced in the persistence part of the study, as the literature on HGFs points at this aspect as a fundamental one (Coad & Rao, 2008). With the aim of checking for innovation, we include research and development intensity, as a proxy for innovation input, and a binary variable, innovator, as a proxy for innovation output.[5]

3.4.2 Econometric specifications

Our strategy entails three, related specifications: one relative to possible level advantages in finance driven either by the export or by the HGF status, one aimed at unraveling a similarly driven dynamic gain for these firms, and finally, one aimed at estimating persistence contributors to the HGF status. This latter estimation is also carried out to curb some of the weaknesses that defining HGF firms over quantiles has.

[5]EFIGE data allows to disaggregate on both the innovator and exporter variables, at a finer grained level; however, to avoid loss of observations, our main estimations are carried out using the aggregate indicator. More estimations can be found in the Appendix.

For the possibility of a level advantage, we estimate equation 3.1:

$$Financialdepvar_{i,01-07} = \beta_0 + \beta_1 Exporter_{i,2007} + \beta_2 HGFsales_{i,07-09} + \\ + \beta_3 Exporter_{i,2007} \times HGFsales_{i,07-09} + \beta_4 HGFemp_{i,07-09} + \\ + \beta_5 Exporter_{i,2007} \times HGFemp_{i,07-09} + \beta_6 X_{i,01-07} + \varepsilon_{1,it} \quad (3.1)$$

As dependent variable, $Financial_depvar$ corresponds to the set of five financial variables mentioned in the paragraph above. $Exporter$[6] refers to the export status in 2007 for each firm, which interacts with the corresponding high-growth status in the same period (using both employment and sales as performance indicator). Due to the peculiar shape of our data (cross-sectional questionnaire merged with panel data), we cannot exploit the panel dimension fully and consequently, our dependent variables are averages relative to the pre-entry period (2001-2007).

Additionally, X includes control variables such as age, size, labor productivity, regional and sectoral fixed effects. Indeed, given the complex nature of causality, we do not provide any causal evidence on the relation, but we just offer an insight of the possible pre-entry premium that HGFs may have before entering foreign markets.

[6]Due to both methodological reasons and a limited number of observations, the main exercise is carried out with the binary variable for exporter, but in the Appendix we also report estimates disaggregating by export status. The possible export statuses are 1) starting to export (starters), 2) permanent exporter, 3) exiting from export (exiters), and 4) never exported (nevers).

Then, we investigate whether the export activity is associated to some dynamic gain, implying a significant impact on the same set of financial variables used in equation 3.1. However, here instead of levels, considering the dynamic nature of the process, we take logarithmic growth rates, and our purpose is to see whether entering global markets eases some aspects of HGFs' capital structure.

$$\begin{aligned}\Delta Financialdepvar_{i,09-14} = \beta_0 + \beta_1 Exporter_{i,2007} + \beta_2 HGFsales_{i,07-09} + \\ + \beta_3 Exporter_{i,2007} \times HGFsales_{i,07-09} + \beta_4 HGFemp_{i,07-09} + \\ + \beta_5 Exporter_{i,2007} \times HGFemp_{i,07-09} + \beta_6 X_{i,01-07} + \varepsilon_{1,it} \quad (3.2)\end{aligned}$$

Our strategy consists of estimating coefficients for each dependent variable, separately, and then to analyze signs, magnitudes and significance under this comparative perspective. With the aim of capturing the specific learning nature of exporting and of opportunity recognition by HGFs we introduce dummy variables for each category and their interactions.

The second research question proposes a fresh view on persistence analysis. This type of studies has mainly been studied looking at autocorrelation coefficients derived from Gibrat-type estimations, Markovian transition matrices or auto-regressive processes. Instead, we estimate a counting model that measures the years that each firm spends in the top-10% quantiles, conditional on the events and variables ob-

served in the antecedent period.

In terms of formulation, the simplest counting model would be the Poisson one, which however relies on the fundamental assumption of having a mean roughly equal to the variance of the variable of interest. Given the shape of our data (Graph 3.8), we apply a negative binomial model, which is a generalization of the latter. Also, the variable of interest has a vast abundance of zeros (6746 for HGF sales and 7239 for HGF employment). In order to deal with this final issue,[7] we estimate a zero-inflated negative binomial model. This class of models makes use of a variable that has a powerful explanatory power for the zeros, and it consists of a mixed model: the non-zero part of the data is modeled as a negative binomial, while the zero part is modeled as a simple logit process with the variable of choice as explanatory one.[8] Confirming our theoretical intuition, we report in Table 3.15 of the Appendix the results relative to the Akaike Information Criterion and its Bayesian counterpart.

Particularly, our aim is to observe how factors related to export, financial situation and innovation impact the length of stay (consecutive

[7]If ignored, this could lead to a significant under-estimation of the independent variable, whose first moment would be inevitably downward bias due to large presence of zeros.

[8]For the zero part of the model, whose results are not of interest for our study, we use the average level of current liabilities in the period 2001-2007, as independent variable. In Figure 3.7, it is possible to see how the distributions differ significantly for the zero-group, as opposed to the persistent one. These modeling choices result in a Vuong (1989) test that indicate the ZINB, as more appropriate than the simple, negative binomial specification.

or non) of firms in the top performing quantiles (Equation 3.3):

$$HGFpers_{i,09-14} = \beta_0 + \beta_1 Finsit_{i,01-07} + \beta_2 Exporter_{i,2007} + \\ + \beta_3 Innov_{i,2007} + \beta_4 HGFpers_{i,01-07} + \beta_5 X_{i,01-07} + \varepsilon_{1,it} \\ \text{where } HGFpers_{i,t-t+n} = \{0, 1, 2, ..., 6\}. \quad (3.3)$$

In the specification above, *HGFpers* corresponds to the number of years that each firm stays in the top-10% performing quantile during the periods indicated by the time indexes (2001-2007 and 2009-2014). The variable is obtained by first computing the unconditional growth quantiles for each year in the sample, and then we sum the number of years in which each firm is in the HG quantiles.

Then, *Finsit* is the vector of financial variables[9] explained for equation 3.1 and 3.2. Similarly, *Exporter* controls either for exporting categories (in terms of starter, permanent, exiter or never), or for general exporting status. *Innov* is a set of variables identifying the innovative nature of the organization, we incorporate the invariant R&D intensity, together with dummies representing process, product, marketing and organizational innovations, and human capital. Finally, vector X includes the same firm-specific factors that could influence the esti-

[9]Here, multi-collinearity between current and non-current liabilities may be an issue. Both correlation and the variance-inflation factor confirm this suspicion. Nevertheless, multicollinearity impacts mostly the error estimates of the coefficients suspected of it. Thus, we look whether the estimated magnitudes and significances varies when quitting the suspected, collinear variables from the estimations and this is not the case.

mation, as in the previous specifications, β is the vector of estimated coefficients, and ε corresponds to the error term.

3.5 Results

3.5.1 Level advantage

Table 3.4 presents the possible level advantages for high-growth firms joining foreign markets. We expect the premium to be different for high-growth firms according to the performance indicator used to identify them, namely sales growth versus employment growth. Due to their considerably different growth modes, the former are likely to be more exposed to this level advantage, while the latter are considerably less affected.

As reported in Table 3.4, size and labor productivity show high, positive and significant elasticities with the financial variables under consideration, implying that these fundamentals play a big role for the financial aspects of firms. In particular, this is true for all the indicators with the exception of the association between liquidity ratio and employment and between long-term debt ratio and labor productivity. The simple explanation behind this is that being the two variables, ratios, they already control for size effects.

Table 3.4: Estimation of equation 3.1 using a binary for *Exporter* (OLS)

	log(Cash-flow)$_{01-07}$	log(Current liabilities)$_{01-07}$	log(Non-current liabilities)$_{01-07}$	log(Liquidity ratio)$_{01-07}$	log(LTD ratio)$_{01-07}$
$Log(Employment)_{01-07}$	1.026***	0.958***	1.102***	-0.007	0.096***
	(0.009)	(0.009)	(0.015)	(0.007)	(0.012)
$Log(lab.productivity)_{01-07}$	4.704***	3.132***	3.390***	0.750***	0.013
	(0.056)	(0.052)	(0.093)	(0.04)	(0.081)
$Exporter_{07-09}$	0.057***	0.284***	0.300***	-0.073***	0.025
	(0.02)	(0.02)	(0.034)	(0.015)	(0.029)
$HGFsales_{07-09}$	-0.002	0.036	-0.005	-0.006	-0.040
	(0.051)	(0.05)	(0.086)	(0.039)	(0.074)
Exporter$_{07-09}\times$	0.051	0.032	0.175*	0.018	0.137
HGF sales$_{07-09}$	(0.062)	(0.061)	(0.105)	(0.047)	(0.091)
$HGFemployment_{07-09}$	-0.011	0.175***	0.14	-0.019	-0.007
	(0.051)	(0.051)	(0.086)	(0.039)	(0.075)
Exporter$_{07-09}\times$	0.149**	-0.001	0.091	-0.006	0.088
HGF empl.$_{07-09}$	(0.062)	(0.062)	(0.106)	(0.048)	(0.092)
Observations	9,553	10,128	9,840	10,109	9,840
Adjusted R^2	0.737	0.678	0.487	0.069	0.029

Note: We do not report the estimated coefficients for the control variables relative to age, regions and sectors. Standard errors in parenthesis, and stars correspond to *, significant at 10%, ** significant at 5%, while *** significant at 1%. All estimations include regional and industry fixed-effects, please refer to Section 3.1 for more details.

When moving our attention to exporting firms, we see that those firms that do not export are somehow penalized in terms of financial structure if compared to the others. This holds for every financial indicators we analyzed other than the liquidity ratio, which instead show a slight negative correlation with the exporting status. On the same line, if we disaggregate by export status (Table 3.10), we notice that firms which either start to export or export for the whole period are advantaged in terms of cash-flow, current and non-current liabilities,

but disadvantaged if we look at liquidity. The negative relationship shows that indeed exporting markets are demanding, and they often require the use of considerable current period resources. At the same time, these markets increase the scope (and access) for financing.

Interestingly, the fact of being an high-growth firm does not seem to be strongly correlated with previous financial health in any systematic way. However, we do find some important hint. Current liabilities show a significant relationship with the future status of high-growth firm in terms of employment growth. Finally, if we look at the interaction terms between growing and exporting statuses, it is possible to notice how the different performance variable (employment and sales) are sensitive to different financial structures. On the one hand, it appears that firms growing strongly in terms of employment and exporting have enjoyed a consistent position in terms of cash-flow, which is needed to sustain both the exporting and employment positions. On the other hand, firms increasing steadily their sales and exporting have had high leverage ability, meaning that they had the chance and the willingness to undertake more long-term debt compared to other firms of the same size. This is shown also by the estimated coefficient for the interaction term associated to export and growing high in sales for non-current liabilities.

In terms of economic interpretation, we find that the signaling and the diversification effects of export participation make firms more liquid, but also more leveraged. Interestingly, if we instead look at the

interaction between HGF and exporting statuses, it is possible to notice that exporting firms are even more leveraged. This makes sense as high-growth firms tend to be relatively smaller than their counterparts, they need (and get) both liquidity and leverages to overcome the sunk costs of export markets. Also, as shown by the introductory part, these firms may have more expansionary plans in their strategic moves.

With the aim of capturing the specific sequence of event, we estimate also the same specifications focusing on two subgroups of exporting firms: "starters" and "nevers"[10] (Tables 3.10 to 3.11). Our results do not show any significant differences. We find that exporting exerts positive influence on cash-flow, current liabilities and non-current liabilities. This is true for both types of high-growth firms, sales and employment, and it complements the evidences for greater financial necessities by firms in exporting market, especially if high-growth ones.

3.5.2 Dynamic gain

Although the evidences gathered in the above sub-section point at a self-selection framework in financial structure, here we analyze whether exporting allows to increase financial capacity dynamically or not. To do so, we replicate the estimations proposed in the previous sub-section

[10]Specifically, we define starters, as those firms that were not exporting pre-2007, but started in 2007-2009, while nevers, as those firms who do not export for the whole period of observation, 2001-2014.

with a different set of measurements for the financial variables under consideration: instead of levels, we now switch our attention to average growth rates. Table 3.5 shows the results for this set of estimations.

Table 3.5: Estimation of equation 3.2 using a binary for *Exporter* (OLS)

	$\Delta\log(\text{Cash-flow})_{09-14}$	$\Delta\log(\text{Current liabilities})_{09-14}$	$\Delta\log(\text{Non-current liabilities})_{09-14}$	$\Delta\log(\text{Liquidity ratio})_{09-14}$	$\Delta\log(\text{LTD ratio})_{09-14}$
$Log(Employment)_{01-07}$	0.007	-0.008***	0.002	0.005*	0.003
	(0.007)	(0.003)	(0.006)	(0.003)	(0.005)
$Log(lab.productivity)_{01-07}$	0.057	0.041**	0.118***	0.01	0.059*
	(0.041)	(0.018)	(0.036)	(0.018)	(0.035)
$Exporter_{07-09}$	0.019	0.002	0.02	0.002	0.012
	(0.015)	(0.007)	(0.013)	(0.007)	(0.012)
$HGFsales_{07-09}$	-0.087**	0.011	0.048	0.027	0.025
	(0.038)	(0.017)	(0.033)	(0.017)	(0.032)
$\text{Exporter}_{07-09}\times$ HGF sales_{07-09}	0.031	-0.011	-0.024	-0.043**	-0.008
	(0.046)	(0.021)	(0.041)	(0.02)	(0.032)
$HGFemployment_{07-09}$	-0.015	-0.013	0.063*	0.016	0.051
	(0.038)	(0.017)	(0.033)	(0.017)	(0.032)
$\text{Exporter}_{07-09}\times$ HGF empl._{07-09}	0.06	0.01	-0.059	0.02	-0.062
	(0.046)	(0.021)	(0.04)	(0.02)	(0.038)
Observations	7836	9224	8642	9182	8642
Adjusted R2	0.006	0.001	0.004	0.008	0.002

Note: We do not report the estimated coefficients for the control variables relative to age, regions and sectors. Standard errors in parenthesis, and stars correspond to *, significant at 10%, ** significant at 5%, while *** significant at 1%. All estimations include regional and industry fixed-effects, please refer to Section 3.1 for more details.

Here, the dynamic situation varies significantly if compared to the "static" one in Table 3.4. Overall, it is important to notice the very poor explanatory power that the model has for detecting possible dynamic gains coming from the exporting activity. Also, typically powerful

variables such as labor productivity and size maintain their significance and sign for only a minor set of dependent variables.

Shifting our attention to the coefficients relative to the exporting status, and the associated cross-products, it is possible to notice how the picture is much more blurred if compared to the previous estimations. However, some trends are detectable. First, we notice that high-growth firms in terms of employment do not reap significant, dynamic increases in their financial structure thanks to export markets. Further, export markets exhibit a "constraining" effect on liquidity (see also Table 3.4) of sales high-growth firms.

Interestingly, the interaction terms between exporting status and high-growth status lose much of their significance, and where they keep it, the coefficients are negative, showing that financial variables for these firms do not grow more than their counterparts. Looking at the interactions we can notice how the constraining effect does not apply for HGF in employment. Finally, using the disaggregated export statuses (Table 3.10), we notice that two types of high-growth firms in employment, those exiting export markets and those who never entered, are somehow penalized in terms of cash-flow, showing again the existence of an exporting premia driving more profitable financial figures.

All of this is compelling and highlights the debt and liquidity dynamics associated to internationalized firms. Nevertheless, focusing on our research question, we do not see strong indications of rein-

forcements in HGFs' financial structures thanks to their participation in exporting markets. This suggests that healthier firms tend to self-select themselves inside foreign markets, also considering their financial health and capacity.

3.5.3 Causal considerations for the relation between export and finance

Although constrained by the available data and existing techniques, in this section, we introduce some causal consideration on the relationship under study. Particularly, we apply some novel causal inference tools derived from both information theory and causal network theory to offer a complimentary view.

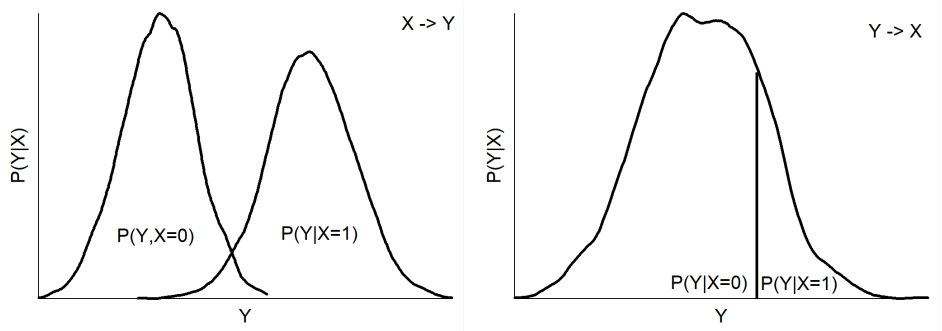
As mentioned in Section 3.2.4, the literature on the relationship between exporting status and firms' financials is quite limited. It is an established fact that firms with better finance self-select themselves into export market, but this does not imply any causal relation by itself. On the topic, Greenaway et al. (2007) observed empirically that the financial structure tends to improve because of joining the exporting markets. This is also in line with our estimations.

Being export a simple binary variable, causal inference is far from being an easy task. However, we exploit the concepts developed by Janzing and Schölkopf (2010) and Lemeire and Janzing (2013), then applied in Coad and Grassano (2018). Particularly, we refer to the

"principle of algorithmically independent conditionals", which is a rather manual and intuitive method that attempts to discern causal directions in settings with one binary variable and one continuously distributed.

This approach is based on the idea that factorizing $P(cause, effect)$ into $P(effect|cause)$ is supposed to lead to a simpler "representation" than the non-natural factorization into $P(effect)P(cause|effect)$. The concept originated as "principle of plausible Markov kernels" in Sun, Janzing, and Schölkopf (2008), and it is based on Markovian graphs[11].

Figure 3.4: Examples of possible factorizations in the case of a continuous and a binary variable interacting



(a) A binary variable X causes a bimodal Gaussian Y

(b) A bimodal Gaussian Y triggers a binary variable X

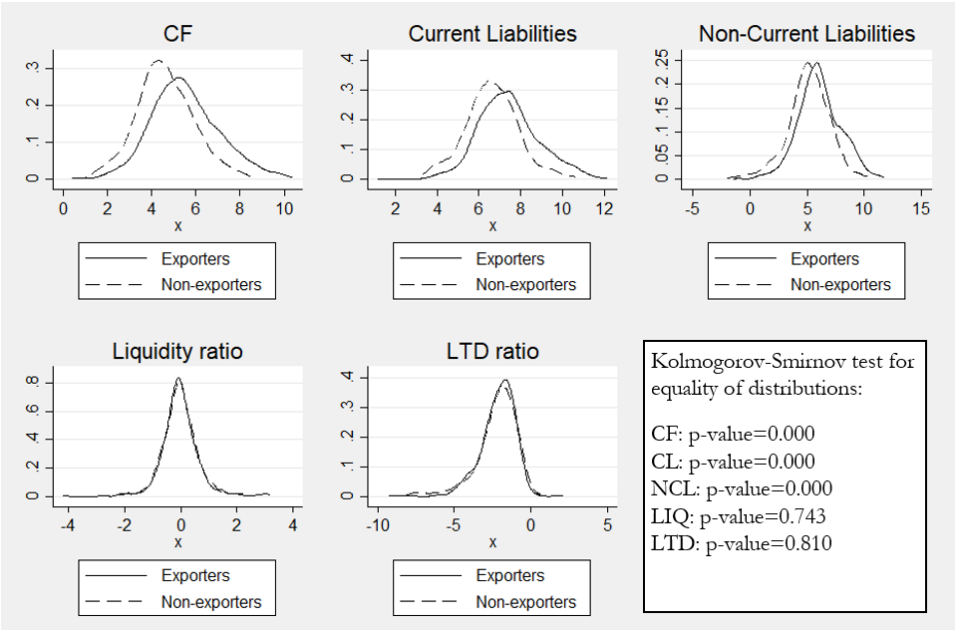
Source: own elaboration.

So, we look at the kernel estimation of each continuous variables' distribution conditioned on the values [0,1] of the binary variable and their joint distribution. If the representation appears like a bimodal Gaussian (see Figure 3.4a), where one is just the copy of the other

[11] Other pillars that stand at the basis of this principle are Kolmogorov (1963) complexity and the Occam's razor (Domingos, 1999).

shifted by a parameter, then we can safely suppose that it is the binary to cause that shift, as this is the simplest decomposition. In the opposite case (Figure 3.4b), we would look at two parts of Gaussian, whose joint distribution makes a quasi-Gaussian. So here, it is clear that some value of the Gaussian distribution triggers the binary status that we are analyzing.

Figure 3.5: Kernel density estimations of the joint probability distributions for $P(financialvariables|exportingstatus)$. - HGF employment



Source: own elaboration.

In our case, we take into consideration the joint distributions the usual financial indicators used previously, in logarithm to account for the strong skewness. Since our focus are high-growth firms, the re-

ported, empirical distributions are relative to this subset of firms, conditioning their value on whether they export or not. In Figure 3.5, we carry out this analysis for high-growth firms identified according to employment growth, while in Figure 3.6 in the Appendix, the reader can find the same estimations using sales as performance indicator and the results are on the very same line.

Here, it is possible to see cash-flow, current and non-current liabilities fall quite straightforwardly in the bimodal case, where the binary variable X, in our case "exporting status" affects the continuous variable Y, the financial indicators. Oppositely, for the two ratios, no underlying mechanism seem to exist connecting them to exporting status. The causal link appears particularly strong for cash-flow. This is even more evident for high-growth employment firms, and related results found in the previous sections (Table 3.4). All these evidences point at the importance of generating, consistent operational cash-flows as a requirement to join export markets.

In order to complement our visual intuition, we also provide the estimated p-values for the Kolmogorov-Smirnov test of equality of distributions. This simple but compelling empirical observation confirms our findings and previous evidence on the causal direction ongoing between export status and financial health. This can also be seen as a complimentary evidence of the existence of self-selection mechanisms that pre-filter firms intending to enter export markets.

3.5.4 Persistence

We now move our attention to a temporal perspective of high-growth firms. In particular, we analyze whether among the typical growth determinants, there is any that is particularly significant in explaining the persistence of a given firm in the top performing quantiles. Also, as specified in equation 3.3, we control for possible path-dependency. Table 3.6 presents the results for both types of HGFs under analysis, employment and sales (while for more disaggregated results in terms of innovative output, please refer to Table 3.13 in the Appendix).

As we can see, results differ quite significantly for the two performance measures, but they also share one common and interesting similarity: the estimated coefficient on "path-dependency". In terms of persistence in the top, sales-wise performing firms, we find that liquidity and cash-flow tend to be associated positively with our indicator. It is quite intuitive to understand why cash-flow, an indicator strongly associated with profitability, and liquidity, a very important factor to control in firms' management, are the two financial candidate fostering persistence in high-growing quantiles.

Interestingly, we observe that having more human capital boosts the likelihood of staying in the top performing sales quantiles. Further, it is possible to notice also how R&D intensity, a measure of innovation input, is associated positively and significantly with persistence in the top sales quantiles, while other measures of output are not.

Table 3.6: HGF persistence results (ZINB)

	HGF employment persistence (2009-2014)	HGF sales persistence (2009-2014)
Log(cash-flow)$_{01-07}$	0.243***	0.073***
	(0.034)	(0.026)
Log(current liabilities)$_{01-07}$	-0.308***	0.052
	(0.058)	(0.048)
Log(non-current liabilities)$_{01-07}$	0.086	0.054
	(0.07)	(0.055)
Log(LTD ratio)$_{01-07}$	-0.086	-0.056
	(0.077)	(0.061)
Log(liquidity ratio)$_{01-07}$	-0.130***	0.101***
	(0.046)	(0.037)
Innovator	0.228***	0.047
	(0.053)	(0.041)
R&D intensity	0.001	0.005**
	(0.003)	(0.002)
Human capital	0.05	0.108***
	(0.052)	(0.038)
Exporter	0.113*	0.127***
	(0.058)	(0.048)
HGF sales persistence$_{01-07}$	0.199***	0.214***
or HGF emp. persistence$_{01-07}$	(0.022)	(0.014)
Log(labor productivity)$_{01-07}$	-0.663***	0.053
	(0.216)	(0.198)
Log(employees)01-07	0.411***	0.001
	(0.045)	(0.034)
Observations	9209	9209
Pseudo R-squared	0.147	0.266

Note: We do not report the estimated coefficients for the control variables relative to age, regions and sectors. Standard errors in parenthesis, and stars correspond to *, significant at 10%, ** significant at 5%, while *** significant at 1%. All estimations include regional and industry fixed-effects, please refer to Section 3.4 for more details. Note: since the sample contains a considerable number of zero valued observations (7,239 for HGF empl.), we "inflate" the model using current liabilities, which are significant at the 1% level.

Even estimating the same specification with "innovator" as a general category does not give significant results. This does not hold for both categories of high-growing firms; indeed, innovation output turns out to be very important for increasing the length of stay in the top performing quantiles. Economically, we can hypothesize that HGF sales show the positive association with R&D investment for two reasons: 1) being smaller, it is easier to have higher levels of R&D intensity, and 2) R&D is a very relevant item to which direct the profits likely earned through the sales increase.

As anticipated, for the employment-identified quantiles, the situation is different. Indeed, financial fundamentals are less impactful on the likelihood of persistence in terms of employment, while cash-flow is an important determinant for granting firms the opportunity to hire personnel. The opposite argument holds when we look at the negative coefficient for liquidity and current liabilities, implying that personnel growth requires immediate funding availability. Also, process and organizational innovation spur employment in the future periods, as it relates positively to future persistence. Curiously, the (log of) size of these candidate HGFs is positively related with future persistence, while labor productivity shows a negative relationship. This outcome is easily interpretable, as firms with high levels of productivity are already operating close to their possibility frontier and do not need to increase the volume of their employment. On the contrary, the positive coefficient linking employment and future persistence in high-growing

quantiles is simply the consequence of the HGF definition we apply, the quantile one, which avoids overestimating relative growth events among small firms.

The most interesting result is that for both performance indicators, we find an interestingly strong path dependency in terms of persistence in the top performing quantiles. This is something that could not be taken for granted, as most research is still inconclusive in determining other than random growth paths for firms, but here, we see that at least for this very restricted group of firms, there exists a quite strong path dependency. Particularly, both Hölzl (2014) and Daunfeldt and Halvarsson (2015) found only small evidences in favor of high-growth firms' capacity to repeat their successes in terms of growth, with some stronger persistence for firms identified according to their job creating capacity. This last element is in line with our findings, but to it, we add that participation in foreign markets and healthy financial structures contribute to the likelihood of being more than one-hit wonder.

Finally, as expected, being an exporter and the associated coefficient turns out to be positive and significant for future persistence in the top performing quantiles for both performance indicators. This is likely to be the outcome of learning dynamics and increased opportunities in terms of demand for goods. In general, we consider this contribution a considerable improvement in the understanding of high-growth performances, especially referring to works such as Bianchini et al. (2017) and Moschella et al. (2019), where few evidences emerged

in favor of persistent high-growth behaviors.

3.6 Discussion and conclusion

The large impact that high-growth firms exert on the market has attracted scholars' attention. However, there is few evidence on their exporting activity and the influence that the financial structure has on their persistent status as high-growth firms. The main motivation is that recent empirical evidences show how HGFs behave differently also in the way they exploit external finance to grow. Consequently, instead of financial constraints, we analyze the effect of leverage variables related to ab-normal performances, both in terms of employment and sales. Thanks to the data available, all of this is done under a multifaceted perspective, which considers possible level advantages and dynamic gains, persistence phenomena and causal directions.

In terms of levels, we find that high-growing, exporting firms have a considerable higher level of long-term debt. This is likely to allow them the pursuit of different and more strategic growth plans, if compared to normally growing firms. On the contrary, firms growing ab-normally in employment seem more focused in the accumulation of current liabilities, but they do not show any apparent advantage from the participation in exporting markets. Then, we focus on the same variables but instead of using levels referring to the pre-questionnaire period, we analyzed growth rates in the post-questionnaire period, with

mostly negative results. This hints at the fact that firms need to accumulate financial resources before entering export markets. In this self-selection context, labor productivity is particularly important to allow firms obtaining debt.

Further, we complement the study of elasticities in our regression models with the application of causal elements. In particular, we exploit the shape of the variables in our data (one continuous, leverage, and one binary, export) jointed with robust theories coming from the machine learning community with the aim of appraising the most likely causal direction between the two. In this case, it seems that especially for current and non-current liabilities, the direction goes from exporting status to the latter.

Finally, we investigate the magnitudes of the determinants that increase the probability of a firm to stay in the higher growing quantiles for longer. In this regard, we find that exporting status and cash-flow are very important contributors. The other financial variables seem to have alternate tendencies. On the one hand, current and non-current liabilities are very relevant for high-growing firms in terms of sales. On the other hand, liquidity ratio shows a negative relation with the number of high-growing phenomena in employment. Similarly, if organizational innovations are very relevant for fostering employment growth, high levels of human capital are more important for sales growth. Past persistence, modeled as number of past exceptional performance is very related to future ones, pointing at a non-totally random growth path,

at least for the firms under consideration.

From a policy point of view, one of the most interesting results that emerges from our analysis is that there is support in the data for the hypothesis that the access to the impact of financial variables is heterogeneous and differs according to the nature of the financial variable and the growth measure. Conversely, already exporting firms are more likely to experience high-growth episodes. Up to some point, our results indicate the need of promoting and fostering competition in the financial sector, but also facilitating the entrance in the international markets. In particular, we offer insights that can help and drive policy decisions aimed at fostering high-growth firms and episodes using different combinations of indicators. Given the extremely heterogeneous dimension of firm growth, this can help to reduce the risk and provide differentiated firms' strategies that lead to high-growth. Obviously, the exporting is associated with the effort of firms to be competitive and innovate. Undoubtedly, the access to financial resources facilitate firms' innovation activity and, consequently, affect their capacity to export and grow. This result is confirmed by the impact of R&D and innovation on the capacity to be a HGF.

3.7 Appendix

Table 3.7: Description of variables

Variables	Definitions
High-growth firm status	
HGF sales	Binary variable that takes value equal to 1 if a firm is in the top 10% of the sales growth distribution
HGF employment	Binary variable that takes value equal to 1 if a firm is in the top 10% of the employment growth distribution
HGF sales persistence	Counting variable that counts the number of years a firm has been in the top 10% of the sales growth distribution in a given period
HGF empl. persistence	Counting variable that counts the number of years a firm has been in the top 10% of the employment growth distribution in a given period
Export status	
Exporter	Binary variable that takes value equal to 1 variable for exporting firms – wide definition (Altomonte et al, 2012)
Innovation input and output	
R&D intensity	Average percentage of sales from research and development expenses during 2007–2009
Innovative sales	Average percentage of turnover from innovative products sales during the 2007–2009

Innovator	Binary variable that takes value equal to 1 if the firm introduced any type of innovation during 2007-2009.
Financial variables	
Cash-flow	Profit for period plus depreciation
Current liabilities	Current liabilities of the firm (loans plus creditors and other current liabilities)
Non-Current liabilities	Long-term liabilities of the firm (long-term financial debts plus other long-term liabilities and provisions)
Liquidity ratio	The difference between current assets and stocks divided by current liabilities
Long-term debt ratio	Non-current liabilities divided by total assets
Firm-specific characteristics	
Employees	Number of employees
Labor Productivity	Labour productivity measured as added value per employee.
Age categories	Dummy variables corresponding to the year range in which each firm was created: before 1980, 1980-1989, 1990-1999, 2000-2009
Control variables	
Regional fixed effect	Randomized regional identifier created from NUTS2 regions
Sectoral fixed effect	Randomized industry identifier created from NACE 3-digit sectors

Table 3.8: Descriptive statistics for the sample

Variable	mean	sd	min	max	N
Avg. level employees (2001-2007)	64.106	114.663	4	1062.333	11407
Avg. level lab. prod (2001-2007)	3.714	0.557	-2.639	11.547	10170
Avg. level cash-flow (2001-2007)	1213.562	13907.85	-299837.4	1000338	11282
Avg. level curr. liab. (2001-2007)	6444.016	70143.58	0	4429203	13892
Avg. level non-curr. liab. (2001-2007)	2888.866	42763.28	-302697.5	4026194	13892
Avg. level liquidity ratio (2001-2007)	1.554	3.130	0	89.6	13345
Avg. level LTD ratio (2001-2007)	0.199	0.954	-97.306	17	13848
Avg. growth cash-flow (2009-2014)	-0.001	0.555	-10.145	5.878	8884
Avg. growth curr. liab. (2009-2014)	0.001	0.346	-8.911	6.974	12488
Avg. growth non-curr. liab. (2009-2014)	-0.035	0.49	-7.852	5.457	12091
Avg. growth liquidity ratio (2009-2014)	-0.011	0.291	-4.052	4.834	12398
Avg. growth LTD ratio (2009-2014)	-0.045	0.474	-7.671	5.434	12089
Exporter	0.667	0.471	0	1	14759
HGF Sales top 10	0.08	0.272	0	1	14759
HGF Employment top 10	0.071	0.257	0	1	14759
HGF Sales pre-2007	0.379	0.965	0	6	14759
HGF Sales post-2009	0.383	0.882	0	6	14759
HGF Employment pre-2007	0.264	0.705	0	6	14759
HGF Employment post-2009	0.278	0.735	0	6	14759
R&D	0.599	0.49	0	1	14759
Human capital	0.278	0.448	0	1	14759

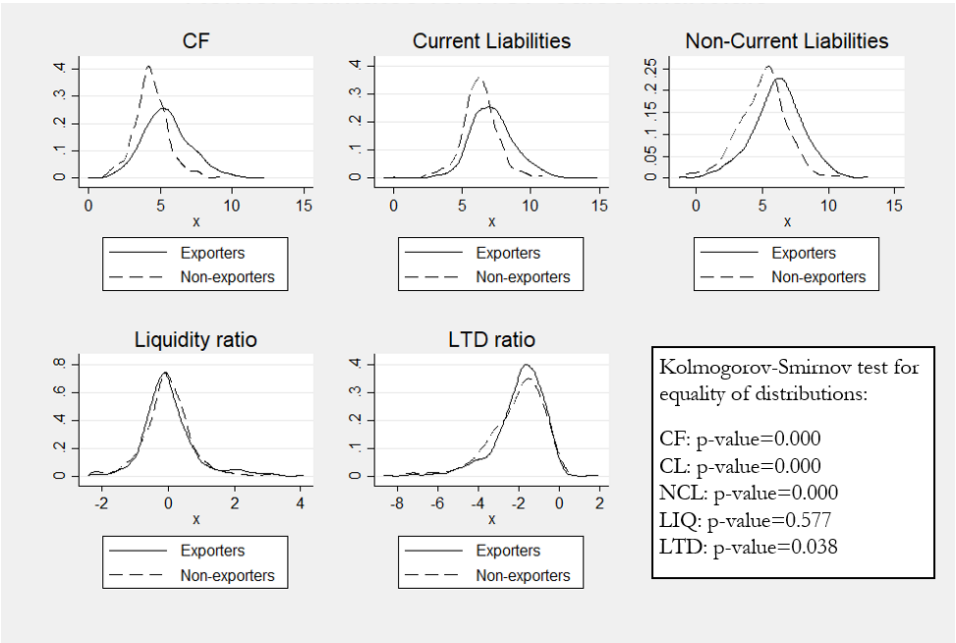
Source: own elaboration.

Table 3.9: Pairwise correlation matrix for the main variables of interest

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
(1) Avg. level employees (2001-2007)	1.00															
(2) Avg. level lab. prod (2001-2007)	0.11*	1.00														
(3) Avg. level cash-flow (2001-2007)	0.25*	0.29*	1.00													
(4) Avg. level curr. liab. (2001-2007)	0.41*	0.25*	0.70*	1.00												
(5) Avg. level non-curr. liab. (2001-2007)	0.39*	0.26*	0.83*	0.68*	1.00											
(6) Avg. level liquidity ratio (2001-2007)	0.01	0.14*	0.04*	-0.02	0.00	1.00										
(7) Avg. level LTD ratio (2001-2007)	0.05*	0.01	0.00	-0.04*	0.07*	0.02*	1.00									
(8) Exporter	0.16*	0.13*	0.03*	0.04*	0.03*	-0.01	0.00	1.00								
(9) HGF Sales Top 10	-0.04*	-0.06*	-0.01	0.00	-0.00	0.00	0.01	-0.02	1.00							
(10) HGF Emp. Top 10	-0.05*	0.04*	-0.01	-0.01	-0.01	-0.02*	0.00	-0.01	0.22*	1.00						
(11) HGF Sales pre-2007	0.43*	0.28*	0.14*	0.16*	0.10*	-0.04*	0.01	0.15*	0.07*	0.05*	1.00					
(12) HGF Sales post-2009	0.36*	0.24*	0.11*	0.14*	0.10*	-0.03*	0.00	0.15*	0.13*	0.07*	0.54*	1.00				
(13) HGF Employment pre-2007	0.37*	0.09*	0.04*	0.05*	0.03*	-0.05*	-0.01	0.09*	0.03*	0.11*	0.48*	0.26*	1.00			
(14) HGF Employment post-2009	0.27*	0.06*	0.02*	0.03*	0.02	-0.02*	0.00	0.10*	0.07*	0.16*	0.23*	0.36*	0.30*	1.00		
(15) R&D	0.15*	0.14*	0.03*	0.03*	0.03*	0.01	0.00	0.25*	0.00	-0.01	0.10*	0.11*	0.08*	0.07*	1.00	
(16) Human Capital	-0.09*	0.11*	-0.01	-0.01	-0.01	-0.01	-0.01	0.10*	0.03*	-0.00	0.02*	0.04*	-0.02*	-0.01	0.12*	1.00

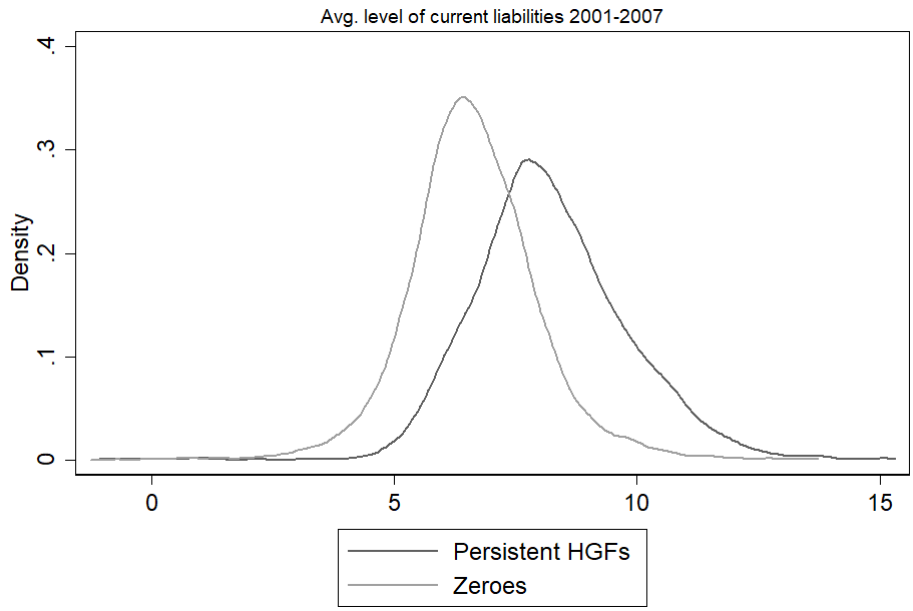
Note: * if significant ot 0.05%.

Figure 3.6: Kernel density estimations of the joint probability distributions for $P(financialvariables|exportingstatus)$ - HGF sales.



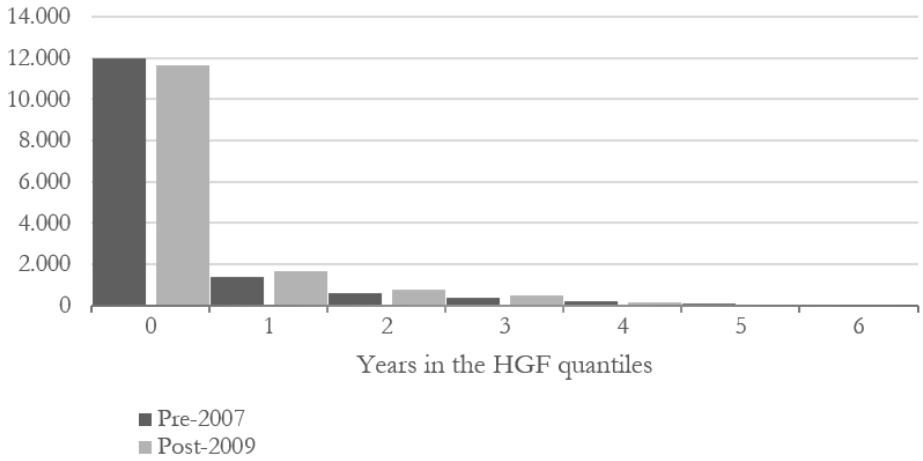
Source: own elaboration from EFIGE database.

Figure 3.7: ZINB inflating variable selection.



Source: own elaboration from EFIGE database.

Figure 3.8: Bar plots of the variables measuring HGF employment persistence.



Source: own elaboration from EFIGE database.

Table 3.10: Estimation of equation 3.1 using Exporting categories (OLS)

	log(Cash-flow)$_{01-07}$	log(Current liabilities)$_{01-07}$	log(Non-current liabilities)$_{01-07}$	log(Liquidity ratio)$_{01-07}$	log(LTD ratio)$_{01-07}$
Log(Employment)$_{01-07}$	1.025***	0.951***	1.096***	-0.006	0.096***
	(0.009)	(0.009)	(0.015)	(0.007)	(0.012)
Log(Lab. Prod)$_{01-07}$	4.682***	3.103***	3.367***	0.757***	0.015
	(0.056)	(0.052)	(0.093)	(0.04)	(0.081)
Export strategy (reference=Nevers)					
Starters	0.142***	0.224***	0.294***	-0.117***	0.127
	(0.054)	(0.053)	(0.092)	(0.042)	(0.08)
Permanent	0.068***	0.329***	0.338***	-0.081***	0.025
	(0.021)	(0.021)	(0.036)	(0.016)	(0.031)
Exiters	-0.037	0.080**	0.101*	-0.042	0.013
	(0.034)	(0.034)	(0.058)	(0.026)	(0.051)
HGF sales	-0.01	0.032	0	-0.001	-0.021
	(0.051)	(0.051)	(0.087)	(0.039)	(0.076)
Cross-products Export strategy×HGF status					
Starters×HGF sales	-0.118	-0.084	-0.298	0.05	-0.254
	(0.157)	(0.154)	(0.27)	(0.119)	(0.235)
Permanent×HGF sales	0.074	0.033	0.174	0.006	0.119
	(0.065)	(0.064)	(0.11)	(0.049)	(0.096)
Exiters×HGF sales	0.07	0.132	0.312	0.018	0.193
	(0.112)	(0.112)	(0.192)	(0.087)	(0.167)
HGF employment	-0.008	0.173***	0.152*	-0.028	0.013
	(0.052)	(0.051)	(0.088)	(0.04)	(0.077)
Cross-products Export strategy×HGF status)					
Starters×HGF emp.	-0.111	-0.214	0.055	0.063	-0.125
	(0.173)	(0.17)	(0.297)	(0.132)	(0.259)
Permanent×HGF emp.	0.170***	0.011	0.062	0.008	0.059
	(0.065)	(0.064)	(0.11)	(0.05)	(0.096)
Exiters×HGF emp.	-0.002	-0.041	0.125	-0.018	0.138
	(0.121)	(0.122)	(0.208)	(0.094)	(0.181)
Observations	9,541	10,113	9,827	10,094	9,827
Adjusted R2	0.738	0.680	0.487	0.069	0.029

Note: We do not report the estimated coefficients for the control variables relative to age, regions and sectors. Standard errors in parenthesis, and stars correspond to *, significant at 10%, ** significant at 5%, while *** significant at 1%. All estimations include regional and industry fixed-effects, please refer to Section 3.4 for more details.

Table 3.11: Level advantage estimation for HGF in terms of sales – Permanent v. Nevers

	log(Cash-flow)$_{01-07}$	log(Current liabilities)$_{01-07}$	log(Non-current liabilities)$_{01-07}$	log(Liquidity ratio)$_{01-07}$	log(LTD ratio)$_{01-07}$
Log(employment) $_{01-07}$	1.016***	0.949***	1.137***	0.023	0.097**
	(0.035)	(0.037)	(0.059)	(0.027)	(0.049)
Permanent export$_{07-09}$	0.271***	0.358***	0.509***	-0.021	0.103
(reference="never export")	(0.071)	(0.075)	(0.122)	(0.054)	(0.102)
Log(Lab. Prod.) $_{01-07}$	3.956***	2.961***	2.766***	0.207	0.139
	(0.188)	(0.173)	(0.296)	(0.125)	(0.246)
Observations	758	819	793	815	793
Adjusted R2	0.712	0.629	0.471	0.016	0.006

Note: We do not report the estimated coefficients for the control variables relative to age, regions and sectors. Standard errors in parenthesis, and stars correspond to *, significant at 10%, ** significant at 5%, while *** significant at 1%. All estimations include regional and industry fixed-effects, please refer to Section 3.4 for more details.

Table 3.12: Level advantage estimation for HGF in terms of sales – Permanent v. Nevers

	log(Cash-flow)$_{01-07}$	log(Current liabilities)$_{01-07}$	log(Non-current liabilities)$_{01-07}$	log(Liquidity ratio)$_{01-07}$	log(LTD ratio)$_{01-07}$
Log(employment)$_{01-07}$	1.057***	0.931***	1.176***	0.023	0.164***
	(0.033)	(0.034)	(0.052)	(0.025)	(0.044)
Permanent export$_{07-09}$ (reference="never export")	0.301***	0.382***	0.441***	-0.044	0.078
	(0.064)	(0.070)	(0.108)	(0.050)	(0.091)
Log(Lab. Prod.) $_{01-07}$	3.751***	2.615***	2.204***	0.345***	-0.514**
	(0.179)	(0.176)	(0.271)	(0.126)	(0.228)
Observations	769	821	808	821	808
Adjusted R2	0.734	0.608	0.486	0.037	0.035

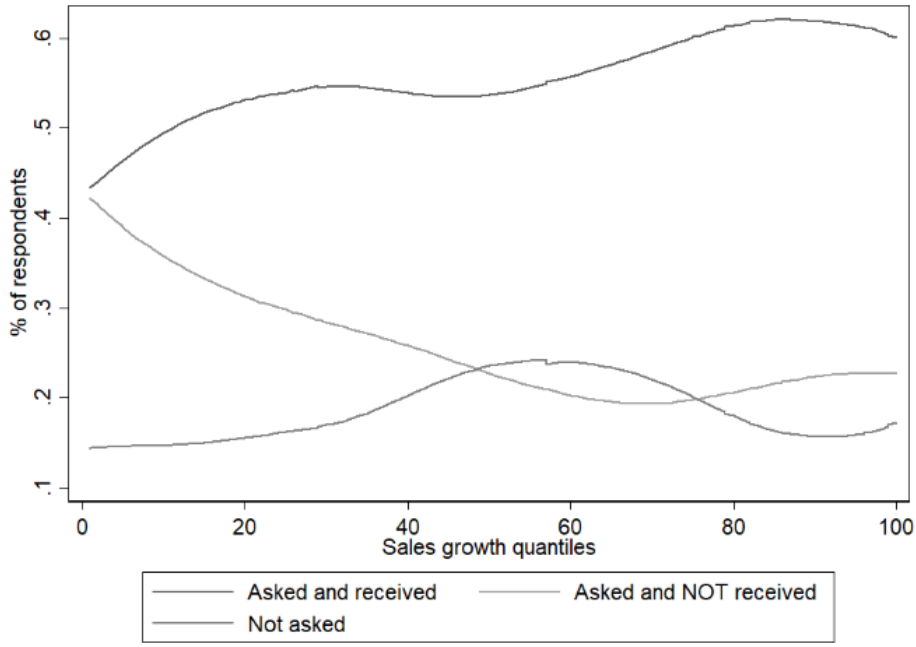
Note: We do not report the estimated coefficients for the control variables relative to age, regions and sectors. Standard errors in parenthesis, and stars correspond to *, significant at 10%, ** significant at 5%, while *** significant at 1%. All estimations include regional and industry fixed-effects, please refer to Section 3.4 for more details.

Table 3.13: Persistence results for HGF (ZINB) - disaggregated results

	HGF employment persistence (2009-2014)	HGF sales persistence (2009-2014)
Log(cash-flow)$_{01-07}$	0.072***	0.238***
	(0.026)	(0.034)
Log(current liabilities) $_{01-07}$	0.051	-0.312***
	(0.048)	(0.058)
Log(non-current liabilities) $_{01-07}$	0.057	0.089
	(0.055)	(0.07)
Log(LTD ratio)$_{01-07}$	-0.059	-0.093
	(0.061)	(0.077)
Log(liquidity ratio)$_{01-07}$	0.100***	-0.131***
	(0.037)	(0.046)
R&D intensity	0.005**	-0.002
	(0.002)	(0.003)
Product innovation	0.035	0.121*
	(0.049)	(0.062)
Process innovation	0.002	0.115**
	(0.039)	(0.052)
Market innovation	-0.003	-0.027
	(0.048)	(0.063)
Organizational innovation	0.043	0.186***
	(0.04)	(0.053)
Human capital	0.107***	0.049
	(0.038)	(0.052)
Exporter	0.126***	0.105*
	(0.048)	(0.058)
HGF sales persistence$_{01-07}$ **or** HGF emp. persistence$_{01-07}$	0.214***	0.194***
	(0.014)	(0.022)
Log(labor productivity) $_{01-07}$	0.047	-0.644***
	(0.197)	(0.215)
Log(employees)$_{01-07}$	-0.001	0.405***
	(0.034)	(0.045)
Observations	9209	9209
Pseudo R2	0.265	0.266

Note: due to the considerable number of zero valued observations (7,239 for HGF empl.), we "inflate" the model using current liabilities, which are significant at the 1% level. , Please refer to Section 3.4 for more details.

Figure 3.9: Credit applications outcome and sales growth quantiles.



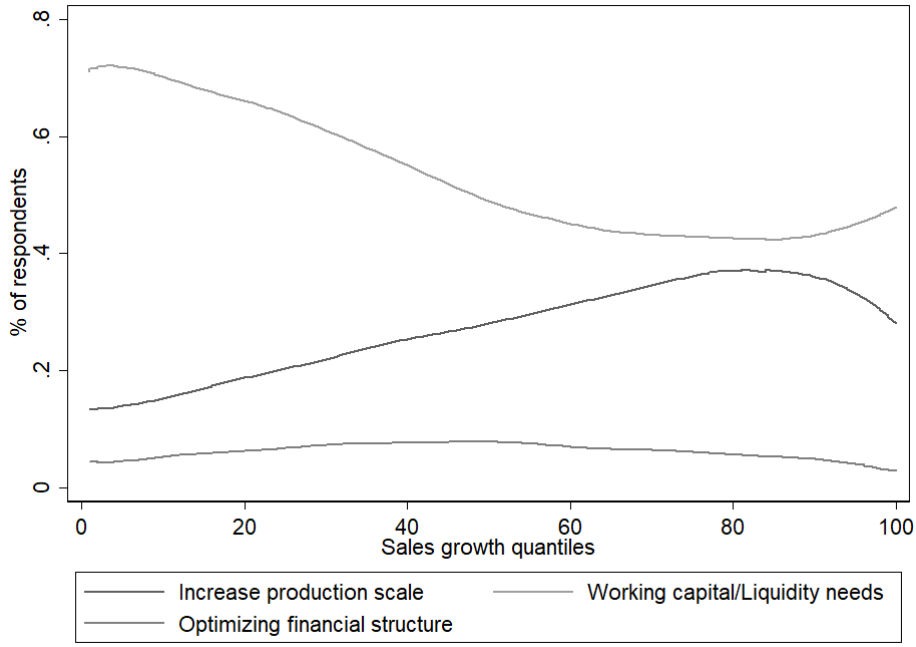
Source: own elaboration from EFIGE database

Table 3.14: Descriptive statistics for the finer-grained variables

Variable	mean	sd	min	max	N
Starter	0.03	0.17	0	1	14759
Permanent	0.55	0.498	0	1	14759
Exiter	0.096	0.295	0	1	14759
Never	0.323	0.467	0	1	14759
Product innovation	0.491	0.5	0	1	14759
Process innovation	0.44	0.496	0	1	14759
Marketing innovation	0.315	0.465	0	1	14759
Organizational innovation	0.318	0.466	0	1	14759

Source: own elaboration.

Figure 3.10: Main purpose of external finance and sales growth quantiles.



Source: own elaboration from EFIGE database.

Table 3.15: Information Criteria for model selection – Relative to Equation 3.3

		AIC	AIC/n	BIC
HGF employment	Poisson	13327.66	1.447	13591.39
	NB	12668.17	1.376	12939.03
	ZINB	12627.33	1.371	12912.45
HGF sales	Poisson	14820.66	1.609	15084.39
	NB	14404.71	1.564	14675.60
	ZINB	14111.66	1.532	14296.78

Note: AIC stands for Akaike Information Criterion, BIC for Bayesian Information criterion, NB for negative binomial, ZINB, for zero-inflated negative binomial.

Table 3.16: Capital structures across unconditional employment growth quantiles

Employment growth deciles	STD	MTD/LTD	STS	MTS/LTS	Other
1	36.1%	49.1%	1.9%	1.8%	10.2%
2	35.0%	50.7%	1.9%	1.5%	10.1%
3	37.5%	45.8%	1.5%	1.7%	11.4%
4	34.0%	49.1%	2.4%	2.5%	11.4%
5	32.4%	51.4%	1.3%	2.0%	11.9%
6	38.4%	50.8%	0.0%	2.7%	8.1%
7	34.5%	48.2%	1.3%	2.6%	11.6%
8	32.9%	50.0%	0.9%	1.1%	12.8%
9	32.1%	50.5%	1.2%	1.0%	14.9%
10	34.7%	49.6%	1.0%	1.6%	13.1%
Total	34.3%	49.5%	1.5%	1.8%	11.9%

Table 3.17: Capital structures across unconditional sales growth quantiles

Sales growth deciles	STD	MTD/LTD	STS	MTS/LTS	Other
1	35.6%	48.6%	1.7%	2.0%	11.3%
2	34.3%	51.1%	1.4%	1.4%	10.7%
3	35.6%	49.2%	1.2%	1.6%	11.8%
4	36.9%	47.8%	1.3%	1.9%	11.9%
5	30.8%	50.2%	2.1%	2.4%	12.7%
6	33.7%	52.0%	1.6%	1.7%	10.2%
7	30.9%	52.6%	1.5%	1.3%	13.0%
8	31.1%	52.0%	1.1%	1.1%	12.9%
9	33.7%	52.5%	1.2%	1.1%	10.7%
10	32.0%	50.7%	1.1%	2.0%	13.9%
Total	33.5%	50.6%	1.4%	1.7%	11.9%

Chapter 4

A decomposition of Spanish firms' internal R&D distribution: going beyond quantile regressions

Synopsis. Using the most comprehensive data for internal research and development in Spain, we provide a decomposition of the aggregate distribution using firm-level components. Namely, the components of interest are R&D public financing, gazelles' contribution, financial constraints, and firms' characteristics. Applying a modern decomposition method, instead of the simple mean decomposition, we are able to estimate contributions' of each component at any point of the distri-

bution. The analysis is carried out for two periods: the pre-crisis one, 2004-2008, and the post-crisis one, 2009-2014. Thus, we also introduce a comparative perspective that allows us to take into account possible business cycle effects. Our findings are that the main responsibilities for the significant post-crisis drop in Spanish aggregate R&D regard the public financing scheme and the decreased contribution by gazelle firms. The results provide interesting evidences for policy-making and a rigorous analysis of Spanish private R&D trends.

4.1 Introduction

Largely applied in the field of economics of innovation, quantile regression models have given researchers the chance to go beyond the study of the "average firm" and to focus instead on the heterogeneity of most undergoing, economic relations (Coad & Rao, 2008). More recently, studies on granularity, opened by Gabaix's article (2011), have spurred and despite the completely different methodologies, their aim is to identify sets of companies that are responsible for a large proportion of the fluctuations in the economy. Our aim is to situate this paper at the crossroad of these approaches.

Due to the extremely peculiar and rare type of data that Gabaix's approach requires, we change methodology, but our aim is still to offer an explanation of the micro to macro relations, and of their evolution over time. Using firm-level data on research and development, both before and after the global economic downturn, we can decompose contribution to the overall distribution by factors of interest (e.g. public financing) and estimate how these contributions change accordingly to the different part of the business cycle.

We do so by applying the decomposition analysis developed by Chernozhukov et al. (2013), who propose estimation and inference procedures to compute appropriately chosen counterfactuals that allow to decompose differences (or time evolutions in our case) of a given distribution. Largely applied in labor economics, to the best of our

knowledge, this method has rarely been applied in firm growth or innovation studies,[1] and it shall be seen as a consistent amendment of the previous quantile regression approaches.

Using this technique, we are able to quantify both the levels and the changes in the contribution of given factors to the composition and evolution of Spanish internal, private R&D. Particularly, we isolate four determinants: i) changes in the level of R&D public financing, ii) contribution by gazelles, iii) financial constraints, and finally, iv) possible changes in firms' characteristics. Also, given the coverage of our data, 2003-2014, we will be able to split the sample in two phases, one uprising and one declining for Spanish aggregate R&D. Thus, the analysis will also shed lights on the role that the above factors play in medium-term, research and development aggregate fluctuations in relation to business cycle movements.

Spain is the perfect candidate for this analysis thanks to many reasons that can be found in the report by COTEC (2018). Among the four major EU economies (Italy, Spain, France and Germany), Spain was the only to experience non-stop contraction in investment between 2009 and 2014. Until 2009, the country trend in R&D expenditure was converging to EU levels, but then started to diverge again. Further, Spanish aggregate R&D expenditure has historically been a balanced

[1]Indeed, as its ancestor, the Oaxaca-Binder decomposition, in the industrial context, this method has mostly been applied to productivity decompositions, for example Ferrante and Freo (2019); Schneider (2018)

mix of public and private expenditure, but these started to diverge with the public expenditure contributing less in time. Despite this and European Commission's recommendations, the private sector contributes for only 47%, while the EU recommends this ratio to be approximately two-thirds.

The contributions of this paper are several and multifaceted, and we have no knowledge of similar works in this direction. From a methodological point of view, we introduce a compelling approach for distribution decomposition, which can be applied to other specific questions in the firm growth and innovation field.

Theoretically, we provide a framework of analysis whose aim is to isolate the most consistent determinants of R&D expenditure. Also, the use of comprehensive, micro-level data allows us to offer detailed explanations of national-level movements in R&D. Empirically, we show how different factors concur in shaping levels and evolution of aggregate research and development expenditure in different moments of the business cycle. Finally, from a policy perspective, the results are relevant to shape innovation policy toward the long pursued 3% target of R&D posed in 2000 with the Lisbon Agenda, and then incorporated in the policies of the Horizon 2020 program (Veugelers & Cincera, 2015).

The rest of the work proceeds as follows. In Section 2, we summarize the vast literature on research and development studies and determinants with the aim of contextualizing our research questions. Section 3 contains a description of the data and insightful statistics,

while Section 4 explains the econometric methodology. Then, Section 5 shows our main empirical results and finally, Section 6 concludes.

4.2 Literature Review

4.2.1 A characterization of R&D investment

Research and development is often the main item of expenditure in the innovative portfolio of business enterprises. According to the Frascati manual (2015),

> "Research and Experimental Development comprise creative and systematic work in order to increase the stock of knowledge - including knowledge of humankind, culture and society - and to devise new applications of available knowledge."

Innovation-oriented firms carry out research and development expenditure allocating part of their productive budget either to specific internal units, or to the purchase of external innovative goods. Internal and external R&D activities have proven to show some complementarity (Segarra-Blasco & Teruel, 2011); however, internal expenditure is by large the main component of innovation input for firms, especially in sectors with high technological intensity (Piga & Vivarelli, 2004). Finally, internal investment in knowledge can be key to improve absorptive capacity and possibility to acquire external knowledge, as

reported by Cassiman and Veugelers (2006) and Segarra-Blasco and Arauzo-Carod (2008), respectively.

Other than the high importance of investing in internal R&D, the literature has highlighted the existence of a skewed distribution of the R&D investment among active firms (Segarra-Blasco & Teruel, 2014). The concentration of internal R&D investment tend to respond to sectoral differences, and may also be subject to scale factors. However, this unequal distribution of R&D effort is also common among firms in the same sector. A potential explanation is that firms follow a R&D race where they accumulate knowledge stocks (Doraszelski, 2003). In this process, firms will invest in R&D to increase their knowledge stock and thus, increasing their likelihood to succeed in the race. Some firms will not be able to follow this race and will go backwards.

In such a context, knowledge stock is a measure of the firm's past R&D efforts, and it is valuable to the extent that, even if success is not immediate, it helps the firm to reach innovative output later on. Knowledge accumulation thus gives rise to learning or otherwise, organizational forgetting.

Hence, the heterogeneous distribution of internal R&D will also correspond to an unequal distribution of the knowledge stock and of R&D returns. Previous results of the unequal impact of R&D returns can be observed in Coad and Rao (2010); Coad et al. (2016); García-Manjón and Romero-Merino (2012). Finally, not all the firms depart from the same conditions. In this context, R&D investment depends

on a set of characteristics which have been analyzed in the literature. Some of the most significant determinants are sales growth (Tomita, Ikeda, & Takeda, 2008), internal funds (Altomonte, Gamba, Mancusi, & Vezzulli, 2016; Bougheas, Görg, & Strobl, 2003; Dunk & Kilgore, 2004; Lai, Lin, & Lin, 2015; Peters, Roberts, Vuong, & Fryges, 2017), public financing and subsidies (Falk, 2006; OECD, 2016) and firm characteristics (Cincera, Ravet, & Veugelers, 2016).

4.2.2 On the country dimension of R&D in Spain: history, components and fluctuations

Hereby, we report some historical and statistical fact that help us to characterize the relevance of the undergoing study and that derive from the report COTEC (2018). First, despite the European Commission recommendations and the economic crisis, the public-private mix has been for large and is still dominated by public expenditures, with private enterprises contributing for only 47% of overall expenditure. In terms of R&D intensity, the country was converging to European levels, but started to diverge in 2009. Indeed, the promising path undertook by Spain at the beginning of 2000s saw a sudden interruption, coinciding with the global economic downturn that hit the country particularly hard.

For instance, between 2008 and 2016, the Spanish economy experienced a loss of 30% in its public R&D budget and a reduction of

43% in the number of enterprises performing R&D activities. This had dramatic impact on the path to convergence, which however had always been a complicated target to reach given the initial conditions. Also, private R&D expenditure did experience the negative effects of the crisis, making Spain the only country among France, Germany and Italy, that saw a continuous decrease in R&D investment between 2009 and 2014 (Xifré, 2016).

A major engine of these expenses has been public financing, which has always been sustaining private expenditures. However, if up to 2007, more than 90% of the allocated budget was invested, since then the trend has been decreasing, reaching the historical minimum in 2017, when only 46.6% of the budget (COTEC, 2018). Finally, in 2009, Spain reached its peak of R&D intensity at 1.35%. Thus, from a policy standpoint, the country was and still is far from the average European R&D intensity, which is 2.3%, from the agreed 2020 target of 2%, and also from the EU-target of 3%.

4.2.3 Isolating R&D main drivers

From Section 4.2.1, it should be clear that research and development is a process starred with uncertainties and thus, very difficult to study and model. This is particularly true when attempting to isolate and identify its main determinants. The objective of this section is precisely the one of extrapolating from the literature the drivers of interest.

Clearly, each author may propose her own factors, but the ones below are the best and most comprehensive candidates to study this context.

R&D public financing

A stylized fact in the innovation literature is that due to its intrinsic characteristics and to market structures, investment in research and development is often conducted at a sub-optimal level. For this reason, public intervention often tries to overcome this difficulty by offering financial support to firms through various forms (fiscal incentives, subsidies and/or loans). As reported by the OECD (2016), subsidies have been for long time now the main tool of support for R&D policy of small and medium enterprises of advanced countries. This is also confirmed by the empirical analysis of Falk (2006).

The well design and application of the public financing scheme can be relevant to reach the already mentioned 3% European target in R&D intensities. Indeed, as reported by COTEC (2018), if we analyze the Spanish R&D performance, it is very positive in terms of efficiency (input to output ratios), but way less in quantity. This means that the few firms doing high-intensity R&D activities tend to perform well, but it would be preferable to have consistently more firms that pose this high targets. One way to achieve this is through a diversified and well-balance subsidy scheme.

Large and long debates have been conducted among scholars that

wanted to establish whether this public support leads potentially to crowding out effects or not (Zúñiga-Vicente, Alonso-Borrego, Forcadell, and Galán (2014) for survey on the evidences[2]). Nevertheless, this question is out of the scope of this paper, as our aim is simply to disentangle the effect that the overall public financing scheme had on every part of the distribution of research and development.

In general, the literature has shown evidence on the positive influence of R&D subsidies on R&D investments. Here, we consider that there will be a positive influence on internal R&D effort. However, it will be more significant for firms with a high intensity in R&D intensity. Mainly, small and young firms are those that have a higher R&D intensity. The evidence shows that the positive influence of R&D subsidies is higher for small and young firms since otherwise they would not have invested in R&D (González & Pazó, 2008). Hence, it is interesting to analyze the relationship between R&D subsidies and the influence on the R&D intensity.

RQ1: Do public R&D financing contributes more to R&D intensive firms?

[2]Using data for Spain, both González and Pazó (2008) and Aristei, Sterlacchini, and Venturini (2017) found that these subsidies have low or none crowding out effects for firms.

Gazelles in the Savannah

The second factor that we take into account for the analysis is the presence of what we define as "gazelles in the Savannah", and that thanks to their dynamicity, they are largely responsible in shaping the innovation patterns of a country (Hölzl, 2009). Particularly, the type of firms included in this group are high-growth firms (either in terms of employment or of sales) and young innovative companies.

The first group, high-growth firms (HGFs), has a long history of analysis that posed them at the center firm growth debate for quite a decade thanks to their ab-normal contribution to aggregate employment dynamics (Henrekson & Johansson, 2010). Despite large heterogeneity in their definition (Delmar et al., 2003), the main characteristics of HGFs are: the above average growth, the tendency to be younger, the quasi-homogeneous presence across sectors, the tendency to be more innovative and to go more into international markets (Moreno & Coad, 2015).

The second group, young innovative companies (YICs), has been more recently defined by the European Commission and it corresponds to these companies younger than 6 years, with fewer than 250 employees, and operating at least at 15% of research and development intensity. Almost by definition, these are the companies that should foster aggregate productivity growth thanks to their large innovation focus and disruptive approaches (Czarnitzki & Delanote, 2012; Schneider &

Veugelers, 2010).

On the one hand, many studies have proven the positive association between HGFs and R&D intensity (Delmar et al., 2003; Schreyer, 2000; Stam & Wennberg, 2009). Also Segarra-Blasco and Teruel (2014) confirm the positive association, which seems stronger when looking exclusively at manufacturing industries. On the other hand, YICs are technologically-intensive by definition, as it requires them to have at least 15% of their turnover to research and development. Further, Cincera and Veugelers (2013) find that one third of the EU-US gap in R&D intensity is due to the lower share of young and innovative companies in the European economy. Consequently, thanks to their peculiar organizational profiles, the above firms, HGFs and YICs, are in the perfect position to be major influencer of the distribution of research and development intensities across a given country.

Chronologically, we might expect this group's contribution to R&D to decrease over time. This suggestion comes from Decker, Haltiwanger, Jarmin, and Miranda (2016), who show that the impact of these firms on productivity has decreased significantly for the US economy. Being R&D one of the main inputs for productivity increases, this parallel is tested.

RQ2: Are HGFs and YICs positive contributors to the intensity of internal R&D investment across the whole distribution? Is the effect larger for the more intensive part of the distribution?

Financial constraints

Another factor that can play a potentially big role in shaping how much money firms allocate to their R&D activities is financial constraints. As for the previous ones, this concept has received large scholarly attention and has been debated in terms of measurement and approaches to model it (Farre-Mensa & Ljungqvist, 2016; Hadlock & Pierce, 2010). However, it is worth discussing how and to what extent these constraints may impact R&D expenditure.

Financial constraints influence all firms to some extent, but especially innovative ones due to both uncertainty and information asymmetries between borrowers and lenders. Nevertheless, the impact is likely to depend on many factors such as the type of technological effort pursued by each company and its internal and accounting characteristics. Particularly, according to Czarnitzki and Hottenrott (2011a), a key distinction is the one between routine versus cutting edge research and development investment, with the latter much more impacted than the former. In a similar fashion, we expect that high R&D intensive firms may be more harmed than normal or low ones. Also, García-Quevedo et al. (2018) find that the innovation concept stage is the most hindered by internal and external financial constraints.

Brown and Petersen (2015) further extended the arguments to why firms should take care first about R&D. They argue that R&D creates tacit knowledge stored in employees' mind rather codified knowledge;

the knowledge will be lost if the employee leaves the firm or are fired, therefore firms need to utilize liquidity first to support R&D. Their results also support this argument by finding that R&D intensive firms utilize cash holdings first to support R&D to sacrifice stock of fixed capital during financial crises. Kabukcuoglu (2019) finds financial strength as a significant determinant of R&D. The main reason is that R&D projects require heavy investments in form of skillful employees and another compulsory setup which consume heavy funds (Cuervo-Cazurra & Un, 2010).

However, small and young firms are not able to take the same advantage of R&D investments in comparison with large firms. R&D projects require of intangible investments and long-term maturation periods. This causes that small and young firms will not have the same capacity to take advantage of R&D activities. Further, financial constraints seem to affect more innovative SMEs, particularly during financial crisis (Lee, Sameen, & Cowling, 2015). Finally, the impact of financial constraints seems to be negatively related with size, meaning that smaller firms are more likely to be harmed by the lack of financing for their projects (Czarnitzki & Hottenrott, 2011b).

RQ3: Do financial constraints affect negatively internal R&D investment across the whole distribution?

Firms' characteristics

Finally, obvious determinants of the firm-level decision to invest in research and development are some basic firms' characteristics. In this, we avoid over-complicated specifications in the decomposition framework as a way to leave the results interpretable, while also controlling for fundamental characteristics in the R&D investment allocation.

Indeed, despite at least 30 years of research on the topic, there is no consensus on the set of determinants of research and development. In 1989, Hall and Hayashi noted that despite the relevance of this expense item, the literature was still lacking a proper formalization of it and its determinants. Hall (1993) constitutes an important attempt in this direction, but as for the previous ones, the exercise relied heavily on Tobin's q theories, which include delicate assumptions that do not always hold (Domns & Dunne, 1998), especially when uncertainty is so present.

For this reason, we follow another approach, whose elements are present in Dosi (1988). Particularly, we rely on the few, robust evidences on the topic that show how firm-level, research and development investment can be modeled as a "martingale with a relatively low variance" (Griliches et al., 1986). Indeed, considering the huge degree of uncertainty involved in the process, firms are likely to develop some heuristics (or meta-rules) that make their routinely-decided level vary according to economic shocks, changes in relative prices and/or sectoral

variations.

In this light, as firms' characteristics, we include their size in terms of employees, their level of sales and finally, their sectorally-normalized sales growth rates. The first two items control for variations in the basis of the above meta-rule. While, the third one has multiple objectives. First, it is to control for sectoral variations in demand that may change the innovative effort of firms. Also, it removes possible biasing factor such as inflation and business cycle, while controlling for individual firms' growth (Bianchini et al., 2017). Second, García-Quevedo, Pellegrino, and Vivarelli (2014) show that especially young companies R&D investment is very sensitive to demand fluctuations. The result is also confirmed when looking at intensities by Barge-Gil and López (2014). Further, this variable can also control for relative performance of the firms, as well as for differences in opportunities among sectors.

RQ4: Do firms' characteristics have a higher influence for firms in the upper part of the internal R&D distribution?

4.3 Data

4.3.1 Database and statistics

Our focus is to analyze the contribution of different components to the Spanish firms', internal research and development distribution. For this reason, instead of selecting firms according to specific economic

sectors, we focus on the sample of firms performing R&D activity. This decision has multiple explanations among which, the fact that the aim of this study is to decompose the distribution of R&D in a country, and we are not interested in firms that are not part of it. Also, as shown by Tether (2005), contrary to common belief, also the service sector is a locus of innovation.

As database, we rely on PITEC, Panel de Innovación Tecnológica, an yearly project conducted by the Spanish Statistical Office (INE) and the Spanish Foundation for Science and Technology (FECYT). Largely based on the Community Innovation Survey framework, thanks to its coverage, representativeness and structure, it is among the most analyzed data sources in innovation studies (Audretsch, Segarra-Blasco, & Teruel, 2014; Barge-Gil & López, 2014; Coad et al., 2016; De Marchi, 2012; Segarra-Blasco & Teruel, 2014).

In terms of representativeness, the data is the first-best in our context, as it contains, according to the year of interest, from 73% to 93% of the total national investment in internal R&D (please refer to Table 4.13). Further, thanks to the peculiar positioning of our data, it is also possible to estimate how these contributions have (or have not) changed before and after the global economic downturn that hit Spain particularly hard. With this aim, we start by proposing the complete descriptive statistics for our sample of firms performing R&D investment for the years of interest.

Table 4.1: Descriptive statistics for the distributions of interest – Spanish firms performing R&D

Year	Internal R&D	Gazelles	Public financing	FC	Sales	Size	Sectorally normalized sales growth	
2004	775,896.40	0.19	125,066.90	0.40	65,100,000.00	251.54	0.01	mean
	5,682.00	5,682.00	4,096.00	5,682.00	5,682.00	5,682.00	4102.00	N
	4,410,000,000.00	1,065.00	512,000,000.00	2,261.00	370,000,000,000.00	1,429,226.00	53.48	sum
	123,000,000.00	1.00	92,300,000.00	1.00	5,790,000,000.00	20,155.00	6.63	max
	151.00	0.00	0.00	0.00	1,623.00	1.00	-8.16	min
	1.55E+13	0.15	2.90E+12	0.24	1.32E+17	1,244,147.00	0.22	variance
	17.98	1.60	45.25	0.42	12.61	11.98	0.74	skewness
	441.02	3.57	2,285.63	1.17	181.85	173.38	63.34	kurtosis
2008	1,288,035.00	0.21	237,293.50	0.45	88,400,000.00	308.27	0.03	mean
	5,296.00	5,296.00	5,296.00	5,296.00	5,296.00	5,296.00	5261.00	N
	6,820,000,000.00	1,112.00	1,260,000,000.00	2,394.00	468,000,000,000.00	1,632,608.00	165.85	sum
	498,000,000.00	1.00	56,500,000.00	1.00	9,250,000,000.00	41,168.00	5.69	max
	921.70	0.00	0.00	0.00	1,661.00	1.00	-6.86	min
	1.17E+14	0.17	1.98E+12	0.25	1.97E+17	2,381,725.00	0.24	variance
	31.51	1.42	21.34	0.19	12.17	15.97	-0.89	skewness
	1,207.59	3.03	684.55	1.04	186.69	341.81	40.72	kurtosis
2009	1,299,279.00	0.20	268,185.70	0.48	87,500,000.00	321.05	0.02	mean
	4,782.00	4,782.00	4,782.00	4,782.00	4,782.00	4,782.00	4741.00	N
	6,210,000,000.00	961.00	1,280,000,000.00	2,279.00	418,000,000,000.00	1,535,265.00	107.08	sum
	365,000,000.00	1.00	61,400,000.00	1.00	9,030,000,000.00	40,504.00	5.69	max
	2,129.00	0.00	0.00	0.00	1,484.00	1.00	-4.53	min
	7.10E+13	0.16	2.90E+12	0.25	2.29E+17	2,618,773.00	0.23	variance
	26.70	1.49	20.45	0.09	12.98	15.41	-0.13	skewness
	965.69	3.23	567.85	1.01	206.13	308.55	25.03	kurtosis
2014	1,472,686.00	0.18	153,202.70	0.44	101,000,000.00	336.28	0.03	mean
	3,340.00	3,340.00	3,340.00	3,340.00	3,340.00	3,340.00	3318.00	N
	4,920,000,000.00	595.00	512,000,000.00	1,455.00	338,000,000,000.00	1,123,167.00	113.97	sum
	188,000,000.00	1.00	38,100,000.00	1.00	9,680,000,000.00	37,835.00	5.72	max
	2,330.80	0.00	0.00	0.00	4,279.00	1.00	-5.37	min
	5.40E+13	0.15	1.26E+12	0.25	2.59E+17	2,034,582.00	0.12	variance
	14.14	1.68	21.21	0.26	13.00	13.47	1.12	skewness
	256.87	3.83	576.94	1.07	208.47	247.88	76.24	kurtosis

Source: own elaboration from PITEC.

For the sake of our study, we remove firms reporting unusual amounts of R&D intensities[3] and also firms from critical sectors such as Oil, Agriculture, and Extractive Industries. Doing so, we arrive to a pol-

[3]Specifically, firms declaring 1€ of sales, while putting large amount on the R&D item and firms declaring R&D intensities higher than 100%

ished version of the data comprising the following number of observations: 4366 in years 2004 and 2008, while 3289 for the years 2009 and 2014, summing up to 15310 year-firm pairs.

From the above statistics, we can observe how the main variables of interest fluctuated during the period of observation. Starting from the research and development item, we can notice that it roughly followed the Spanish business cycle trend, meaning that it increased constantly and voluminously during the period 2004-2008 to then contract, also due to the austerity measures, in the period 2009-2014. In parallel, the governmental financing scheme of research and development followed roughly the same trend. On the contrary, the presence of gazelles in the economy tended to stay constant in relative number. Finally, we can observe how financial constraints seem to have slightly increased their influence during the uprising of Spanish economy.

As a measure of R&D, we focus on R&D intensities, rather than pure investment. Doing so, we correct for likely, scale effects following a large literature on the topic (Dosi, 1988; Graboskwi & Baxter, 1973; Leonard, 1971; Smith & Creamer, 1968). By this, we define R&D intensity posing investment in R&D at the numerator of a ratio, whose denominator is net sales, thus obtaining some quantity proportional to the volume of sales, as a way to eliminate scale effects.

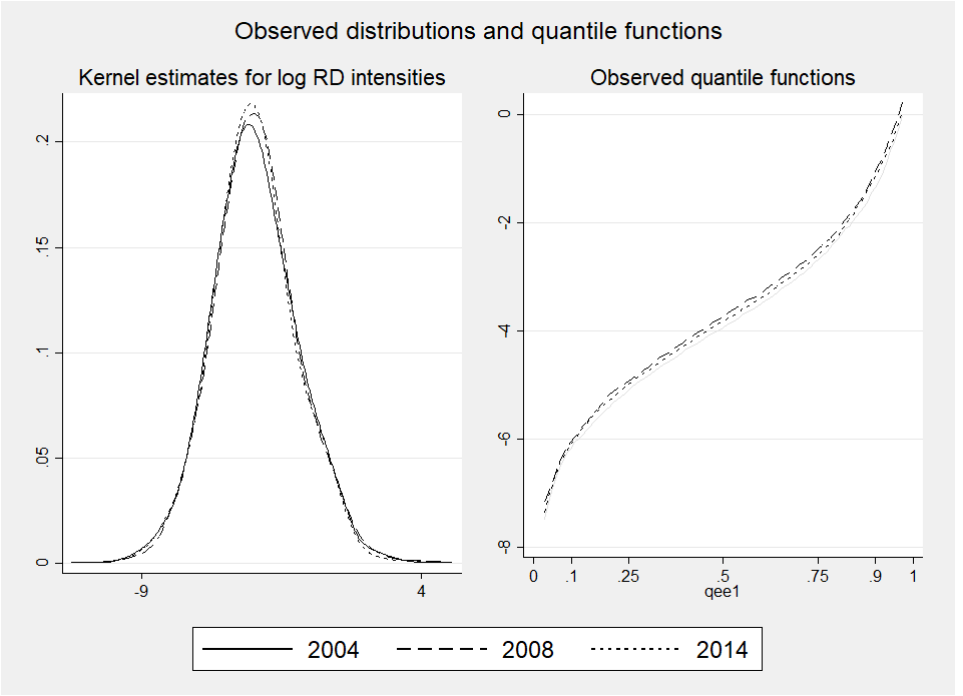
One statistical fact about research and development is the high degree of concentration that its concentration curve shows, with the

vast majority of registered firms doing no R&D at all.[4] This is especially true for private business enterprises, where few firms compose the almost entirety of global expenditure in R&D. The other feature relative to research and development intensities is its considerably high variance, which tend to increase across the unconditional distribution, with the most intensive quantiles showing the most variance (see Figure 4.1). This is also in line with what detected by Xifré (2016), who showed that Spain R&D expenditure volatility is twice than Italy, and three times as much as France and Germany.

From Figure 4.1, we can observe where the empirical differences emerge along the distributions of interest. First, looking at the kernel densities, it is quite clear that from 2004 there has been a small location shift toward the right, such that the aggregate distributions relative to 2009 and 2014 exhibit a higher mean value. Also, we can see that unconditionally, the changes that took place in the expansionary period are quite widespread and balanced over the distribution. On the contrary, looking at the contractionary period, it is clear that movements are concentrated in the two tails. The quantiles with low R&D intensive firms become more populated, while the top intensive ones experience a reduction in volume.

[4]E.g. For Spain, in 2017, there were 10,179 total enterprises doing some R&D, over a population of roughly 3.5 million enterprises (INE, 2017). Also, across all years, the internal R&D investment by the top 1% of R&D investors in our sample, on average 190 firms, correspond to 1/4 of the overall aggregate, internal and external R&D expenditure in Spain.

Figure 4.1: Kernel density of and quantile functions (2004, 2008, 2014).



Source: own elaboration from PITEC database.

In the next sub-section, we analyze also where these changes are located once we introduce our conditional model, and this allows to get an intuition of some of the mechanisms at play in the time evolution of Spanish internal private R&D distribution.

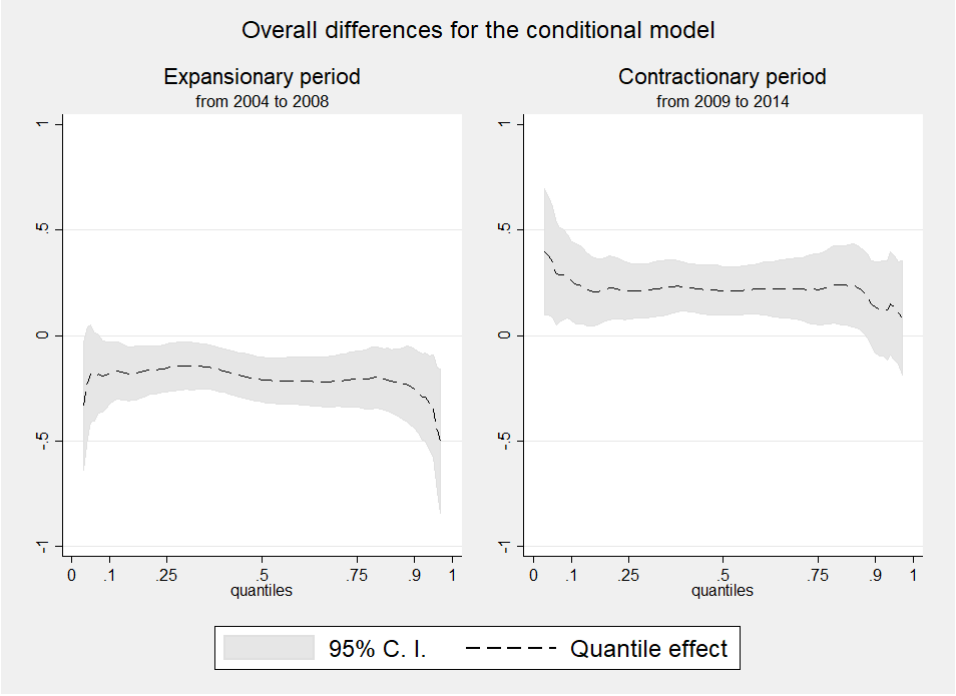
4.3.2 Further motivation(s) and statistics

From Figure 4.2, we notice how the changes in our conditional distributions[5] of interest took place in different manners. On the one hand,

[5]Corresponding to the first terms of Equation 1.1

for the expansionary period, we can see that the changes in the conditional model tend to be constant at the center of the distribution, but increase notably in the two tails. This setting is already requiring an econometric approach able to disentangle effects across the whole distribution, as a way to make the picture clearer.

Figure 4.2: Overall differences for the conditional model (2004-2008, 2009-2014).



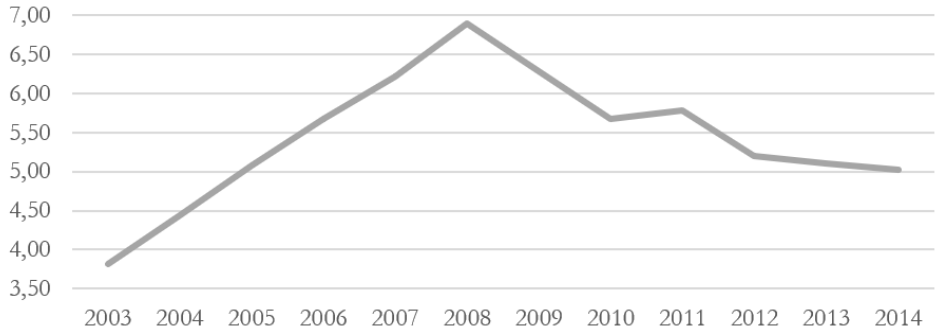
Source: own elaboration from PITEC database.

On the other hand, for the contractionary period, we can see that the bigger changes takes place in the less R&D intensive quantiles, while the more intensive ones are characterized by higher variance. For

this reason, the estimation approach shall also be able to differentiate the possible effects of different determinants.

Further, as anticipated in the above section, we exploit this dataset because of its extensive coverage and its perfect time location for our scope. Indeed, the Spanish R&D expenditure has followed two strong trends: a great uprising, during the period 2004-2008, as opposed to a non-trivial decline dictated by the consequences of the economic crisis in the period 2009-2014. This trend is depicted in Figure 4.3.

Figure 4.3: Spanish internal R&D expenditures (2003-2014).



Source: own elaboration from PITEC database.

4.4 Econometric approach

4.4.1 Methodology

Despite seldomly explicitly referred, decomposition methods have a long tradition in economics. The seminal works by Oaxaca (1973) and

Blinder (1973) paved the way to the refinement and development of methods aimed at decomposing a distribution according to appropriately chosen components, going also beyond the simple distributional mean. In this context, Chernozhukov et al. (2013) is among the most updated and rich approach to this problem.

The main advancement in this sense has been to overcome the apparent inapplicability of quantile regressions to this purpose finding an alternate route: distribution regressions (Fortin, Lemieux, & Firpo, 2011). If a cumulative distribution represents the one-to-one mapping between the unconditional quantiles and the associated proportion observed, it is possible to start from there. Particularly, Chernozhukov et al. (2013) follow this route and by decomposing proportions at each percentile of the distribution and then reversing the fitted relationship to quantiles.

Extensively used in labor economics, these approaches have seen little attention from the innovation scholars community. A relevant exception is Fariñas and Ruano (2004), which decompose productivity trying to disentangle the separate contributions of incumbent, entering and exiting firms. Although the estimation methodology was still at embryonic stages, it is possible to define one common trait: the reliance on estimating a counterfactual distribution. This is also key in Chernozhukov et al. (2013) approach, where the idea is to estimate appropriately defined counterfactuals, and thanks to them, estimating the individual factors contributions.

Finally, despite its undeniable perks, these approaches have one main limitation: counterfactuals may not be enough for causal insights, or understanding the exact underlying mechanisms in act. This is only possible through extremely careful and well checked assumptions that do not always hold and that we do not check for here.

4.4.2 Identification strategy and our decomposition

Following Chernozhukov et al. (2013) and Fortin et al. (2011), we develop our identification strategy to decompose the changes in the R&D distribution of Spain. As anticipated, we conduct our analysis for two periods that have been particularly relevant and turbulent for the global economy. The same identification strategy will be applied for the two periods, also in light of a comparability perspective. We isolate four main factors suspected to influence the evolution of research and development dynamics: the level of governmental financing, the role of gazelles, the number and structure of financially-constrained firms, and finally, firms' characteristics. Particularly, the employed methodology allows to insert each factor as if it was an equation, thus not limiting to use only one explanatory variable per factor. Also, it gives us the possibility to explain one factor by more than one variable.[6] In our case, the specification entails the following:

[6]Trivially, this implies a trade-off between interpretability of the results and explanatory power of the model. Keeping this in mind, we strive for maintaining the results interpretable, while also checking for some, basic firms' characteristics.

Table 4.2: Variables definition

Factor name	Definition	Reference variable in PITEC
Internal R&D intensity	Ratio of internal R&D expenditure to sales level (in logs)	GINTID
R&D public financing	Internal R&D expenditure financed with public funding	FONPUBLI
Gazzelles	Either one of the three conditions below holds.	
- HGF sales		Own elaboration
- HGF employment		Own elaboration
- YIC		Own elaboration
Financial constraints	Firms declaring lack of either internal or external funding as highly relevant	FACE1, FACE2[a]
Firm-level characteristics		
- sales level	Volume of turnover	CIFRA
- size	Number of employees	TAMANO
- sectorally normalized sales growth	Year sales growth minus 2-digit sector average growth [b]	Own elaboration

[a]This is a categorical variable and firms can report their constraints as 1) high, 2) medium, 3) low, or 4) irrelevant. We consider as financially constrained, only firms reporting "high" as an answer to either FACE1 or FACE2. The question asks: "How much importance has the lack of funding in obstructing your innovative activities or your innovation decision?"

[b]In PITEC, sectors follow the CNAE-2009 classification. It is possible to find more information on it and on its relationship with NACE Rev. 2 at the following link: `https://www.ine.es/dyngs/INEbase/es/operacion.htm?c=Estadistica_C&cid=1254736177032&menu=ultiDatos&idp=1254735976614`

The definition of the above four effects can emerge as differences between appropriately chosen and estimated counterfactual distributions. Hereby, we develop the decomposition relative to the years 2004-2008, the expansionary period. It is possible to obtain the same decomposition for the contractionary period by simply substituting the appropriate time indexes. Suppose $F_{RDint(a,b,c,d)}$, corresponds to the counterfactual distribution of log R&D intensities, when: a) the public financing scheme is as in year a, b) the gazzelles are those in year b, c) financial constraints apply as in year c, and, d) firms' characteristics are as in year d.

Given the above counterfactuals and thanks to the law of iterated probabilities, it is possible to decompose the observed change in the distribution of research and development intensity between two years (2004, year 0, and 2008, year 1) into the sum of the above four effects, as follows:

$$\begin{aligned} & F_{RDint_1|(1,1,1,1)} - F_{RDint_0|(0,0,0,0)} = \\ & = [F_{RDint_1|(1,1,1,1)} - F_{RDint_1|(0,1,1,1)}] + [F_{RDint_1|(0,1,1,1)} - F_{RDint_1|(0,0,1,1)}] + \\ & + [F_{RDint_1|(0,0,1,1)} - F_{RDint_1|(0,0,0,1)}] + [F_{RDint_1|(0,0,0,1)} - F_{RDint_1|(0,0,0,0)}] \end{aligned} \tag{4.1}$$

More in detail, this requires the identification and estimation of the following counterfactuals:

- $F_{RDint_1|(0,1,1,1)}(y) = \int F_{RDint_1|(1,1,1,1)} \cdot dF_{RDint_1|(0,1,1,1)}(x)$, which

corresponds to the distribution of R&D intensities that would prevail in 2008 if firms were subjects to the public financing scheme of 2004;[7]

- $F_{RDint_1|(0,0,1,1)}(y) = \int F_{RDint_1|(1,1,1,1)} \cdot dF_{RDint_1|(0,0,1,1)}(x)$, which corresponds to the distribution of R&D intensities that would prevail for firms in 2008 if firms were subjects to the public financing scheme of 2004 and the gazzelles were those of 2004;

- $F_{RDint_1|(0,0,0,1)}(y) = \int F_{RDint_1|(1,1,1,1)} \cdot dF_{RDint_1|(0,0,0,1)}(x)$, which corresponds to the distribution of R&D intensities that would prevail in 2008 if gazzelles were the ones of 2004 and firms were subjects to the public financing scheme and financial constraints of 2004.

Some final notes before moving to the actual estimation of our decomposition. As largely acknowledged in the literature, the results of this type of decompositions can be order-independent. For this reason, it is necessary to run the estimation model for each possible order of the decomposition, as a way to better explore the sensitivity and robustness of the findings.

Further, there exists a decision involved in the choice of the esti-

[7]Due to data limitations, firm-level public financing data is available only for 2003 and 2005. Thus, for the baseline version, we actually use 2003 public financing data, but we then explore in the robustness checks, the sensitivity of the findings to alternative choices. All the relevant results show correlations higher than 90%, thus we can safely conclude that this does not affect our findings.

mator for the above-outlined conditional distributions. Among the existing techniques, Chernozhukov et al. (2013) individuate as a leading candidate the distribution regression approach, both under theoretical and empirical considerations. Indeed, the possibility of non-linear effects across quantiles and the better performance in presence of sizable mass points make distribution regression also our preferred candidate estimator.

Finally, following the Oaxaca-Binder decomposition approach, it is possible to decompose the left-hand side of equation 4.1 in an alternatively valid manner, as follows:

$$F_{RDint_1|(1,1,1,1)} - F_{RDint_0|(0,0,0,0)} = \\ = \left[F_{RDint_1|(1,1,1,1)} - F_{RDint_1|(0,0,0,0)}\right] + \left[F_{RDint_1|(0,0,0,0)} - F_{RDint_0|(0,0,0,0)}\right] \tag{4.2}$$

Above, we can identify two effects at play for the observed variations in the distribution: 1) a "characteristic effect" due to changes in our selected determinants, and 2) a "coefficient effect", which is imputable to changes in the estimated parameters. If the characteristic effect can be interpreted quite straightforwardly, the same does not hold for the coefficient effect, which may hide simple intercept shifts or altered coefficient in any of our covariates. Despite this apparent black-box, we will also get robust hints at how to interpret the two effects in our application.

Finally, the whole analysis outlined above is performed twice for the two periods of interest: the pre-crisis period (2004-2008) and the post-crisis one (2009-2014). This is done for mostly two reasons. On the one hand, the temporal division according to the business cycle movements reduces the bias coming from them. On the other hand, this division allows the introduction of a comparative perspective, which can bring insights on how our variables' influence changed according to the period of interest.

4.5 Main empirical results

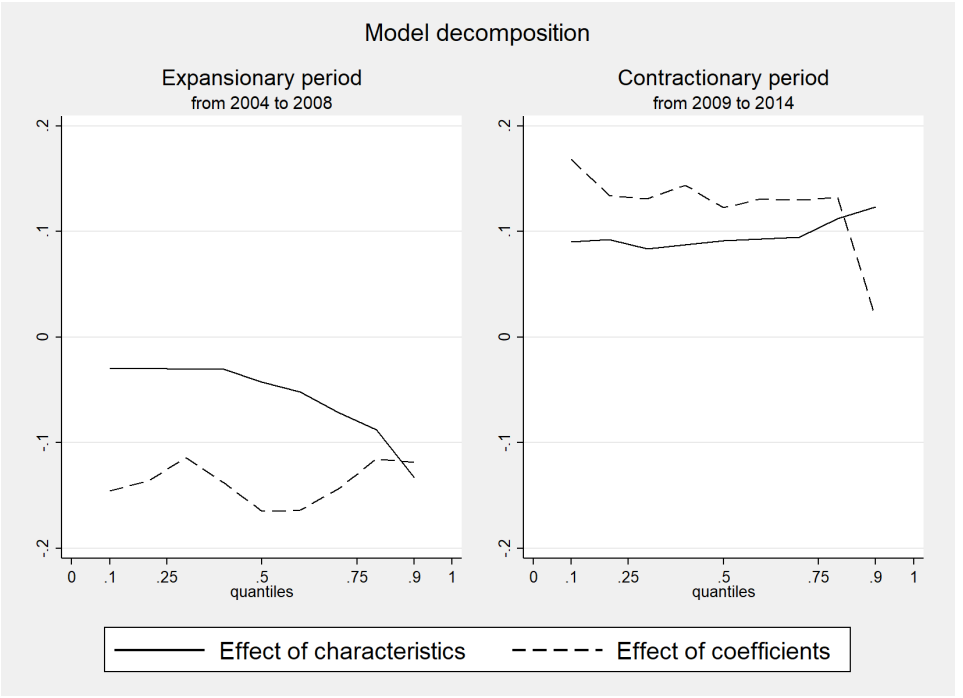
4.5.1 Aggregate model decomposition

Before analyzing the estimations of interest, we propose some results that have the potential to recap the explanatory power of our model and thus, also to assess its performance. This is done by estimating the decomposition outlined in equation 4.2, whose plots can be found below in Figure 4.4.

From them, it is possible to observe how the aggregate evolution is driven by change in characteristics (possible variations in the determinants), or by changes in coefficients (the implicit effect of our determinants). First, we notice that with the exception of the top, R&D intensive quantiles, the model is driven by the coefficient effect more than it is by the characteristics. This implies that the majority of

the changes are either due to a change in the implicit effect of our determinants or by intercept changes. Indeed, we also observe differences in the relative magnitudes of these effect between the two phases under analysis. The effect of our selected determinants in the expansionary phase dominates the same effect estimated for the contractionary phase.

Figure 4.4: Model decomposition following equation 4.2.



Source: own elaboration from PITEC database.

This is also clear from Table 4.3, where the relative magnitudes are roughly two-fold for the expansionary period. In the next sections, we will see how this result is mostly driven by an impoverishment of the

contribution made by gazelles, which decreases strongly over time.

Table 4.3: Aggregate decomposition results – relative magnitudes

Quantiles	Characteristics effect explained by determinants		Coefficient effect explained by coefficients	
	2004-08	2009-14	2004-08	2009-14
0.1	34.9%	17.1%	65.1%	82.9%
0.2	40.8%	17.7%	59.2%	82.3%
0.3	39.0%	21.0%	61.0%	79.0%
0.4	37.9%	18.1%	62.1%	81.9%
0.5	42.7%	20.5%	57.3%	79.5%
0.6	41.5%	24.0%	58.5%	76.0%
0.7	42.2%	33.1%	57.8%	66.9%
0.8	45.8%	43.2%	54.2%	56.8%
0.9	86.6%	52.9%	13.4%	47.1%

Source: own elaboration from PITEC.

Generally, the fact that the coefficient effect is so strong in both periods hints strongly at the influence that business cycle has on the impact of typical R&D determinants. Nevertheless, in both specifications, this effect decreases across quantiles, making the top R&D intensive quantiles less "easily influenced" by these economic fluctuations. Economically, this can be explained by the fact that these quantiles are mostly composed of science-based firms, or R&D specialists (Cattaruzzo, 2020), whose main (or only) business focus is actually introducing novelties in the market.

4.5.2 Pre-crisis (2004-2008) – expansionary phase

R&D public financing

Starting our decomposition analysis, the first terms correspond to estimating the effects that governmental financing had on shaping the research and development distribution. Particularly, a somehow equivalent question would be: how would the distribution of R&D in 2008 look if public financing was of the same level and given to the same firms as they were in 2003? The general answer is quite trivial, lower.

Table 4.4: Estimations of the first term of equation 4.1 – the effect that 2003 R&D public financing would have on the 2008 expansionary peak

Quantile	QE	Pointwise Std. Err.	Pointwise [95% Conf.	Interval]	Functional [95% Conf.	Interval]
0.1	-0.023***	0.007	-0.037	-0.008	-0.041	-0.004
0.2	-0.027***	0.007	-0.041	-0.013	-0.045	-0.009
0.3	-0.031***	0.007	-0.044	-0.017	-0.048	-0.013
0.4	-0.035***	0.007	-0.048	-0.022	-0.052	-0.019
0.5	-0.040***	0.007	-0.054	-0.027	-0.057	-0.023
0.6	-0.043***	0.007	-0.057	-0.030	-0.061	-0.026
0.7	-0.051***	0.008	-0.066	-0.036	-0.071	-0.032
0.8	-0.066***	0.010	-0.084	-0.047	-0.090	-0.041
0.9	-0.095***	0.015	-0.124	-0.066	-0.132	-0.058

Number of observations: 4,366. Significance levels corresponding to * p<0.1, ** p<0.05, and *** p<0.01. Source: own elaboration from PITEC.

Not only it is possible to notice the generalized positive effect that the new financing scheme had on firms' technological intensity, but also it is clear the progressiveness with which these subsidies influenced the

distribution, being the majority of the effects concentrated among top, R&D intensity firms. Indeed, as reported by COTEC (2018), Spanish public financing reached its peak in 2009, not only in levels, but also in efficiency (claimed money over allocated budget), and then plummeted vertically, both in levels, and efficiency.

Gazelles

Similarly to what done for R&D public financing, in this part, the analysis shows how would the distribution look at the peak, if instead of 2008 gazzelles, the ones from 2004 were in place.

Table 4.5: Estimations of the first term of equation 4.1 – the effect that 2004 gazelles would have on the 2008 expansionary peak

Quantile	QE	Pointwise Std. Err.	Pointwise [95% Conf. Interval]		Functional [95% Conf. Interval]	
0.1	-0.009	0.008	-0.026	0.006	-0.032	0.012
0.2	-0.004	0.007	-0.018	0.010	-0.024	0.016
0.3	0.007	0.008	-0.009	0.023	-0.015	0.029
0.4	0.019**	0.008	0.003	0.036	-0.004	0.042
0.5	0.029***	0.009	0.010	0.047	0.003	0.055
0.6	0.041***	0.010	0.021	0.061	0.013	0.069
0.7	0.067***	0.014	0.040	0.094	0.030	0.104
0.8	0.106***	0.017	0.073	0.139	0.060	0.152
0.9	0.190***	0.024	0.144	0.237	0.125	0.255

Number of observations: 4,366. Significance levels corresponding to * p<0.1, ** p<0.05, and *** p<0.01. Source: own elaboration from PITEC.

Here, we can find the first hints at a progressive impoverishment

of this "hyper-firms" contribution to research and development. Indeed, it appears that past gazzelles were able to contribute more to the aggregate technological effort of the country.

Curiously, contrary to what could be expected, these effects are not only concentrated in the more R&D intensive part of the distribution, but also in the less intensive quantiles. The magnitude of the effects differs quite significantly, being the 90-50 ratio roughly 7-fold, but it is interesting to notice how this class of firms contribute quite extensively to research and development intensity.

Financial constraints

Looking at how financial constraints impacted the research and development distribution, some interesting facts emerge. Generally, the (negative) impact of these constraints decreased during the expansionary period, very likely also thanks to the impact of R&D subsidies. This is curious as from Table 1, we can see clearly how firms who declared themselves as financially-constrained increased in number during the expansionary period.

More in detail, top R&D intensive firms were the most affected by financial constraints, which is also in line with the results by Czarnitzki and Hottenrott (2011b), who found cutting-edge research (as opposed to routine one) more impacted by these constraints. In the next section, we will see whether these constraints worsen even more the situation

in a contraction phase or not.

Table 4.6: Estimations of the first term of equation 4.1 – the effect that 2004 financial constraints would have on the 2008 expansionary peak

Quantile	QE	Pointwise Std. Err.	Pointwise [95% Conf. Interval]		Functional [95% Conf. Interval]	
0.1	-0.019***	0.005	-0.028	-0.009	-0.032	-0.006
0.2	-0.031***	0.005	-0.041	-0.020	-0.045	-0.017
0.3	-0.036***	0.006	-0.048	-0.025	-0.052	-0.020
0.4	-0.038***	0.006	-0.051	-0.026	-0.055	-0.021
0.5	-0.040***	0.006	-0.052	-0.028	-0.057	-0.023
0.6	-0.040***	0.006	-0.051	-0.028	-0.056	-0.024
0.7	-0.039***	0.007	-0.052	-0.026	-0.057	-0.022
0.8	-0.041***	0.008	-0.057	-0.026	-0.062	-0.020
0.9	-0.038***	0.010	-0.057	-0.019	-0.064	-0.011

Number of observations: 4,366. Significance levels corresponding to * p<0.1, ** p<0.05, and *** p<0.01. Source: own elaboration from PITEC.

Firms' characteristics

This part of decomposition has mainly the purpose to act as a control for possible structural changes experienced by the Spanish industrial system during the period of analysis. Particularly, here we see whether firms' main characteristics (such as size, sales, and sectorally-normalized growth) played a significant role in shaping aggregate research and development or not, during the expansionary phase.

Table 4.7: Estimations of the first term of equation 4.1 – how would the 2008 expansionary peak look with firms' characteristics as the ones of 2004

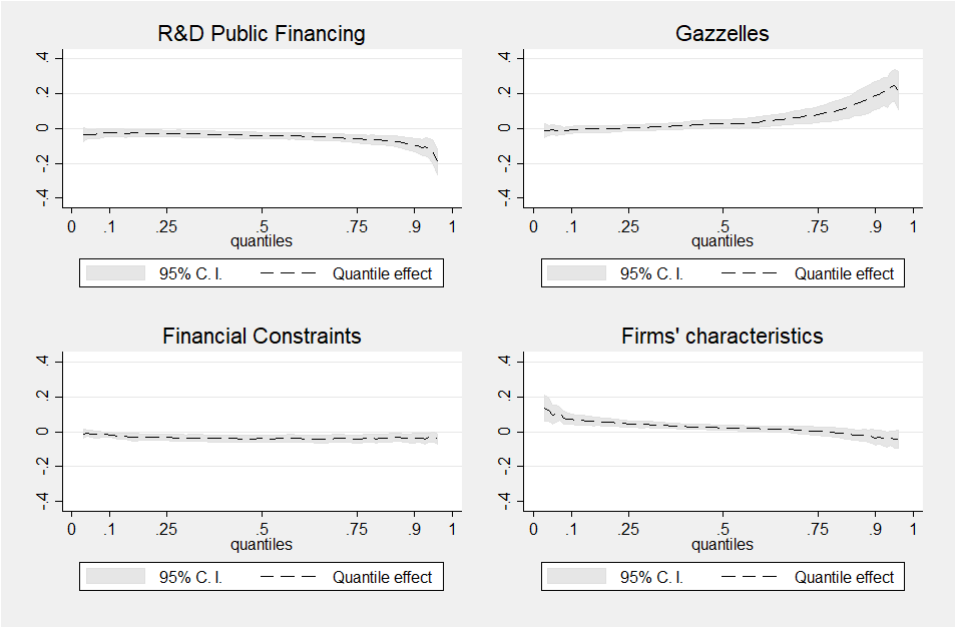
		Pointwise	Pointwise		Functional	
Quantile	QE	Std. Err.	[95% Conf.	Interval]	[95% Conf.	Interval]
0.1	0.072***	0.010	0.053	0.091	0.044	0.100
0.2	0.056***	0.007	0.041	0.070	0.035	0.076
0.3	0.042***	0.007	0.029	0.056	0.023	0.062
0.4	0.031***	0.005	0.021	0.041	0.017	0.046
0.5	0.024***	0.005	0.013	0.035	0.008	0.040
0.6	0.017***	0.006	0.005	0.028	0.000	0.033
0.7	0.007	0.008	-0.009	0.022	-0.016	0.029
0.8	-0.010	0.011	-0.032	0.012	-0.042	0.022
0.9	-0.044**	0.017	-0.078	-0.010	-0.093	0.005

Number of observations: 4,366. Significance levels corresponding to * p<0.1, ** p<0.05, and *** p<0.01. Source: own elaboration from PITEC.

Interestingly, here the effects on the distribution show some strong asymmetry. On the one hand, the upper part of the distribution would show lower performance if firms' characteristics were those of 2004. On the other hand, the lower quantiles would be more abundant in presence. All of this hints at the fact that during the expansionary phase, Spanish firms became somehow more specialized, increasing their presence in top performing quantiles.

Below, in Figure 4.5, it is possible to visualize the plots corresponding to the last four tables. The summary of the results for the expansionary period stresses what has been tried to underline during the previous paragraphs. In particular, the fundamental role played by Gazelles and R&D public financing schemes.

Figure 4.5: Plots of the pre-crisis counterfactual effects (2004-2008)



Source: own elaboration from PITEC database.

4.5.3 Post-crisis (2009-2014) – contractionary phase

R&D public financing

The global economic downturn hit Spain with ferocious strength, damaging several markets, spanning from real estate to research-intensive industries. As introduced in the previous sections, this turn of events also led to a considerable contraction in both R&D investment and subsidies. In this context, it is particularly interesting to see what could have happened if the Spanish government was able to maintain the pre-crisis, public financing scheme intact.

Table 4.8: Estimations of the first term of equation 4.1 – the effect that 2009 R&D public financing would have on the 2014 contractionary downturn

Quantile	QE	Pointwise Std. Err.	Pointwise [95% Conf.	Interval]	Functional [95% Conf.	Interval]
0.1	0.072***	0.010	0.053	0.091	0.044	0.100
0.2	0.056***	0.007	0.041	0.070	0.035	0.076
0.3	0.042***	0.007	0.029	0.056	0.023	0.062
0.4	0.031***	0.005	0.021	0.041	0.017	0.046
0.5	0.024***	0.005	0.013	0.035	0.008	0.040
0.6	0.017***	0.006	0.005	0.028	0.000	0.033
0.7	0.007	0.008	-0.009	0.022	-0.016	0.029
0.8	-0.010	0.011	-0.032	0.012	-0.042	0.022
0.9	-0.044**	0.017	-0.078	-0.010	-0.093	0.005

Number of observations: 3,308. Significance levels corresponding to * p<0.1, ** p<0.05, and *** p<0.01. Source: own elaboration from PITEC.

The answer to the above question is that the previous public financing scheme would have granted a generalized higher performance among firms' R&D intensity. Again, the progressive effect of the scheme emerged also in the previous estimation is confirmed, being the top performing quantiles those who would have benefited the most

Gazelles

Here, we resume our analysis on the role that gazelles had in shaping the research and development distribution under the contractionary phase. What emerged in the previous section was that gazelles' contribution slowed down considerably when comparing 2004 gazelles' performance to those of 2008. Following this finding, the same is confirmed

when comparing 2009 gazelles' with those of 2014. These evidences together show a general decrease in the capacity (or willingness) of this class of firms to contribute to aggregate research and development, which at the contrary is likely to be sustained now by different types of firms.

Table 4.9: Estimations of the first term of equation 4.1 – the effect that 2009 R&D gazelles would have on the 2014 contractionary downturn

Quantile	QE	Pointwise Std. Err.	Pointwise [95% Conf. Interval]		Functional [95% Conf. Interval]	
0.1	-0.002	0.008	-0.018	0.013	-0.023	0.018
0.2	0.000	0.007	-0.014	0.014	-0.018	0.018
0.3	-0.001	0.007	-0.014	0.011	-0.018	0.016
0.4	0.004	0.008	-0.011	0.019	-0.016	0.024
0.5	0.007	0.008	-0.010	0.023	-0.015	0.029
0.6	0.015	0.010	-0.004	0.034	-0.011	0.040
0.7	0.029**	0.012	0.006	0.052	-0.002	0.059
0.8	0.044***	0.015	0.016	0.073	0.006	0.082
0.9	0.097***	0.022	0.054	0.140	0.040	0.155

Number of observations: 3,308. Significance levels corresponding to * p<0.1, ** p<0.05, and *** p<0.01. Source: own elaboration from PITEC.

Interestingly, focusing on the 90-50 ratio, as a proxy for (positive) outliers dispersion, this is way bigger if compared to the magnitude of the ratio measured during the expansionary phase (from 7 to 14), hinting thus also at major concentration of the effects on the right part of the distribution. Beside the observed, general decline in gazelles relevance for R&D dynamics, it is also clear that these firms show low resiliency during the crisis, struggling quite much to maintain their

usual contributions to the economy.

Financial constraints

Despite the quite distinct trend that financial constraints had during the expansionary phase, the corresponding results for the following, contractionary period are considerably different. Quite unexpectedly, we find that financial constraints seemed to have almost no role in affecting research and development expenditures by Spanish firms in the period 2009-2014.

Table 4.10: Estimations of the first term of equation 4.1 – the effect that 2009 financial constraints would have on the 2014 contractionary downturn

		Pointwise	Pointwise		Functional	
Quantile	QE	Std. Err.	[95% Conf.	Interval]	[95% Conf.	Interval]
0.1	-0.002	0.008	-0.018	0.013	-0.023	0.018
0.2	0.000	0.007	-0.014	0.014	-0.018	0.018
0.3	-0.001	0.007	-0.014	0.011	-0.018	0.016
0.4	0.004	0.008	-0.011	0.019	-0.016	0.024
0.5	0.007	0.008	-0.010	0.023	-0.015	0.029
0.6	0.015	0.010	-0.004	0.034	-0.011	0.040
0.7	0.029**	0.012	0.006	0.052	-0.002	0.059
0.8	0.044***	0.015	0.016	0.073	0.006	0.082
0.9	0.097***	0.022	0.054	0.140	0.040	0.155

Number of observations: 3,308. Significance levels corresponding to * p<0.1, ** p<0.05, and *** p<0.01. Source: own elaboration from PITEC.

Indeed, some negative effect is there, but the absence of statistical significance under several, different statistical tests hints at large lev-

els of dispersion in the way financial constraints impacted firm-level contributions (and decisions).

These results are in line with Harhoff (2000), Mulkay, Hall, and Mairesse (2001), Cincera (2002) and Audretsch and Weigand (2005) who find that R&D investments are less subject to financial constraints than physical capital investments. The reasoning under this lack of impact may be the characteristics of R&D projects where long-term nature and high adjustment costs cause insensibility between financial constraints and the decision to reduce the investment.

In particular, Cincera (2002) find that financial constraints affect the decision to start new R&D activities rather than on ongoing R&D projects; while similarly García-Quevedo et al. (2018) confirmed that innovation projects are more sensitive to internal financial sources while, the execution stage is more sensitive to external sources. However, sectors highly dependent of external financial sources or with a low degree of asset tangibility may be more affected (Aghion, Askenazy, Berman, Cette, & Eymard, 2012).

Firms' characteristics

Again, we take a look at whether firms were subject to significant changes that impacted their attitude toward research and development. During the contractionary phase, apparently the asymmetric effect emerged during expansion vanishes. Instead, we find a negative

impact, more strongly concentrated around two quantiles (0.6 and 0.7), but also generally present. This shall be interpreted as an improvement of the general characteristics of Spanish firms from 2004 to 2014, who became more technologically-prone and showed more attitude to invest in research and development.

Table 4.11: Estimations of the first term of equation 4.1 – how would the 2014 contractionary downturn look with firms' characteristics as the ones of 2009

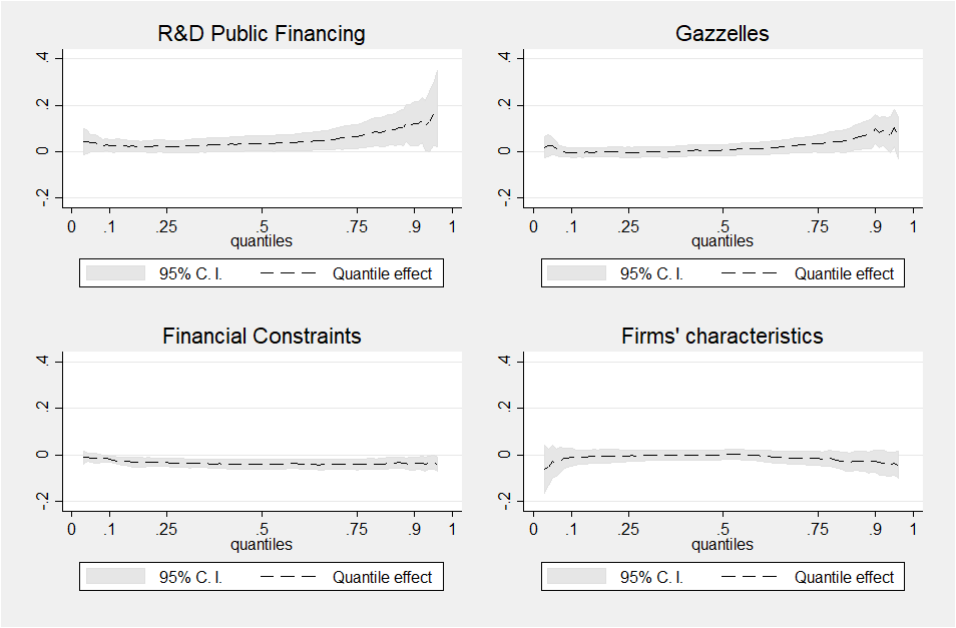
		Pointwise	Pointwise		Functional	
Quantile	QE	Std. Err.	[95% Conf.	Interval]	[95% Conf.	Interval]
0.1	-0.009	0.012	-0.032	0.013	-0.042	0.023
0.2	-0.006	0.009	-0.024	0.011	-0.031	0.019
0.3	-0.002	0.007	-0.015	0.012	-0.021	0.018
0.4	-0.003	0.006	-0.015	0.009	-0.020	0.014
0.5	0.001	0.006	-0.011	0.012	-0.016	0.017
0.6	-0.004	0.008	-0.020	0.012	-0.027	0.019
0.7	-0.012	0.010	-0.032	0.007	-0.040	0.016
0.8	-0.021*	0.013	-0.046	0.003	-0.057	0.014
0.9	-0.029*	0.017	-0.063	0.005	-0.078	0.020

Number of observations: 3,308. Significance levels corresponding to * p<0.1, ** p<0.05, and *** p<0.01. Source: own elaboration from PITEC.

4.5.4 Comparison and interpretation

The most interesting asymmetries that we can derive from the analysis relate to the role that R&D public financing and "gazelles" had in shaping the distribution of Spanish, internal research and develop-

Figure 4.6: Plots of the post-crisis counterfactual effects (2009-2014)



Source: own elaboration from PITEC database.

ment. Indeed, in the expansionary period, it is possible to see how public financing from the years 2008 and 2009, at the very peak of the expansion, were strongly positive and progressive in incentivizing firms' technological intensity. Additional evidence on this is the fact that in 2007, the exploitation of public R&D financing reached its peak, and then, started a monotonic decline that led to only 1/2 of the allocated national budget for R&D financing to be actually claimed by enterprises (COTEC, 2018). This is likely to changes in the application and format of the public financing, which led to much more inefficiency.

In a similar fashion, the role of gazelles, as defined in our analysis, had been very central, especially in the expansionary period. However,

it is also clear how their role loses strength during the period of analysis. The contribution to research and development, which quite trivially was concentrated in the top R&D intensive quantiles, seem to decline as time goes on from 2004 to 2014.

The latter fact is very compelling and it is likely related to the work by Decker et al. (2016), who noticed a general impoverishment in the tails of the growth rate distribution, thus hinting at a progressive, post-2000 decline in the contribution to aggregate productivity from young innovative companies and high-growth firms. In partial confirmation of this for aggregate research and development, we have the distributional results presented above, showing that gazelles' contribution to Spanish firms' R&D intensity is strongly declining. This can potentially explain also their declining contribution to productivity growth through the usual transmission channels (research and development $\rightarrow$ innovation $\rightarrow$ productivity enhancement). Further, the results of the aggregate decomposition between characteristics and coefficient effect reinforce this interpretation.

Finally, if financial constraints were indeed impacting firms at the beginning of the expansionary period, what emerged is that the same did not happen during the strong contraction to which the Spanish industrial system underwent.

Table 4.12: Results summary table

	Expansionary period					Contractionary period				
			Effect of					Effect of		
quantile	Total change	Public financing	Gazelles	FC	Firms' chars.	Total change	Public financing	Gazzelles	FC	Firms' chars.
0.1	0.021	-0.023	-0.010	-0.019	0.072	0.013	0.026	-0.002	-0.001	-0.009
		18.5%	7.9%	15.1%	58.6%		66.5%	6.3%	3.1%	24.1%
0.3	-0.017	-0.031	0.007	-0.036	0.042	0.021	0.024	-0.001	-0.001	-0.002
		26.5%	6.1%	31.0%	36.5%		86.6%	5.1%	1.8%	6.4%
0.5	-0.028	-0.040	0.029	-0.040	0.024	0.044	0.036	0.007	0.000	0.001
		30.2%	21.6%	30.1%	18.0%		82.7%	15.7%	0.4%	1.2%
0.7	-0.016	-0.051	0.067	-0.039	0.007	0.072	0.057	0.029	-0.002	-0.012
		31.1%	40.8%	23.9%	4.2%		57.3%	28.5%	1.9%	12.3%
0.9	0.014	-0.095	0.190	-0.038	-0.044	0.188	0.122	0.097	-0.003	-0.029
		25.8%	51.9%	10.3%	12.0%		48.6%	38.9%	1.0%	11.5%

The coefficient estimates are reported from the above estimations, while percentage contributions to the total variation is computed and reported in the second line of each cell.

4.6 Dicussion and concluding remarks

In this work, we carry out a detailed decomposition of the R&D aggregate distribution. For this aim, we use data for Spain before and after the 2007 global economic downturn. This allows us to have the best possible coverage of data, to analyze each components' contribution according to aggregate economic fluctuations and to study a country that in the years of study, first doubled its private internal R&D levels, and then lost roughly 1/3 in the subsequent period.

To do so, we apply some decomposition techniques that derive from the well-known Oaxaca-Binder decomposition. Nevertheless, instead of focusing on the simple average, we go beyond it and offer detailed explanations of the individual factors' contribution to each part of the R&D distribution. This also allows us to take into account its skewed nature, and its largely heterogeneous composition. First, we select a set of determinants, namely: public financing, gazelles, financial constraints and firms' characteristics. Then, we analyze how these determinants, together and individually, contribute to shaping the overall distribution of research and development.

The empirical results show a general "dominance" of the business cycles for all quantiles other than the very top R&D intensive firms. This implies that for non-R&D specialists, the determinants under study are not the main drivers of their investment decision, rather they are mostly driven by other aggregate economic fluctuations. Looking

at the individual determinants, we identify public financing and the gazelles' contribution as the main determinants in shaping the distribution of interest. Nevertheless, the contribution from gazelles decreases considerably over time from 2004 to 2014. Curiously, financial constraints did impact (negatively) the distribution in the expansionary phases, while seeming unimportant in the contractionary period.

Considering the high degree of influence that governments and administrations have on the management of R&D activities, the obtained results can provide relevant guidance to correct some of the emerged weaknesses in Spanish R&D, especially in the contractionary period. Indeed, from the analysis, it is clear that public financing and the contribution from the group of gazelles are key relevant aspects.

On the one hand, gazelles have been known to be very important players in innovative and dynamic markets. Their support has always been difficult due to the quasi-random firms' growth process; policies aimed at promoting not only their presence, but their contribution in terms of innovative performance shall be pursued.

On the other hand, public financing schemes have been subject to the economic crisis, which caused a reduction in their magnitudes. Despite this, it is clear how their effectiveness decreased significantly in the post-crisis period. Efforts shall be made by institutions and governmental agencies to individuate the reasons why firms do not apply for R&D financing allocated budget. As reported by Maqueda (2019), Spain has one of the most generous financing scheme in Europe. How-

ever, stakeholders highlight the large obstacles that firms face when looking for financing, especially small and medium ones. A careful and directed intervention aimed at easing these obstacles is a must-do in the current situation.

4.7 Appendix

Table 4.13: Coverage of Spanish aggregate R&D expenditure originated by business enterprises

year	Internal R&D - PITEC	Internal R&D - INE	% coverage
2003	3,820,000.00 €	4,443,438.00 €	86%
2004	4,440,000.00 €	4,864,930.20 €	91%
2005	5,080,000.00 €	5,485,033.50 €	93%
2006	5,680,000.00 €	6,557,529.00 €	87%
2007	6,210,000.00 €	7,453,901.80 €	83%
2008	6,900,000.00 €	8,073,521.20 €	85%
2009	6,280,000.00 €	7,567,595.90 €	83%
2010	5,670,000.00 €	7,506,442.60 €	76%
2011	5,780,000.00 €	7,396,369.00 €	78%
2012	5,200,000.00 €	7,094,280.50 €	73%
2013	5,110,000.00 €	6,906,395.90 €	74%
2014	5,020,000.00 €	6,784,311.10 €	74%

Please note that data are expressed in thousands. Source: own elaboration from INE and PITEC.

4.7.1 Robustness checks

For the sake of robustness, we explore the sensitivity of our results to the few, specification-related choices that are implicit in this analysis. We do so by modifying our baseline estimation in several aspects. First, we lag the public financing scheme of the contractionary period, as we were imposed to do for the expansionary one.[8] Second, we impute the

[8]PITEC database lacks data for public financing in 2004.

firm-level values of R&D public financing in 2004 using the mean of the values in 2003 and 2005. Further, again to avoid the imposed data limitation, we estimate the expansionary period using exclusively 2005-2008 data. Finally, as the applied methodology and relative estimates could be order-dependent, following Chernozhukov et al. (2013), we re-estimate the baseline specification in reverse order.

On request to the authors the precise quantile estimates can be shared; however, for the sake of conciseness, we report the pairwise correlations for each of our four effect estimated along 100 percentiles of the distribution under each of the above specifications. Particularly, we use the baseline model as reference and see how similar are the estimates produced by the alternatives, for each of the four effects appraised in the analysis.

As emerging from the correlations, the estimates derived from our empirical analysis are quite robust across many different dimensions. Particularly, this holds constantly for the most prominent and significant effect that emerge in our analysis. Obviously, the non-statistically significant effects and the controls (i.e. financial constraints in the contractionary period and firms' characteristics) show very low correlations, as the large error estimates make them fluctuate considerably. On the contrary, we stress the high degree of correlation that the identified, statistically significant effects show in each of the specifications.

Table 4.14: Robustness checks recap

EXPANSIONARY PERIOD (2004-2008)					CONTRACTIONARY PERIOD (2009-2014)			
	Effect of R&D public financing					Effect of R&D public financing		
	(1)	(2)	(3)	(4)		(1)	(2)	(3)
(1) - Baseline	1				(1) - Baseline	1		
(2) - Imputation	.99*	1			(2) - Lag on RD_publi	.99*	1	
(3) - 2005-2008	.99*	.99*	1		(3) - Reverse order	.98*	.98*	1
(4) - Reverse order	.95*	.96*	.95*	1				
	Effect of gazzelles					Effect of gazzelles		
	(1)	(2)	(3)	(4)		(1)	(2)	(3)
(1) - Baseline	1				(1) - Baseline	1		
(2) - Imputation	.99*	1			(2) - Lag on RD_publi	.99*	1	
(3) - 2005-2008	.99*	.99*	1		(3) - Reverse order	.44*	.43*	1
(4) - Reverse order	.95*	.95*	.92*	1				
	Effect of financial constraints					Effect of financial constraints		
	(1)	(2)	(3)	(4)		(1)	(2)	(3)
(1) - Baseline	1				(1) - Baseline	1		
(2) - Imputation	.97*	1			(2) - Lag on RD_publi	.72*	1	
(3) – 2005-2008	.83*	.80*	1		(3) - Reverse order	.23*	.19	1
(4) - Reverse order	.74*	.74*	.84*	1				
	Effect of firms' characteristics					Effect of firms' characteristics		
	(1)	(2)	(3)	(4)		(1)	(2)	(3)
(1) - Baseline	1				(1) - Baseline	1		
(2) - Imputation	.99*	1			(2) - Lag on RD_publi	.95*	1	
(3) - 2005-2008	.96*	.96*	1		(3) - Reverse order	-.53*	-.41*	1
(4) - Reverse order	-.38*	-.37*	-.57*	1				

Source: own elaborations of PITEC. Significance stars correspond at the 5% significance level.

Conclusions

Do all firms contribute and perform equally? Obviously no. They do not, and this thesis' objective was to identify at least a part of the reasons and of the consequences that this heterogeneity bears. To conclude this thesis, we first review the main outcomes of each chapter and then, a more general discussion is built upon them.

The aim of literature review was to unify in one place all the relevant pieces of research coming from sometimes, different or specific sub-fields. However, through it, some very relevant traits emerged. First, the relevance of coupling theoretical work with empirical considerations shall come out as paramount in contemporary research. Many models, assumptions and presumptions of the past turned out to be faulty or incomplete in their way of depicting industries, and key findings on their structures brought significant advancements to the comprehension of the matter. Second, it is more fruitful to analyze firm growth asking what are the enabling mechanisms and processes leading only some, usually few, firms to abnormal performances, rather

than normal ones. Third, despite extensive research on these abnormal performances, still some gaps exist, in particular when considering the exporting and financial aspects related to these performances. Finally, we will never stress enough the importance of correctly aligning innovative methodologies and approaches with relevant research objectives.

Chapter 2 attempts to establish robust associational links between a specific firm financial indicator, long-term leverage, and firm growth. Through a simple augmented growth model, the application of a novel quantile regression technique allows to study this nexus across the whole unconditional, growth distribution, thus allowing to precisely individuate differently growing firms. This exercise is conducted for a number of countries in a dynamic setting and it brings to few, but significant results. Contrary to what expected, high-growing firms do not seem to benefit particularly from this type of leverage and probably rely on different financial instruments to fuel their growth, for instance R&D subsidies. Those who really benefit from long-term leverage are low-growing firms, which are probably in a more needy position and the obtainment of long-term leverage is a way to better control their statuses, for instance by disciplining managers in companies with sparse or few growth opportunities.

Chapter 3 continues the analysis of firms' financial, but in the context of exporting, high-growth firms. The results section, as the analysis, is split up in two parts. First, it tests and confirms the presence of a self-selection framework, where only financially-healthy and pro-

ductive firms participate in exporting markets, which are indeed very demanding and require firms, especially small ones, to accumulate resources well before jumping abroad. Particularly, carrying out this analysis for different financial indicators and for both firms growing high in employment and those in sales, we shed some light on additional sources of heterogeneity in the firms' capital structure and its relation to firms' processes. Second, the chapter contains a thorough persistence analysis, which shows how factors such as exporting and cash-flow are obvious contributors to the probability of repeating high-growth episodes. Moreover, the number of past high-growth episodes turned out to be a remarkably significant predictor of future repeating in the future similarly ab-normal performances, under both employment and sales as growth indicators.

Chapter 4 switches the attention to one of the most common measures of innovative input: research and development. Focusing on data with almost complete coverage of the Spanish internal R&D, the study advances the understanding of how specific factors relate to each part of the R&D intensity distribution. The analysis considers two different phases of the business cycle and highlights how with the exception of the most R&D intensive firms, aggregate fluctuations are the major drivers of R&D decisions. Then, looking at more disaggregate determinants, our findings show how the provision of R&D subsidies is essential in fostering major technological efforts, and in this sense, gazelles emerge as major contributors. Finally, financial constraints

turned out to negatively affect the R&D distribution in expansionary periods, while being insignificant in contractionary ones, posing even more vagueness on the concept.

This whole thesis has been shaped around the concept of heterogeneity, giving to it an almost ubiquitous nature. If anything, the results presented here confirm this and actually, expand the heterogeneity frontier even more. The choice of research subjects has been done in a diversified, but related way.

The idea has been to explore remaining research gaps, while experimenting possibly new approaches, techniques and datasets. For this reason, a great variety of data sources and statistical tools have been applied, hopefully not to detriment of its scientific relevance. On the contrary, this shall be seen as an effort to bring together possibly old-fashioned concepts with new ideas or societal needs. The current world is extremely turbulent and abilities such as innovating and job creation are every day more rare and relevant. This apparent paradox can only be solved by developing an understanding of how firms can achieve greater growth and contribute more to society.

Despite the utilization of different data sources does not allow perfect comparability, some linked results also emerge from these thesis together. However, from a certain perspective, rather than certain and authoritative answers, this research succeed more in posing relevant and unanswered additional questions. First, a need of improving the understanding on which influence is exerted by different financial tools

on each part of the growth distribution. Recognizing that the behavior, strategy and responsiveness of firms in different growing situation is of key importance to delivery well-articulated policy recipes. Also, overcoming the concept of financial constraint, or at least pondering its fields of validity, emerged as an output of both the literature reviews and of Chapter 4. Second, the facts that many high-growth firms also export, and that thanks to export, these firms are also able to persist more in the right-tail, is an interesting and relevant policy-driver. Also, in this context, again finance appeared an important, pre-export factor, whose access shall then be favored, at least for those firms with clear growth potential. Third, despite the variety of definitions and selection criteria of gazelles, it is clear that there are firms contributing way more than others to growth, export and innovation. Understanding how they react to business cycle variations, credit crunches, and other factors is essential to foster their presence and duration in this role of ab-normal contributor. Finally, the advancement in firm-level data availability, especially longitudinal datasets, and the development of efficient and precise techniques for econometric estimates ranging all over distributions of interest have made all of this possible.

On the one hand, the progressive improvements on the above-mentioned aspects will keep bringing benefits and new possibilities to researchers. On the other hand, the increasingly complex and interdependent global situation will make some of the questions asked here even more urgent, relevant, and possibly challenging to be answered.

However, a balanced approach is possible and only the accumulation of scientifically sound evidences, and their subsequent critical analysis, will bring to possibly establish other robust stylized facts that advance our understanding of firms' behavior and performance.

Policy implications

Given the high heterogeneity in terms of datasets, techniques and topics presented in this thesis, the current section aims at grouping and giving a unified perspective to the policy implications that have emerged in each chapter. Despite their relevance, these results are far from satisfying to design and develop a comprehensive policy strategy aimed at dealing with some (or all) of the economic issues highlighted in the previous chapters. Nevertheless, the obtained empirical results are certainly of some guidance in understanding the overall European industrial dynamics in three key aspects, such as: finance, export and innovation. Also, the main policy message that shall derive from this thesis is embracing heterogeneity. Although a possibly vague concept, heterogeneity is at the basis of our world and an effective policy intervention shall accommodate it and carefully take it into consideration.

Chapter 2 focuses in unraveling the heterogeneous impact that debt instruments, in this case leverage, have on firms at different points of the unconditional growth distribution. Indeed, the results show a considerably varying impact for firms in different growing positions. More

specifically, the impact is positive for firms growing negatively, while non-significant for almost all the rest of the distribution. This points clearly at how each debt instrument fits differently each growing status. For instance, in this chapter, leverage emerged as an important tool to "rescue" badly performing firms, which may have strong liquidity constraints or need to invest. Thus, policy-makers shall take into account the different nature of each financial instrument very carefully when trying to ease manufacturing firms' financial aspects.

Chapter 3 follows up from the previous chapter and extend the results in two ways: the inclusion of additional financial indicators and the consideration of exporting dynamics. Here, the results are mostly a confirmation of the large heterogeneity in terms of financial structure with relation to growth, and export. Also, a very robust export self-selection framework emerges for both productivity and financials. In this sense, policy has a fundamental role in acknowledging the multi-dimensionality of firms' financial structure in its relation with growth and export. Generally, fostering and promoting competition in the financial sector may allocate better the available resources, while providing financial support to firms before their jump abroad is also very incidental.

Chapter 4 focuses on the heterogeneity of research and development intensities at firm-level. Given the analyzed dataset, PITEC, the results obtained here have strong validity for Spanish policy making, while differences in each national innovation system shall be taken into

account in an attempt of transferring the following policy prescriptions to other countries. First, dividing the period in a contractionary and an expansionary one allowed to underline one more time the importance of counter-cyclical R&D support policies. Second, heterogeneity emerged again as very revealing in the way each of the analyzed factor impact across the distribution. If gazelles as expected have a fundamental role in research and development activities, their role appeared decreasing time. In this, policy should find ways to promote the presence, and persistence, of these special firms. Further, the financial aspects are again in foreground, both as impact of financial constraints and as need of public R&D subsidies, which shall thus be incentivized and made less bureaucratic.

Concluding, it emerges how policymakers' role is increasingly the one of embracing heterogeneity and complexity in economic and social relations, as opposed to simplifying and aggregative approaches. Firm strategies in different industrial sectors and in different growing statuses shall be understood and accommodated by policy. One consistent way of doing this is to tighten the industry-public relationship. On the one hand, this step is helpful in getting closer to the reality of the needs that firms have. On the other, it can be the occasion to obtain a better understanding of internal research objectives, potential and relevance. In this way, funding agencies would be able to better technically support firms and to provide tailored sources of finance. Finally, although tricky as a suggestion, it is paramount before policies implementation,

to always set up a consistent measurement scheme, which would allow to measure impacts and understand failures or obstacles to the enacted policy.

Final considerations, current status and future directions

After three years of work, a final reflection on this work is almost an obligation. Differently from typical approaches, this thesis is quite various in terms of methodologies, datasets, and topics. This choice may easily imply advantages and disadvantages. On the one hand, it has been the chance for a young researcher, me, to confront himself with different realities, sometimes economist communities, and to develop routines that allow a dynamic approach in economics. Further, giving a strong social connotation to economics, it would have been hard to focus in a narrow area of knowledge, without considering and understanding the multiple interaction channels that exist among almost all area of economics. On the other hand, the constant change of techniques and datasets may pose significant obstacles related to time and familiarity. Undoubtedly, a narrower focus would have granted a stronger specialization.

Despite being at the end of the doctorate journey, there is still work to do both in the present and in the future. Starting from current

considerations, only one of the chapters has been submitted, in article form, to a journal up to now. Precisely, it is Chapter 2, which is now undergoing the second phase of revision at Structural Change and Economic Dynamics. Although Chapter 3 and Chapter 4 have already been presented to international conferences, they still have to be submitted to a peer-reviewed journal, which will be done shortly.

Nevertheless, the three-year period spent as PhD have been full of stimuli also from the publications worlds. The chance of being a referee for a number of international journals has been greatly appreciated as an additional and invaluable source of learning. Also, in parallel to this thesis, other works saw the light. Particularly, collaborating with the director and co-director of this thesis, Segarra-Blasco et al. (2020) has been published in *Economics of Innovation and New Technologies*, on topics and data that are at least tangential to Chapter 3. With the same authors, an additional study on bilateral export determinants of human vaccines have been produced and submitted. Finally, an analysis of R&D sectoral convergence has been published as working paper by the Joint Research Center of the European Commission in Seville (Cattaruzzo, 2020).

Future objectives involve a multi-dimensional approach. First, the publication of the present chapters will be a priority. Extensions of some of the implemented thematics will be pursued in parallel, especially in an attempt of combining perspectives on export and innovation in a more comprehensive perspective. Despite its age, EFIGE

questionnaire has still potential and some further analysis using more survey questions may be very relevant. Second, in an evolutionary vein, examining the three topics under consideration at a finer, sectoral level would be very compelling. Indeed, selecting sectors of relevance according to societal characteristics would allow to get a finer-grained picture and understand even more the possibly emerging heterogeneity. Finally, the great availability of highly disaggregated panel data on bilateral export is certainly a chance not to leave loose.

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