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MASTER THESIS

Growth and Financial Dynamics of Innovating Firms

An Empirical Analysis of Italian SMEs

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«There is nothing more difficult to plan, more doubtful of success, or more dangerous to manage that the creation of a new order of things…Whenever his enemies have the ability to attack the innovator they do so with the passion of partisans, while the others defend him sluggishly, so that innovator and his party alike are vulnerable».

Niccolò Machiavelli – The Prince

ABSTRACT

In order to investigate the effect of innovative efforts on firm's growth and financial dynamics, we examine two samples of Italian SMEs in manufacturing industry; the selection process started searching for the firms that applied for patents in 2005, and selecting 249 "top innovators" among small and medium enterprises ; then a set of comparable non-innovating firms has been chosen. Our finding shows that innovative activity is not a significant determinant of firm growth and debt level; instead innovating firms turn out to be more profitable than non-innovating.

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This work would not have been possible without the support of the good people around me; it is not possible to mention all of them here, but some of them deserve personal thanks.

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INTRODUCTION

Nowadays the word “innovation” is very popular on specialized press and government reports. Such companies like biotechnologies and internet firms – businesses that are all about being new and groundbreaking – along with a general need for the economy to be more innovative are playing a central role in the process of replacing old knowledge with better and newer solutions. The media are celebrating the entrepreneurs and innovators as the new business gurus. The word innovation is appearing in corporate mission and advertisements.

But what does innovation mean to these companies? How could be measured? What are the effects of innovation on companies’ performances and financial structures?

The purpose of this work is to analyze if the presence of innovation makes the difference on enterprises’ financial features.

We will deeply investigate the particular Italian case, showing how the crisis has affected the performance of the small and medium enterprises that innovate; moreover we will focus on the financing problems that regard innovation.

The literature on innovation is fragmented and there is no clear understanding of the innovation phenomena in relation to firms’ characteristics. Then we are trying to add a little contribution to this literature, analyzing the differences between a sample of innovating firms and a set of comparables.

Chapter 1 is divided in two sections; in the first one we will expose the theoretical framework of innovation definitions and innovation indicators. In the second section we will recall the financing issues of innovating firms, along with the important role of venture capital; at last there will be a mention of the “alternative pecking order theory”, that states the priority of private equity to debt in capital structure choices.

In chapter 2, after a brief discussion about the sectors that show a greater propensity to patent, the most popular ranks of innovating firms will be presented. The third section of chapter 2 expose previous empirical works on the relationship between innovation and firms' performance, and the fourth section will provide examples of previous works on financial issues and the results that came up.

In the chapter 3 we are going to analyze a sample of innovative firms, where the selection criteria is the number of patents registered in 2005, and we will look at the effects on their balance sheets. Then we will compare with a control sample and we will explore the financial dynamics related to the presence of the innovation.

I. INNOVATION, INNOVATIVE FIRM, AND FINANCE

I.1 The concept of innovation

What is innovation?

According to the Cambridge dictionary, it could be defined as: *« (the use) of a new idea or method»*[1].

Inspecting this definition of innovation, we can identify the concepts of "new", as evolution, change, and "idea", as invention, concept. Of course innovation is not a new phenomenon. It is probably old as the humanity itself. There is something inherently "human" about the tendency to think of new and better ways of doing things and try them out in practice.

In the history of economic thinking, the first in-depth analysis of the innovation phenomenon belongs to the Austrian – American economist and political scientist Joseph Alois Schumpeter, author of *"Theory of the Economic Development"* (Schumpeter, 1912). Innovation, in his view, could be found in different forms: a new product, a new organizational structure, a new production process, new raw material or anything new that could allow an extra profit to the entrepreneur-innovator; up ahead we will examine them deeper.

According to Ramadani the definition of innovations can be explained by several aspects. From the viewpoint of the customers, innovation means products with better quality and better services, which together bring about a better way of life (Ramadani & Shqipe, 2011). From the aspect of business, innovation means sustainable growth and development, realization of profits. For the employees, innovation means new and more interesting jobs, which require mental faculty resulting in high salaries.

[1] Definition of innovation noun from the Cambridge Advanced Learners Dictionary & Thesaurus © Cambridge University Press.

I.1.1 Innovation and novelty

Looking for a definition of innovation, the first word that we associate with it is novelty, something that has been invented in just that moment. The concept of innovation is strictly related to the concept of invention.

For instance, in the Italian Industrial Property Code, the discipline of "patents for invention" is legislated. In particular, the article 46 of the code states that:

«An invention is considered new if it is not included in the current state of art […] State of art is everything that has been accessible to public in the territory of (Italian) State or abroad, before the registering of the patent application, through a written or spoken description, or utilization or any other mean» (Adapted from Italian, Art 46.1 and 46.2 of Italian Code of Intellectual Property)[2].

Reading this article, it is immediately clear that when a national patent is released, the patentee innovates in respect to the world knowledge, former through an invention, that later will lead to innovation by way of the applied development of the invention itself.

I.1.2 Invention and innovation

Innovating does not just mean introducing product and services; as it is already been noted, the concept of innovation is strictly related to that one of invention.

The verb *"to innovate"* comes from Latin and it means *"to change the established structure of the things in order to do new things"*.[3] Starting from here, we can state that with the word innovation we can identify the realization of a new idea, applied for the first time.

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[2] «Un'invenzione è considerata nuova se non è compresa nello stato della tecnica. […] Lo stato della tecnica è tutto ciò che è stato reso accessibile al pubblico nel territorio dello Stato (italiano) o all'estero prima della data del deposito della domanda di brevetto, mediante una descrizione scritta od orale, una utilizzazione o un qualsiasi altro mezzo» (Art. 46.1 e 46.2 del CPI)

[3] www.etimo.it

The concept of invention has a different origin: this word comes from Latin too and it literally means: *"give existence to something that was unknown before"*. Then an invention is the first occurrence of an idea for a new product or process, while an innovation is the first commercialization of the idea.

According to Fageberg, sometimes invention and innovation are closely linked, to such an extent that it could be impossible to distinguish one from another. Usually there is a considerable time lag between the two, despite they are often confused in the daily language; indeed innovation can occur on something that already exists, then already invented. (Fagerberg et al., 2006)

The first one that has made this distinction was, once again, Schumpeter. From his words: *«the making of the invention and the carrying out of innovation are two entirely different things»* (Schumpeter, 1939). The social processes involved with producing inventions and innovations belong to different spheres with complex interrelationships, and *«do not stand in any invariant relationship to each other»* (Schumpeter, 1939). Important inventions or scientific breakthroughs can occur without being incorporated into innovation affecting industry. Innovation is the outcome of a process that combines production factors in novel ways to produce old products more efficiently or to create new products. In fact, to be able to turn an invention into an innovation, a firm needs to combine several different types of knowledge, skills and facilities. Then, the role of the innovator (the Schumpeter's entrepreneur), may be quite different from that of the inventor.

Another peculiarity of innovation and invention is the fact that they are one continuous process. According to the idea of Kline and Rosenberg:

> *«it is a serious mistake to treat an innovation as if it were a well-defined, homogeneous thing that could be identified as entering the economy at a precise date- or becoming available at a precise time (…) The fact is that most important innovations go through a drastic changes in their lifetimes, changes that may, and often do, totally*

> *transform their economic significance. The subsequent improvements in an invention after its first introduction may be vastly more important, economically, than the initial availability of the invention in its original form»* (Kline & Rosenberg, 1986)

Then, what we think of a single innovation is often the result of an articulated process that involves many interrelated innovations. This is one of the reasons why a system perspective is usually applied rather than to focus exclusively on individual inventions/innovations.

Not all inventions turn into innovations and not all innovations originate from inventions. For instance, innovations that hail from recombination of products and services that already exists, or given by the application of an existing good on a new market. The same distinction between invention and innovation, even though using a different terminology, has been argued by several following authors as Airoldi Brunetti and Coda that wrote of *economic innovation* in contrast with *technological innovation;*

Economic innovation: in the course of time, close to the economic activity, there are many evolutionary processes, which could be slow, fast or turbulent. They have been defined as act of economic innovation that is seen not just as optimal exploiting of lacking resources but as *«science of the innovation of the way of execution of the economic activity»*. (Airoldi et al., 2005)

Technological innovation: this could be defined as the growth process of the instruments, both theoretical and material, which through the economy acts on the economic subjects.

These two types of innovation should not be confused, because usually they do not exhibit together and technological innovation is not the only way to obtain boosts in productivity. Indeed we could have a look at the concepts of technological innovation, market innovation and organizational innovation proposed by Schumpeter ninety years before (Schumpeter, 1912) and to the

concept of organizational innovation introduced by Hannan and Freeman, meant as “adjustment to environmental newness” (that happens into a single organizational unit and consists of learning of new skills that allow to compete better) or as “selection” (that happens through the elimination of weak organizations and surviving of the others) (Freeman & Hannan, 1977).

I.1.3 Innovation and entrepreneur-innovator

The characters of innovator and entrepreneur have been studied by different authors in recent economic literature. One more time, Schumpeter has been a pioneer in defining this distinction.

His analysis focuses on the role of the entrepreneur and his function of leader-innovator to such an extent that Schumpeter decided to analyze radical innovations as well, defining them as *«a special case of leadership phenomenon»* (Schumpeter, 1928); he considered the entrepreneur as a limited rationality subject. The author has then provided a theory about market economy pinpointed on the concept of innovation; he describes the capitalism dynamics as a run after between innovators and imitators, especially in his masterpiece “Theory of economic development” (Schumpeter, 1912). He uses a model where the starting point is the *“stationary state”* where firms run ordinary businesses without creation of new wealth. According to his theory, the economic development starts only when an entrepreneur breaks the stationary state, introducing an innovation, that allows the firm to create new wealth, and that offsets costs, amortizations creating profits as well. Then the profits can be positive only in presence of innovations. The entrepreneur-innovator is the main character of economic development given that he creates added value, eliminating the steady state from the economic system. Moreover, innovator is followed by a succession of imitators (that Schumpeter does not consider as entrepreneurs), which competing against innovator, bring back the stationary state; this circumstance persists until there is another innovation and the cycle restarts.

Hence, we can understand that, in the Schumpeter's theory:

- Profit has a temporary nature, since it exists only in presence of innovation, particularly in the period between innovation and imitation;
- The entrepreneur is a factor of economic development only if he produces a real innovation. When he stops to innovate, he "dies" as *entrepreneur-innovator*.

Indeed, in Schumpeter's opinion, *«the entrepreneur and his function are not difficult to conceptualize; the characteristic that defines him is just doing new things or doing things already done in new ways (innovation) »* (Schumpeter, 1912).

An entrepreneur, in this point of view, has to develop an innovative-creative capacity, whereas in order to be an inventor it is not necessary to be an entrepreneur. Furthermore, the entrepreneur role does not require being inside firm's organization, because an innovator could be someone that has just a partnership with the firm.

At last, Schumpeter evidences that an entrepreneur should have a certain set of skills that he connects with the leadership concept. In order to beat the resistances (social and psychological) he has to be a leader. Indeed he needs to convince other about the goodness of his ideas (and this will be an issue when we will analyze fundraising).

I.1.4 Types of innovation

Innovation may be classified into different types. Schumpeter distinguished between five different types, stating that innovation would consist in "introducing new combination", related to five different cases recalled in the Theory of the Economic Development:

- *The introduction of a new good:* the entrepreneur should produce, i.e. introduce a new product which can be easily sold and which is not offered in the market.
- *The introduction of a new method of production:* innovation should offer a new scheme of production which can lead to an increased output through existing input, decrease of costs per unit product, introduction of new inputs and change of existing ones.
- *The conquest of a new source of supply of raw materials or half-manufactured goods*: the raw material supplier can often lower raw materials' quality or increase their price and this directly influences the quality and the selling price of the new product. Then, the entrepreneur should find an appropriate source of inputs, which are needed for production of new products.
- *The opening of new market:* innovation can increase the sales in new regions, and also increase the number of customers.
- *The carrying out of the new organization of any industry:* Schumpeter describes this step as an entrance of the entrepreneur in the monopoly market, where there has been no competition previously, or as the creation of conditions through which the entrepreneur would take the monopoly position in the market.(Schumpeter, 1934)

In this passage of his masterpiece, we can deduce how the scholar identifies the ways through which an innovation could happen: a new process, a new product-service, the opening of a new market or achieving new sources of raw materials or just reorganizing an industry.

Innovation can be easily managed according to Peter Drucker, that in his article *"The discipline of innovation"*, where he states that innovation comes from only a few situation, that should be well analyzed. They can subsist within a company or an industry:

- *Unexpected occurrences:* unexpected successes and failures are productive sources of innovation because most businesses dismiss them.
- *Incongruities:* an incongruity within the logic of a process or between economic realities can produce innovation opportunities, as well as an incongruity between expectations and results.
- *Process needs:* there is a need to satisfy within the industry.
- *Industry and market changes:* when an industry grows quickly, its structure changes. The established companies, concentrating on defending what they already have, do not counterattack when a newcomers challenges them. New opportunities are usually in a different way from that one the industry has always approached the market. Then innovators have a good chance of being left alone for a long time.

Or outside the industry, in the social and intellectual environment:

- *Demographic changes:* of the outside opportunities, they are the most reliable. Managers believe that demographic factor changes slowly, but in this century this is not true anymore. Indeed the innovation opportunities that changes in the numbers of the people and their age distribution, education, occupations, and geographic location make possible are the least risky and most rewarding.
- *Changes in perception:* they do not modify facts, but change their meaning, and it does this very quickly.
- *New knowledge:* this is the classical example of innovation.

Of course these sources can overlap, but through them there are the majority of opportunities (Drucker, 1985). After the examination of this opportunities area, we can perceive how the author agrees with Schumpeter's vision, looking at innovation as something that goes beyond the simple concept of invention.

Another definition of innovation is given by Lionnet that sees it as *"a process by which a novel idea is brought to the stage where it eventually produces money* (Lionnet, 2003)*"*. It is a dynamical technical, economic and social process involving the interaction of people coming from different horizons, with different perspectives and different motivations. It represents a process, namely an activity of creating a new product or service, new technology, new organization, or enhancement of existing product or service using existing technologic processes and organizations (Lionnet, 2003).

Even Feldman, in his article "The Significance of Innovation", confirms that invention and innovation are totally different; indeed in her view:

- Invention is the discovery and creation of something novel that did not previously exists.
- Innovation carries inventions further with the commercial realization of the value of the invention or the receipt of an economic return. Indeed, for example, patents reveal an invention, while marketing and consumer acceptance of a new drug is an innovation (Feldmann, 2004).

Always according to Feldman, the key step that turns an invention into an innovation is the *commercialization.* It involves defining a concept around who is willing to pay for the new idea, what attributes they value and how much they are willing to pay for the added value. Through commercialization economic value is realized from new ideas and inventions.

Baglieri analyze the classification of innovation strategies by Freeman and Soete identifying five categories of the *inclination to innovation* (Baglieri, 2003) (Freeman & Soete, 1997)*:*

1. *Offensive inclination:* consists of pursuing a development of technology and product with the aim of beat the competitors. The requirements of this strategy, which Ansoff defined as *leadership*, are

the result of a strong investment in R&D and of a good timing choice (Ansoff & Stewart, 1967). This strategy usually leads to the *"first mover"* advantage for the firm that is applying it.

2. The *defensive* strategy is the first alternative to the *offensive*" behavior and it is also known as *fast follower*; it consists in developing the condition to have an immediate reaction to the first mover. Given that the technology is necessary in order to follow the leader, even this firm should massively invest in R&D.
3. *Imitative inclination:* this strategy involves a long distance pursuit, waiting for the market standard stereotype. Even Kline and Rosenberg pointed out how many economically significant innovations occur while a product or a process is diffusing.
4. *Hypo tactical inclination:* this inclination, proposed by Baglieri, supposes that innovation is applied only when namely asked from the customers, so that the default probability is minimized.
5. *Conservative Inclination:* it is a traditional strategy, typical of the firms that focus on the capacity of combine the usual components of a product.

I.2 Dimensions of innovation

Innovations, according to Melissa Schilling, can arise from many different sources and there are several dimensions that are often used to categorize technologies (Schilling, 2005).

Generally, the dimensions used to classify are:

1. Nature of innovation: Product versus Process Innovation.
2. Intensity of innovation: Radical versus Incremental Innovation.
3. Effect on firm's competencies: Competence Enhancing versus Competence Destroying Innovation.
4. Destination of Innovation: Architectural Innovation versus Component Innovation.
5. Origin of Innovation: Market Pull, Technology Push and Design Driven Innovation.

I.2.1 Innovation's Nature: Product and Process Innovation

This is the most widely known, in writer's opinion, of the classifications of innovations; in fact they originate from Schumpeter itself, in the *"Theory of the Economic Development"*;

- Product Innovations are embodied in the outputs of an organization (i.e. its good or services).
- Process Innovations are innovations in the way an organization conducts its business, such as in the techniques of producing or marketing goods or services. An example, always in accordance with Schilling (2005), a process innovation in biotechnology firm might entail developing a genetic algorithm that can speed up the research of disease related genes. In this case, this process innovation can lead up to develop a product innovation (a new therapeutic drug). Indeed these two types of innovation can often occur in tandem; another example could be the development of advanced workstations that enables firms to implements computer-aided-

manufacturing processes that increase the speed and the efficiency of production.

Anyway, product innovations are usually more visible than process innovations, even though both are extremely important to a firm's ability to compete.

Schmookler, in his "Invention and Economic Growth", realized that distinction between "product technology" and "production technology" was "critical for a complete understanding of this phenomenon (Schmookler, 1966). In a similar way a distinction between "product innovation" and "process innovation" has been used to characterize the occurrence of new improved goods and services and improvements in the ways to produce them, respectively (Henderson & Clark, 1990).The argument for focusing particularly on the distinction between product and process innovation rests on the assumption that the economic and social impact may differ; moreover, the process innovation, due to its cost cutting nature, may have a more ambiguous effect while the introduction of new products have a clear positive effect on growth of income and employment (Edquist et al., 2001).

However, even though the focus on product-process innovation is a useful tool, it should not prevent us from recognize other important aspect of innovation.

I.2.2 Intensity of innovation: Radical and Incremental Innovations

Another dimension that is suggested to distinguish types of innovation is the continuum between radical versus incremental innovations (Freeman & Soete, 1997). Many definitions have been proposed, but most focus on the degree to which an innovation represents a departure from existing practices.

Radicalness could be conceived as the combination of *newness* and the degree of *differentness* (Dewar & Dutton, 1986). The most radical innovation would be new to the world and totally different from existing products and processes.

Otherwise, an incremental innovation might not be particularly new or exceptional; it might involve only a minor change from existing practices.

Precisely we can define:

- Radical Innovation: An innovation that is very new and different from prior solutions.
- Incremental Innovation: An innovation that makes a relatively minor change from existing practices. (Schilling, 2005)

Sometimes, the radicalness of innovation is defined in terms of risk; since it embodies new knowledge, producers and customers will vary in their experience and familiarity with the innovation, and in their judgment of its usefulness or reliability. Radical and incremental innovation show, more than the feature of *newness* and *differentness*, the nature of *riskiness* and *relativeness*, especially regarding time. In fact, an innovation that would have been radical at time *T* might be incremental at time *T+1*. (Schilling, 2005)

I.2.3 Effect on firm's competencies: competence enhancing and competence destroying.

The third dimension widely accepted in literature is based on the effects that innovation produces on the degree of competence within the firm:

- *Competence Enhancing:* An innovation that builds on existing knowledge and skill.
- *Competence Destroying:* An innovation that renders obsolete existing knowledge and skills.

An example given by Schilling is the Keuffel & Esser, a slide rules producer. In the early 1970s the handheld calculator relegated the slide rule to museums displays. In this case the innovation was competence destroying, since the firm did not have any experience in the production of electronic components; instead

it was competence enhancing for companies such as Texas Instruments and Hewlett Packard.

I.2.4 Destination of innovation: architectural Innovation versus Component Innovation

The last dimension usually accepted is considering a differentiation based on destination of the innovation:

- *Component innovation:* (or Modular innovation) is an innovation to one or more components that does not significantly affect the overall configuration of the system. (Henderson & Clark, 1990)
- *Architectural innovation:* an innovation that changes the overall design of a system or the way its components interact with each other. Indeed, an innovation that is strictly architectural may reconfigure the way that components link together in the system, without changing the component themselves (Schilling, 2005).

All the different dimensions that have been analyzed are not independent one from each other. Actually they are strictly correlated; e.g. it is believed that architectural innovation would have a destroying effect on firm's competencies and that they have a higher degree of radicalness.

I.2.5 The origin of innovations: Technology Push and Market Pull

The debate on the origin of innovation is focused on two main models: the former sets that an invention is *pushed* through research and development, production and sales functions into the market, without consideration of customer's needs. Within the latter model, the invention is developed as response to a precise market need.

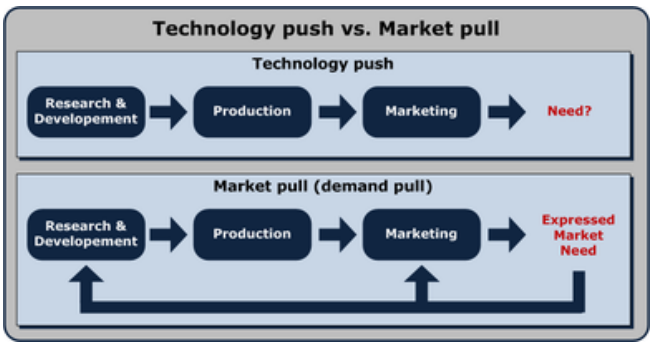
- *Technology push Innovation* was conceived for the first time by Schumpeter. In his work *"Theory of the Economic Development"*, he recognizes that the origin of the innovation was usually the within the

production (and precisely they were identified with the entrepreneur). A relationship between innovations and market needs it is not considered. Hence, the *technology push* model shows a deterministic point of view, never considering market needs and (even in the subsequent years) presuming that all innovation will be accepted by the market (Schumpeter, 1912).

- *Market Pull Innovation (or Demand Pull) Model* was introduced by Jacop Schmookler in contrast with the technology-push hypothesis. He was sustaining that it is the market that is playing the fundamental role in determining direction and dimension of innovative activity (Schmookler, 1966). Then the primary force in the *Market Pull Model* is the identification of market needs by firms at which follows the attempt of these firms to satisfy market desires, with new and better goods and products. Everything lies on the premise that it is possible to know, before the innovation is realized, the direction of the market.

While the *"technology push innovations"* usually are at the beginning of innovation's life cycle, the *"market pull innovations"* exist in the successive moments (a classic example are incremental innovations).Applying this model to the firm dimension, we can identify the marketing branch as the one operating in the "market pull" sense, while the R&D would be the firm's area that is operating in the "technology push" logic. (Adamoli, 2013)

Figure I-I Technology Push and Market Pull Innovation



Source: www.wikipedia.it

I.3 Measuring innovation performance

The measurement of technological change is of rising importance in business. In the last three centuries the science improvement has been very remarkable and technology and innovation have always been a key factor in the competition between firms. Within firms, detailed information is needed to take the right decisions. Measuring technological change could be very difficult as well as to decide on which project invest. There are different methods in order to measure innovation; one of them distinguishes the measurements focusing on the *level:*

- *Organizational level*: measuring innovation at this level is related to valuing people, teams and firms; usually the way to measure firm's organizational structure is through surveys, workshops, benchmarking, while generally the measurement occurs through the *balanced scorecard*, which makes it possible to measure values that are very different one from each other.
- *Political level:* at this level, measures of innovation are mainly focused on competitive advantage, deriving from innovation, of a single state or geographical region. There are different frameworks in this case, generally supplied by European institutions. For instance, the *Oslo Manual* that suggests the general guidelines for measuring product, process and technological innovation of the Organization for Economic Co-operation and Development (OECD). The last edition (published in 2005) includes the *marketing innovation* and *organizational innovation*. These features are used in many classifications and studies; one of the most important is the European Community Innovation Surveys (CIS) that gives prominence to R&D spending, usually comparing it with the country GDP.

It has been widely known that innovation is not a linear process from R&D to commercialization of the product. The aspects of innovation interact between themselves in various stages.

Three main aspects of innovation should be mentioned;

- The technological change has impact on codified and tacit knowledge
- The sources of innovation may be external or internal to the firm
- Innovation can be embodied in capital goods and product or disembodied (know how included in patents, licenses, design, R&D activities or directly in human resources). (Archibugi & Pianta, 1996).

These features suggest how complex could be the nature of technological change. That is why it is difficult to find a measure that provides a satisfactory explanation of dimension, intensity, rate and direction of innovative activity.
In this work we will focus on the measurement of technological change by patent data.

The first problem that we have to approach is the range to which available indicators overlap or provide information on different aspects of sciences or technology activities. The second is the extent to which indicators of the same activity provide similar answers.

Using the data provided by innovation surveys and patent data, it is possible to acquire different kinds of deals about firms, industries, companies. Certain kinds of innovation have been monitored for years, like the investments in R&D. But other types of innovation are not measured. Innovation surveys can account the efforts made by the firms in order to make new products and the patent data can protect the enterprises from their competitors, thanks to intellectual property rights. As Archibugi and Pianta suggest, there are at least four different criteria for classifying innovation:

- Technology, i.e. according to the technical characteristics of the innovation;
- Product, i.e. according to the nature of the product in which the innovation is likely to be embodied;
- Sector of production, i.e. the main economic activity of the users of the innovation.

A first distinction that has to be made is between "*inputs to innovation*" and "*output to innovation*".

- *Inputs to innovation:* they measure the quantity (and sometimes the quality) of resources provided for project activities; in case of innovative activity, they measure the resources allocated to innovation.
- *Innovation Output:* they measure the quantity (and sometimes the quality) of the goods or services created or provided through the uses of inputs. (Mosse & Sontheimer, 1996)

The main problem in measuring innovative activity is choosing the right indicators and the level of analysis. For instance, if we would like to measure a single individual innovative activity, a good indicator could be the number of scientific publications, while if we would like to measure the innovative activity of projects and organizations, we should focus on enterprises, universities and research centers.

According to Sirilli, we have got a wide set of science and technology indicators: R&D, patents, bibliometrics, the technological balance of payments, human resources dedicated to innovation, surveys on technological innovation in industry. The most used indicators statistics are related to patents and R&D (Sirilli, 1999).

I.3.1 Indicators of innovative output: the patents

"A patent is a set of exclusive rights granted by a sovereign state to an inventor or assignee for a limited period of time in exchange for detailed public disclosure of an invention. An invention is a solution to a specific technological problem and is a product or a process" (WIPO, 2004).

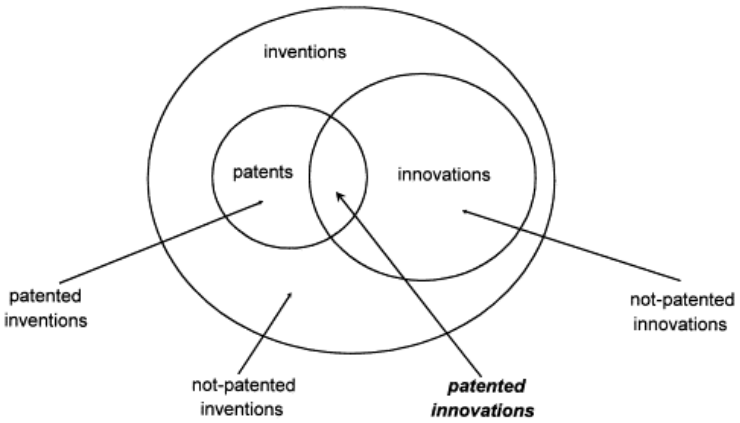
The patent system is one of the procedures firm uses to protect their inventions; indeed, for legal reasons, patent are registered by governments. They are classified and organized, so they can provide a very useful source of information about innovation. This is also a way to represent output indicators that measure

the actual innovative performance. As already outlined, to obtain a patent the inventor has to satisfy the patent-granting authority that he has met three conditions. The invention has to have *novelty* (in the worldwide domain), it has to embody a significant *inventive step* and it must be capable of industrial application. However, in Europe there are some areas that are excluded from the patenting system: these are discoveries (something that preexisted and was not created by the inventor), scientific theories/mathematical methods, aesthetic creations, methods of doing business, databases and computer programs, animal or plant varieties, and methods of treatment and diagnosis. In the US, in contrast, patents for computer software and business methods are allowed (Roberts, 2001).

Another important aspect of patenting is the geographical coverage; the patent property right is geographically limited to the area of the legal jurisdiction under which it is registered. Within the European Union, the firm can apply to the European Patent Office in order to get a total coverage in the area. A worldwide patent system is provided by the World Trade Organization (WTO) (Greenhalgh & Rogers, 2010).

Empirical works that show the absence of a lag of time between expenditure in R&D and patent registration (Hall et al., 1984). According to this point of view, patents would represent an inventive output more than an innovative output, since most of the patents do not succeeds. Furthermore, use of patents may be driven by tactical motives (an improved bargaining position in licensing negotiation) then not directly related to firm's innovatory activity; Figure II shows the relationship between patents, inventions and innovations. Anyway, aside from this features, the patent is widely accepted in literature as one of the best indicators of innovative output and then a good indicator in order to measure innovation performance.

Figure I-II Relationship between patents, inventions and innovations.



Source: Ernst (2001)

Patents, like other indicators, have advantages and disadvantages.

The advantages are:

- They are a direct output of inventive process, specifically of inventions which are expected to have a commercial impact;
- Given that obtaining patent protection is costly and time consuming, usually patents are requested only for those inventions that are expected to provide benefits that outweigh these costs;
- Patent statistics are available in large numbers and for a very long time series;
- Patents are public documents. All information are not covered by statistical confidentiality;
- They provide information also on the direction of the innovation activity.

The disadvantages are:

- Not all the inventions are actually patentable (e.g. : software is protected by copyright);
- Not all inventions are patented, especially for industrial secrecy reasons.
- Patents usually have a geographical validity, and then decisions of firms depend on their expectations for exploiting their inventions commercially.

- Even if there are international patent agreement, each national patent office have is features of cost and protection accorded. (Archibugi & Pianta, 1996)

Patents data can be obtained from National Patent Offices of each single country, as well as from continental and worldwide offices. In Italy there is the *"Ufficio Italiano Brevetti e Marchi"* [4](UIBM); at a continental level there is the already mentioned *"European Patent Office"* [5](EPO); last there is for the worldwide patent there is the *"World Intellectual Property Organization"* [6](WIPO).

The analysis that can be conducted can refer to *"patent applications"* or *"granted patents"*. The former are more up-to-date than granted patents, while the latter are more precise and reliable. But of course it is important to remember that patents are not the expression of all the innovative activity within a firm, and above all, there is a different propensity to patenting, depending from the sector (e.g. the software industry is protected by copyright instead of patent system). Furthermore, larger firms are inclined to patent more than small and medium enterprises.

In accounting (according to the Italian Civil Code), the patents are entered into the balance sheet into the voice B.1 *"Immobilizzazioni immateriali" (Intangible assets)*, point 3.*"Diritti di brevetto industriale e diritti di utilizzazione delle opere dell'ingegno"* (Patents) (VV.AA., 2013).

The three evaluation methods for intellectual property are:

- *The cost approach:* is based upon the principle of substitution; the value of an asset is estimated on the basis of cost to construct a similar asset at current prices. The assumption underlying this approach is that the cost to purchase or develop new property is commensurate with economic value of the service that property can provide during life.
- *The income approach:* under this approach assets are valued based on what they will earn in the future. Then there will be an estimation of

[4] http://www.uibm.gov.it/
[5] http://www.epo.org/
[6] http://www.wipo.int/portal/index.html.en

future cash flows, economic life and a risk-adjusted discount rate that reflects the required return. Under this approach it is important that the analysis should capture all direct and indirect costs associated with the IP in question. Even though this method is very analytic, it is also very subjective, especially regarding the assessing of the financial dynamics that impact the expected incremental cash flows.

- *The market approach (or transactional):* the value of intellectual property is determined by considering the market prices paid for similar properties as a part of third party transactions. This approach provides indications of value by studying transactions of property similar to the property for which value a value conclusion is sought. When there are enough data, this is considered the most reliable method of valuation for intellectual property (Smith, 2009).

Cariola and Costabile[7], in their analysis of the indicators that have been developed to measure innovation performance, identify the following related to the design and engineering activity within the firm (here are only the strictly connected to patents):

- Number of patents
- Average time length for developing new patents
- Numbers of new concepts

I.3.2 Innovation input: R&D

This is another one of the most important indicators of innovation performance. Even though the terms *research* and *development* are often lumped together, they actually represent different kind of investment in innovation-related activities.

[7] (Costabile & Cariola, 2004)

- *Research:* can refer to
  - *Basic Research:* it is a research targeted at increasing scientific knowledge for its own sake. It may have or may not have any long-term commercial application
  - *Applied Research:* it is targeted at increasing knowledge for a specific application or need.
- *Development:* refers to activities that apply knowledge to produce useful devices, materials, or processes.

.Other criteria that have been used to classify R&D are:

- Sector of performance:
  - Business enterprise
  - Government
  - Higher education
  - Private Non-Profit
- Source of Finance:
  - Domestic
  - International

The data on R&D have been collected since the 1950s, so there is a wide database, improved by the effort of the OECD towards international harmonization of data collection. The recent year's data make it possible even to divide between by product versus process efforts.

The OECD document *"Standard Practices for Survey of Research and Experimental Development"*, even known as *Frascati* Manual, is the key document for the collection of R&D statistics. It is difficult to define what should be counted as R&D and what should be excluded: *"the basic criterion for distinguishing R&D from related activities is the presence in R&D of an appreciable element of novelty and the resolution of scientific and /or technological uncertainty, i.e. when the solution to a problem is not readily*

apparent to someone familiar with the basic stock of commonly used knowledge and techniques in the area concerned." (OECD, 2002)

For instance, education and training in general is not counted as R&D, as well as market research. (Smith, 2005)

Concerns have also been expressed about the tendency towards underestimation of small firm R&D through the official statistics. Indeed, in accordance with Kleinknecht, the standard R&D surveys tend to underestimate the small-scale; in contrast, using the Frascati definition of R&D, innovation surveys include questions about R&D that are simpler and easier to answer compared to those in the official surveys. Hence, innovation surveys usually find better data in the middle-small size firms than the standard surveys (Kleinknecht et al., 2001).

Another issue with R&D data identified by Kleinknecht is the need for secrecy; especially in small country, data have to be published at high level of sectorial aggregation in order to protect from the large firms inferences. It could be difficult as well to split the R&D data by regions, especially if the data is reported by the holding company but the research plants are decentralized. A similar problem could arise at a country level; also known as *Singapore effect*. Singapore itself has a modest R&D potential, but the data are higher because of the multinational presence in the state that benefits from the R&D of their mother and sister companies elsewhere in the world.

According to Roberts, firms consider their inner R&D as the most important source of innovation.

Table I-I Firm's Rank Ordering of the Importance of Sources for R&D

Rank Order of Sources of Research Work	
1	Central Corporate Research
2	Internal R&D with divisions

3	Sponsored university research
4	Recruited students
5	Continuing education
6	University liaison programs
7	Consultants/Contract R&D
8	Joint Ventures/Alliances

Source: Roberts, 2001

This perception is supported by evidence; Roberts cites several studies that show how a firm's R&D intensity has a strong positive correlation with its sales growth rate, sales from new product, and profitability (Roberts, 2001).

Most of indicators of R&D refer to a country dimension. Cariola and Costabile identify a list of indicators that could be applied to a firm level (in function on the investments allocated to innovation):

- Investment in education for R&D operators
- Percentage of investments in R&D
- Percentage of operators in R&D

These indicators combined with the classical indicators of R&D (the actual amount of funding and the number of operators in R&D) could be usefully applied to a firm level (anyway, we have to consider that may SMEs publish the brief balance sheet, so the financial data could not be available at all) (Costabile & Cariola, 2004).

According to the Italian accounting regulation, the R&D costs are entered into the balance sheet as "Intangible Assets", point 2, when it is decided to capitalize them, along with the advertisement costs.[8]

[8] Art. 2424, (VV.AA., 2013)

I.3.3 Other indicators

I.3.3.1 The innovation surveys

These surveys have been developed with the specific aim of acquiring information on innovative activities carried out in firms. They are organized by government agencies, statistical offices, or academic institutions for their specific needs; then they could be quite different and difficult to compare.

Furthermore, innovation surveys have to confront a very heterogeneous nature of innovations. There are two different ways to approach innovation through surveys:

- The first collects information at the level of individual innovation: it is called “object approach”
- The second collects information at the level of the firm producing innovation: it is called “subject approach”.

Both approaches attempts to explore aspect of the innovation process itself and define innovation in a Schumpeterian sense, as the commercialization of a new product or process.

The object approach

It is an approach where the individual innovation is the analytical unit of survey. It originated in order to acquire information on the dynamics of technological change in the context of the link between innovation and long run swings of the economy.

This approach has much in common with patent analysis, since both represent innovation count. But, while patents are a well-defined population, it is not the same for innovation counts. Indeed there is not any database that collects information on all innovation introduced. Generally, counts of innovation monitor fewer observer than patents, but with a larger amount of information for each one of them.

The advantages of innovation surveys based on the object approach are:

- They represent a direct measure of innovation, and they only include innovation considered to be significant (economically or technologically);
- They provide significant information on the evolution of technology, since they make it possible to record precisely when and how a certain innovation was introduced.

Their disadvantages are:

- The definition of sample is arbitrary
- It is very difficult to develop an international database.

The most important example of "object approach" is the SPRU database, developed by the Science Policy Research Unit at the University of Sussex, which collected information on major technical innovation in British Industry.[9]

The subject approach

This is an alternative method of acquiring direct information on innovation in industry, in which firms are surveyed to learn the inputs, outputs and characteristics of their innovative activities. While both patenting and innovation counts collect information on innovation specifically, the subject approach also allows one to see various aspects related to innovative activities, as well as on non-innovating firms.

It also makes it possible to collect information on innovative activities that do not lead to the introduction of actual innovations, e.g. the results in failures.

In relation with the type of individual surveys, different kind of data might be collected. These data can be treated as part of industrial statistics, because they provide information at firm level on both the inputs and output of innovative activities.

The OECD, through the Oslo Manual, has listed the limits of the object approach (the heterogeneity of the individual innovations) and then the subject approach is

[9] http://www.sussex.ac.uk/spru/

becoming the standard method for collecting direct information on innovation in industry.

The main advantages of subject approach are:

- The information collected can be related to the industrial structure. Innovations can be matched to economic data on production, value added, employment, etc.
- It provides coverage of both innovating and non-innovating firms;
- It gives information both on the firms generating and on those using innovation. This allows one to treat not only manufacturing but also the service industry.

The main disadvantages are:

- It is difficult to collect internationally comparable data;
- Given that this method is still in its early stages, time series data are not available.
- This method does not collect information on the technological nature of the innovation introduced in firms. (Archibugi & Pianta, 1996)

The already mentioned *Community Innovation Survey (CIS)* was implemented in 1992-1993; it collected an internationally comparable set of direct measures of innovation and these data, collected at highly disaggregated level, have been made available to analysts. The CIS collected data on the following topics:

- Expenditure on activities related to the innovation of new products (R&D, training, design market exploration, equipment acquisition).
- Outputs of incrementally and radically changed products, and sales flowing from these products.
- Sources of information relevant to innovation
- Technological collaboration
- Perceptions of obstacles to innovation, and factors promoting innovation.

Table I-II the nature of patents and innovation surveys

	Patents	INNOVATION SURVEYS Object approach	Subject approach
Unit of analysis	Patented inventions.	Sample of innovation.	Firms.
Origin of the information	Collected for legal and administrative purposes.	Collected for analytical and/or policy purposes.	Collected for analytical and/or policy purposes.
Method of collecting information	Patent office data and applications filed by inventors or grants.	Collected from different sources (new product announcement, expert surveys, etc.).	Collected at the firm level either by mail questionnaires or direct interviews.
Periodicity	Regular data collection. Very up to date information.	Occasional surveys.	Occasional surveys.
Coverage	Inventions for which legal protection is sought.	Sample of successful innovation introduced by both the business and the non-profit sectors.	Successful and unsuccessful innovative activities; innovating and non-innovating firms.
Main criteria of classification	Technological; Firm's principal economic activity.	Product; Firm's principal activity	Firm's principal economic activity; Firm size; Main user sector

Source: (Archibugi & Pianta, 1996)

The table II shows the main differences between these methods of analysis.

Trademark, Copyright and Trade Secret

These are the most used methods, along with the patents, that are used to protect innovation.

A *trademark* is a word, phrase, symbol, design or other indicator that is used to distinguish the source of goods from one party from the goods of others. A good example is stylized apple, symbol of Apple Inc. (Schilling, 2005)

The *copyright* is a form of protection granted to works of authorship, protecting the authors of original literary, dramatic, musical artistic and other intellectual works. Like trademarks, the rights of copyright are established by legitimate use of work. (Schilling, 2005) An example could be anyone of the pc software like Microsoft Office or Windows.

A *trade secret* is information that belongs to a business that is generally unknown to the others; these have to offers a distinctive advantage to the company in the

form of economic rents and have to remain valuable only as long the information remains private. A classic example of *trade secret* is the Coca-Cola recipe.

I.4 Small innovative firms

The innovation theory examined until here states that, because of high barriers to entry, innovation requires considerable market power and so takes place in large firms. The object of our research and analysis will be the small and medium enterprises, and then here we will focus on their contribution to innovation. In contrast, according to Giudici and Paleari, there are several factors which may determine a relative advantage for small firms to innovate; the role of industrial structure, marketing and R&D management, have been examined; the empirical results by Acs and Audretsch found out that small firm's innovative activity at least offsets the size-related disadvantage that they experience (Giudici & Paleari, 2000) (Acs & Audretsch, 1990). Hence they are contributing as well as large firms, also in manufacturing and capital intensive sectors.

The difference is in the source of innovative activity, different in comparison with larger industries. Indeed, large firm use to count on private R&D to support the innovation process; for the SMEs this is not a preferred channel (of course due to their financial constraints); then for small firms the "fuel" for innovation are spillovers from university research and informal external sources.

Moreover, a small firm's strength could be its dimension itself. Indeed, they could benefit from it specializing in niches where the large companies are inefficient, because the market could be too small of because of difficulties to absorb processes of learning by doing and learning by using. Or another advantage might be a dynamic and entrepreneurial management and efficient network cooperation. (Rothwell, 1989). Hence, they are successful thanks to a variety of elements, like the entrepreneurial dynamism, a good network strategy and technological competencies.

I.5 Innovation and Finance

Economics' literature widely studied the firms' financing issues, trying to understand which the factors that influence it are. We will draw the lines of the general theory and then we will focus on the small and medium innovative enterprises that are the object of our study.

The financial constraints for investment decisions have been analyzed since the 1950s, with the first propositions of the Modigliani and Miller Theorem (Modigliani & Miller, 1958)[10]. In the course of the years, researchers and academics reviewed the hypotheses of perfect markets and showed that capital structure choice do matter, and that there are different factors that combined together affect the value of the firm. Despite of tax regimes[11], the opening to imperfect markets saw many contributions to the research of the financial hierarchy in the sources of financing for firms; the traditional order is that internal sources are to be preferred to bank credit, which in turn is favored above the direct issue of shares.

Two main theories were developed: the *"Trade-off theory"* and *"The pecking Order Theory"*.

The trade-off theory

According to this theory, it could be stated that under some conditions, an optimal capital structure can be 100% debt finance due to the preferential treatment of debt relative to equity in tax code. For instance, in Italy interest payments on debt are excluded from corporate taxes[12]; this is called fiscal benefit or tax shield. Hence, the firms are incited to substitute debt for equity in order to pay fewer taxes to the government and pass this surplus to investors through

[10] As well known, the Modigliani- Miller Theorem assumes the existence of perfect capital markets (i.e. complete, symmetrical availability of information) and uniformity in fiscal regimes regarding business incomes. Under these conditions, it would be possible to have unlimited access to funds at a certain and constant cost.

[11] A different taxation could be applied to returns on dividends and capital gains; in many industrialized countries, the business incomes are penalized by the fiscal regime.

[12] A change has been seen in the last decades, especially with the introduction of IRAP and IRES as substitutes of IRPEG and ILOR. With the old system taxes reached up 50%; now IRAP taxable income is calculated on the EBIT; IRES is diminished as well.

higher returns. The “tax-bankruptcy tradeoff” links the benefit of interest’s tax deductibility with the costs of bankruptcy and financial difficulties.

According to the original “static” specification of Jensen and Meckling, this is known as the “Tradeoff Model”, that assumes that there are benefits to leverage within a capital structure up until the optimal capital structure is reached (Jensen & Meckling, 1976). The theory recognizes the tax benefit from interest payments - that is, because interest paid on debt is tax deductible as stated before, then issuing bonds effectively reduces a company's tax liability. Paying dividends on equity, however, does not. Thought of another way, the actual rate of interest that companies pay on the bonds they issue is less than the nominal rate of interest because of the tax savings. The optimal capital structures is found at the point in which the marginal benefit of a higher interest tax shield from an increase leverage is exactly offset by the marginal increase in the costs of raising extra debt. Firms who can benefit from higher tax shields of debt and which suffer lower cost of financial distress will tend towards their preferred capital structure by raising extra debt and/or by reducing equity. In this specification, the value of a levered firm is equal to the value of the unlevered firm plus the present value of the tax shields, minus the present value of financial distress costs.

The agency[13] theory describes the extra debt as an instrument to control manager’s behavior, under the threat of bankruptcy if debt is not repaid. When a firm is levered, the higher the riskiness of an operation, the higher the conflict of interest for managers, if decisions have a lower impact on equity holders than on debt holders[14]. On the other side, debt has the agency benefit of granting firm owners a higher control over the company.

[13] *”An agency relationship is a contract under which one or more persons (the principal(s)) engage another person (the agent) to perform some services on their behalf which involves delegating some decisions making authority to the agent. If both parties to the relationship want to maximize utility, there is good reason to believe that the agent will not always act in the best interests of the principal.”* (Jensen & Meckling, 1976). In the framework we consider the principal and the agent are defined as follows. The principle is alternatively identified in the minority shareholders and in the creditors of the firm; the agent in the managers - controlling shareholders of the company.

[14] This is known in literature as “overinvestment”.

The "Trade-Off Model" is the most studied and used model of capital structure. There is also a "dynamic" version (where leverage ratios are adjusted within a specific range") that could be considered a good approximation of the real world. Indeed the "static" model assumes that every company should be at its optimal capital structure in any given moment that could be unrealistic. Instead the "dynamic" model includes a multi-period analysis that allows a company to be in a sub-optimal capital structure at a given moment, tending towards the real optimum in a further moment.

The Pecking Order Theory

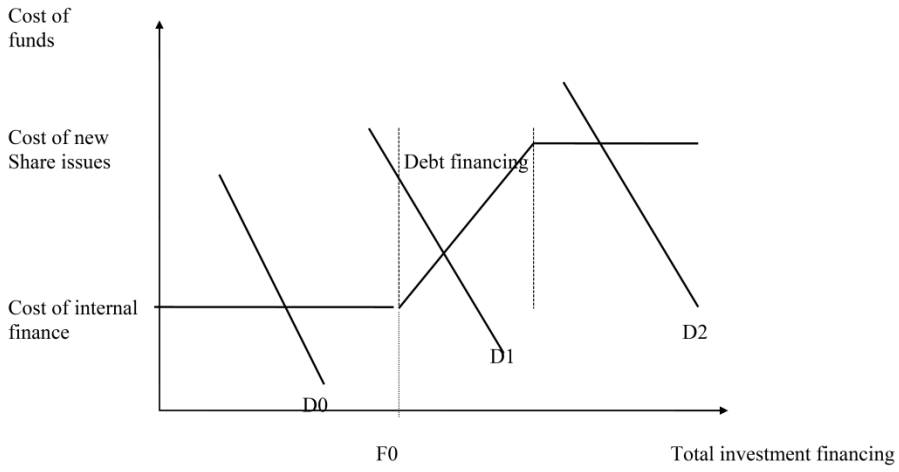
This theory has been developed as an alternative to the Trade-off model, by (Myers & Majluf, 1984). According to them, the first financial decision to be made by managers is in regard to the ability to support corporate business with cash flows internally generated, namely retained earnings. If the firm could not find enough internal funds to finance worthy projects, it might become necessary the recourse to outside funding. In this theory, debt is preferred to equity due to lower costs required to raise the former. Indeed the risk premium that should be paid, would be larger for equity that than for debt.

The concept of asymmetric information is usually used to support this theory. As stated before, the debt minimizes information revelation; when there is a mismatch in information availability about a firm, debt is preferred because it signals conviction in the profitability of a project and that the current stock price is undervalued. Indeed if stock price was overvalued, the firm would of course choose equity as the way to get funds. Indeed, the internal *cash-flows* are preferred to the other sources of financing because their use does not imply agency costs deriving from the asymmetry of information (whether ex-ante or ex-post)[15] between insider and outsider (respectively managers-entrepreneurs and investors-financiers). Relying on external finances is more costly because there is a *lemon premium* to count (Akerlof, 1970). The evolution of the firm's financing

[15] The crucial moment is when the financing contract is determined: *ex-ante* information asymmetry gives rise to the problem of adverse selection, while *ex-post* to the problem of *moral hazard* or a cost for verification of the state of the investment plans.

in relation to its cost is reported in Figure III. The use of debt financing causes a growth in the degree of debt (*leverage);* as the ratio between internal and external resources increases, so do the risk of bankruptcy. This effect might be enhanced by a lower value of high liquid assets or inside collateral[16] given in guarantee; in both the previous cases, the marginal cost involved in bank financing will increase. If the bank decides to ration credit to the firm, the rising part of the supply curve would vertical and the level of investment would then depend on the inside resources.

Figure I-III Pecking order financing and investment for traditional firms.



Source: Sau (2007)

Despite these issues, bank credit would still be preferable to direct issues of shares because the banks apply screening and delegated monitoring directly to the firms, in order to reduce the information asymmetry, so that the agency costs are minimized (Diamond, 1984). Another reason is that in an environment of imperfect, asymmetrical information, the banks take on the function of producing information (Stiglitz & Weiss, 1988); indeed, obtaining financing is considered worthy by the market, even by other potential investors and often obtaining a loan involves an increase in share price (De Jong & Veld, 2001).

[16] There is a difference between inside and outside collaterals; the former are capital goods or highly liquid assets, while the latter are goods in the property of the entrepreneur himself.

A direct issue of shares (*public equity*) usually is seen by investors as a signal from managers-entrepreneurs that the firm is unable to obtain financing or that in their opinion is overvalued; consequently, the firm's investment plans are of the riskiest nature; in fact the potential shareholders know that managers act in the interests of the actual shareholders (and they usually are shareholders as well) and then are reluctant to issue new share on account of the *dilution* of capital that would follow. Moreover, more than the agency costs due to information asymmetry, it is important to consider that issuing new share entails heavy direct costs: publicity, rating, placement costs; these make it a very expensive form of financing. Hence this would be the last choice of the managers.

Another interesting aspect of "Trade-off" theory is that it is supported by the role of transaction costs. Indeed they play a fundamental part in the financing decisions, since they concern only external source of finances. Hence the firms should always prefer internal equity financing that is the cheapest way to obtain liquidity; then, if necessary, the firm will look for external debt financing and, at last, external equity financing.

The Market timing theory

The last theory of capital structure has been formalized by (Baker & Wurgler, 2002). They claim that firms' managers choose the form of financing that, at that point of time, seems to be more valued by financial markets. According to this thesis, the market timing is the only thing that matters in the capital structure's decisions. The direct implication of this theory is that a specific capital structure is caused just by the market conditions in that specific moment of the history.

I.5.1 Innovative Small and Medium Enterprises Financing

According to theoretical literature, innovative firms should find more difficult to obtain external finance; these difficulties are due to moral hazard problems and to the higher risk of their activity. These firms are even defined in literature as *"Technology-based small firms"*, i.e. as businesses whose products or services depend largely on the application of scientific or technological knowledge

(Allen, 1992). Especially when the firms' size diminishes, a wide set of issues may arise. TBSFs have always found obstacles to access the common sources of financing. This lack of capital prevents them from increasing their productivity and investing in NPV positive projects and these features are accentuated for innovative firms.

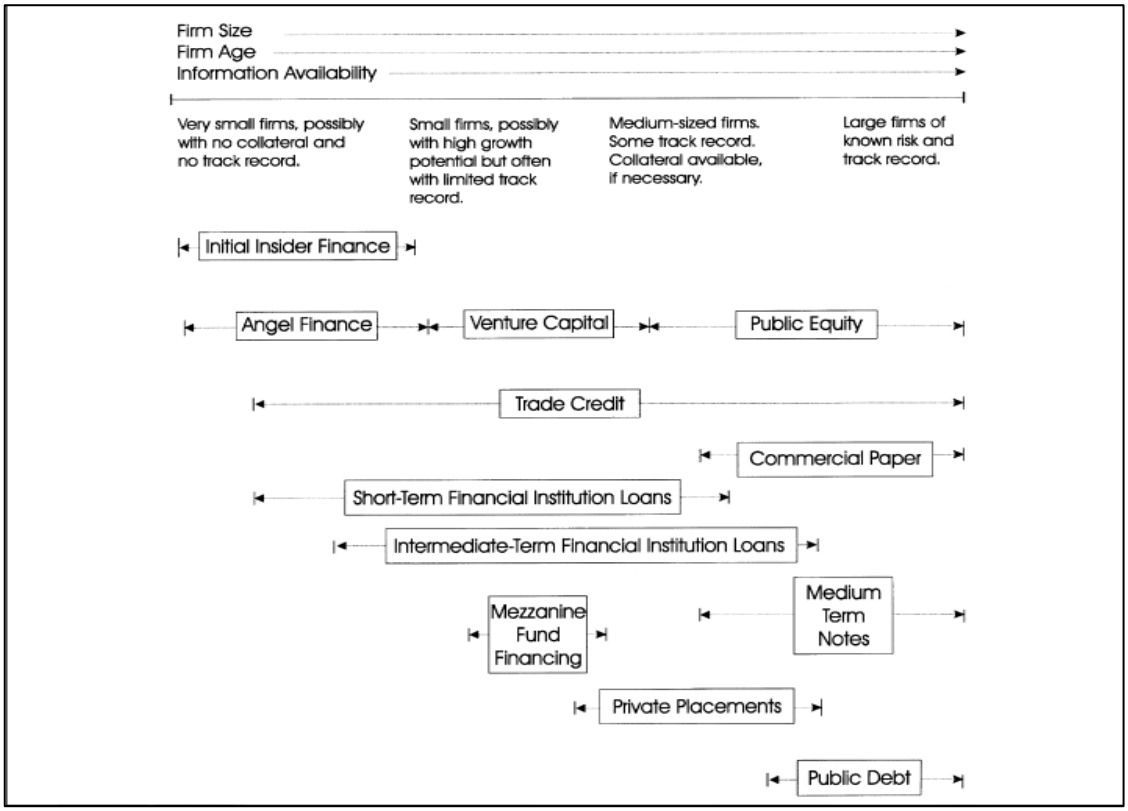
The first attempt to analyze the capital structure of SMEs was written in 1998 by Berger and Udell and observes that SMEs financing decisions depend mainly on their industrial sector and on their growth cycle (Berger & Udell, 1998). Before this analysis, academics and researchers tried to use the traditional capital structure frameworks and applied them to small and medium enterprises. But this did not succeeded, since the classical agency theory cannot be applied to small business environment, given that usually owners and managers are the same person.

The small innovative firms particularly suffer the problem of information opaqueness. Due to innovation and high returns on their projects, financiers could find very difficult to evaluate their activity and then the cost of external finance could be higher for innovative firms. Debt increases moral hazard problems; managers can substitute high-risk projects for low-risk investments (Jensen & Meckling, 1976); high risk projects increase the probability of bankruptcy, but offer no offsetting gain to debt holders if success is achieved. This case is likely for innovative firms, where there are more opportunities for this substitution. They rarely access public markets and they keep private the contracts stipulated. Moreover, many of the smallest firms do not have audited financial statements that can be shared with any provider of outside finance. Without this information, it is difficult for financial intermediaries to implement their usual *screening* and *monitoring* functions. Because of their lack of transparency, SMEs find very difficult to signal their quality and construct financial relationships. For these reasons, the financial institution may consider too difficult to finance SMEs, preferring larger and more transparent businesses.

Another issue is that the marginal cost of financial debt could increase very quickly, due to fewer tangible assets that can be used to secure loans[17]. On the other side, equity finance does not increase probability of bankruptcy.

The fundamental feature of small firms that approach to markets is their *informational opacity*.

Figure I-IV Firm continuum and source of finance



Source: Berger and Udell (1998)

Figure IV shows how the firms evolve. Starting from the left side, where financial support comes from start-up team, family and friend there are the first stages (*seed and start up stages)* where the idea is put into effect; they can be sustained also by angel finance. As firms grow up (*early growth and sustained growth*), they can access to intermediate finance (venture capital) and debt (banking, finance companies). If the growth persists, the firm may gain access to

[17] We should consider that usually a large portion of innovative firm's assets is made of human capital, which could easily walk away.

public equity and debt markets. Of course this does not fit all small businesses, but it gives a general idea about the financial growth of the SMEs.

Usually banks and commercial finance companies lending would be not available to SMEs until they reach a stage where their balance sheet reflects enough tangible assets that might be used as collaterals (Berger & Udell, 1998).

Micro and Small Businesses

This stage, as suggested before, is most frequently financed by a mixing of personal finances and angel financing. Angel financing is usually defined "*an individual investor (qualified as defined by some national regulations) that invests directly (or through their personal holding) their own money predominantly in seed or start-up companies with no family relationships. Business angels make their own (final) investment decisions and are financially independent, […]* (EBAN, 2013). Angel investors are usually found among an entrepreneur's family and friends. The capital they provide can be a one-time injection of seed money or ongoing support to carry the company through difficult times. After a business plan has been developed, the firm can access to both equity and debt financing, usually in the form of *private equity*[18] first and *venture capital* afterwards. Furthermore, the small company can rely on trade credit, i.e. delays of credits with suppliers; thus it will be financed by working capital.

It is important to analyze the degree of risk at this stage, especially for an innovative firm. During the *seed* stage, the project is very risky but the financial need is still modest, only related to the assessing of the business plan. The situation is different in the subsequent stage; in fact, while the risk degree is still rather high, the financial needs result higher in order to support the practical application of the idea.

[18] Private equity is a form of equity investment into private companies that are not quoted on a stock exchange. Private equity is distinguished by its active investment model, in which it seeks to deliver operational improvements in its companies, over several years (EVCA, 2013)

Medium businesses

As the firms grow and become more tangible, they can access the public sources of capital, mainly in the form of debt. Indeed, having a consolidated asset gave the firm the possibility to sell its assets in case of financial distress and honor its obligation. This usually come along with entrepreneur's personal belonging as collateral together with company possessions.

However, when the entrepreneur uses part of his personal belongings to guarantee a bank's loan, personal relationships take place and the individual might be more valuable than the collateral.

At last, a continuum in the growth will lead to access to public market with an IPO, that is usually followed by an exit of the venture capitalist. These are the stages of *early growth* and *sustained growth*, which hold rather less risk than the previous stages and are differentiated on from each other by the fact that the early growth require a rather high supply of liquidity, needed to distribute the product and apply marketing strategies (Sau, 2007).

Tools to reduce informational opacity

Small businesses have a series of instruments to reduce the informational opacity problem. Through these, financial intermediaries are not forced to impose extremely penalizing terms.

- *Debt covenants and maturity*. In order to ensure that borrowers will not invest on excessively risky projects, small businesses' capital suppliers tend to apply short-term contracts, according to the degree of informational opacity. The threat of not reconfirming a credit line, could force a small business to reduce the risk of the projects the firm is investing on. However the contracts are usually renegotiated as long as firms grow and reduce their riskiness.
- *Collateral and guarantees*. This instrument is useful until the firm has tangible assets that can be easily valued. Given that most of the SMEs

cannot rely on tangible assets, outside collateral and personal guarantees accounts for most of the negotiation terms.

Another approach is based on control rights (Aghion & Bolton, 1992). The lower the amount of tangible wealth, the more outside investors will insist on having control rights over the firm's decisions to satisfy their ex-ante participation constraints. Firms will try first to use retained earnings first to alleviate the participation constraints of outside financiers. When more funds are acquired, firms will initially use debt to retain some control, which they lose only in the case of default; it is only when the project's size (or scope) becomes sufficiently intangible that firms will allocate fuller control rights to outside investors by issuing new equity. As innovative firms have more investment opportunities and intangible assets, they are more likely to issue new equity.

Starting again with the source of finance considered by the general theory, explained in the previous section, we can realize how the most important source of financing for SMEs (and TBSF as well), namely *self-financing*, is very difficult to obtain; indeed these firms do not generate sufficient cash flows, especially in the early stages of development. Then the innovative firms may have liabilities in excess of the expected future income flow (Sau, 2007).

Furthermore, for innovative firms, it may be difficult assessing the project, and this could be characterized by a high degree of uncertainty, higher than the firms operating in the traditional sector. Given that innovative firms are by definition young firms, the fact that they do not have any "history" can increase the informational opacity issue in comparison with the traditional small firms. This means agency costs above average and accessing to finance almost impossible.

A possible and obvious solution to informational opacity would be to transmit all the information about the project to the investor-financer. But, of course, the entrepreneur in this case would lose his competitive advantage; indeed an innovative project loses its values when the information about it starts to circulate (Anton & Yao, 2002).

Frequently, innovative firms do not have sufficient guarantees to offer in order to mitigate the creditor's risk. Especially at initial stages, they do not have enough cash flow to service the debt and the most of the assets are *immaterial*, so that they cannot be easily offered as collateral to the potential financier (Hall, 2002). This large presence of intangibles constitutes a limit to the bank credit because it leaves the firm with few *inside collaterals* and this increases the risk of bankruptcy. Even the presence of *specific firm* assets is a cause of illiquidity and means heavier bankruptcy costs as well. In fact there is no perfect resale market for these assets, and then the investment decisions might irreversible (Sau, 2007). Hence, the high level of uncertainty and information opacity together with the lack of collateral and *pledge-able income* makes it almost impossible for TBSF to apply to traditional financing sources. These characteristic imply a situation of *market failure* as far as the use of traditional financing tool is concerned (Sau, 2007). Hall defines it as a *missing market for the financing of the innovation* (Hall, 2002).

I.5.2 The role of the venture capital

One of the best solutions to the problems previously exposed is identified in the private equity. It has already been defined as *"a form of equity investment into private companies that are not quoted on a stock exchange"* (EVCA, 2013). Inside this category there is the Venture Capital that is when the private equity is invested into young, entrepreneur-led, high potential companies that are typically driven by technological innovation; it is defined as *"a type of private equity focused on start-up companies. Venture capital funds often back entrepreneurs who have just the germ of a business idea"* (EVCA, 2013).

In the contract literature, Venture Capital come under informed finance[19] and the first operation that is done when approaching a firm is the *screening* in order to reduce *ex-ante* information asymmetry.

[19] In literature, depending on the relationship between lender and borrower, it is usual to distinguish two different channels for financing:

- Arm's length finance, which refers to direct brokering, where the investment bank participate in order to make the access to markets easier; this is common in American financial markets.

Precisely, the first one to investigate the role of venture capitalists in the resolution of these issues was Sahlman. In his study, he represented venture capitalists as facing two-level principal-agent relationship with investee companies and end-investors. In the first, the VC acts as a principal and it has to evaluate potential investment in companies in an environment affected by *moral hazard* and *adverse selection*. In the second relationship, the VC is the agent, subject to the risk that if its performance will not be good as expected, it would fail attracting further funding from the end-investor as principal (Sahlman, 1990). The *screening function* is less efficient because of the entrepreneur's desire for autonomy that makes him reluctant to share all relevant information and creates the conditions for a potential *adverse selection*. In innovative firms this problem is most acute, in view of the more complex specialist skill required to assess the technology projects.

The Venture Capital will also perform the *delegated monitoring* function since it has invested risk-capital in the innovative firms. Direct monitoring reduces the degree of *ex-post* information asymmetry and the associated problem of *moral hazard*. In practice it usually sees the venture capitalist in the innovative firm's board of director, in order to use a strict control. But this loss of control is temporary; indeed it is implied in the relationship (and sometimes explicated in the Venture Capital contract) that the entrepreneur will regain control when it is time for disinvestment, in the best situation with an IPO (Initial Public Offering).

According to Sau, the Venture Capital takes an hybrid form, because although it is characterized by the investment in risk-capital it also shows certain feature suggestive of debt capital (Sau, 2007) (Hall, 2002). Indeed if the firm is not performing well, there are contract provisions that establish a transferring of control into the hands of the venture capitalists (as it happens with the use of debt capital in case of insolvency); vice-versa if the firm's performance is positive, the control remains with or returns to the entrepreneur-innovator.

- Informed finance, typical of European markets, that is related to the funding through the banking channel. This presumes a close relationship between lender and firm based on information that are not publicly available. (Rajan, 1992)

The venture capitalist usually performs other functions more than the classic screening and monitoring. In fact, these can range from *managerial consultancy* to *information production.* The innovative firm could benefit from the presence of qualified management in the board of directors, with experience and competencies that usually are missing to the innovator-entrepreneur that excels in technological skills. Furthermore, the venture capitalist is also producing information, a function that is generally performed by banks. This function has effects on third parties too; in fact obtaining finance from a venture capitalist is considered as a signal of a promising project for the other potential investors and the banks may be ready to grant loans given that the information problems are alleviated (Black & Gilson, 1998).

I.5.3 Is there a different pecking order for innovative firms?

We have seen that the venture capital offers a way to overcame market failure for financing innovative firms. But this solution has limits: indeed it tends to focus only on a few sectors at a time and the minimum size investments are too large for firms at seed and start-up stage. Furthermore venture capital requires a thick market in small and new firms stocks in order to provide an exit strategy for early-stage investors (Hall, 2002).

Moreover, the VC tends to disinvest rapidly through an IPO; then at a certain point of its growth, a firm must look for other forms of financing (credit, issue of shares and bonds). Hence, despite the fundamental role of the VC, even in the innovative firms there is still a hierarchy in the sources of financing. This hierarchy is sensible on the size of the firms and its stages of development that are characterized by a different degree of information opacity and financial requirement; this is known as the *financial growth cycle* (Berger & Udell, 1998).

According to this cycle, before looking for finance under the private equity form, the innovative firms seek funding in the two “informal” forms of financing: *insider financing* (use of the capital of the entrepreneur and his friend/family) and *angel finance.*

At the seed stage there are also two forms of public financing that are playing a fundamental role, especially for small-size firms. In Europe, there are the ETF (European Technology Facility), I-TEC (Innovation and Technology Capital) and LIFT (Linking Innovation, Finance and Technology) and in the USA we can recall the SBIR (Small Business Innovation Research) and SBIC (Small Business Investment Company). Lerner has examined the long-run impact of awards to new high technology firms made by the mentioned SBIR program. He found out that the awarded firms seem to grow up substantially faster than the others and then they are able to obtain more funds from the market (Lerner, 1999).

Going back to the analysis of financial hierarchy, venture capital seems to be the source on which the entrepreneur-innovator draws upon *after* having resorted to the three mentioned above, but *before* drawing on credit (Sau, 2007).

Then the classic hierarchy, which sees the use of debt capital before the risk capital, might be *inverted* in the case of innovative firms. Indeed they resort to bank financing only after the venture capitalist; this happens because the venture capitalist, producing information, lowers the degree of information asymmetry. Hence, at a certain point, it will be easier for the banks to pass over the adverse selection problem and finance the firms.

Complements to the financing of innovation are the alternative markets for innovative firms[20]; they are efficient and transparent market that should allow the venture capitalist for a fast disinvestment via the IPO exit. In fact if the venture capitalist can rapidly exit, the entrepreneur can reacquire the control and the venture capitalist resources can be addressed to the financing of new projects (Black & Gilson, 1998).

At last there is the issue that public equity that is feasible when the degree of information opacity and risk has been lowered and the firm has established a solid reputation.

Concluding, according to Sau, the pecking order for innovative firms is:

[20] In many countries the new markets have emerged, aiming to sustain the diffusion of venture capital: “Nuovo Mercato” in Italy, “Nouveau Marchè” in France, “Neuer Markt” in Germany, and “Swiss NM” in Switzerland etc.

1. Insider capital, informal private equity and easy term public financing (Seed)
2. Venture Capital Financing (Start-up)
3. Self-financing, bank and/or business credit (Early-Growth)
4. Direct-issue of bonds and public equity (Sustained-Growth)

Of course there are interconnections between these sources of finance. It is particularly clear the one between venture capital and New markets, as already explained. Even the fact that business angel precedes venture capital is an indication of the complementarity between these two.

II. EMPIRICAL STUDIES ON THE INNOVATION'S EFFECTS

The empirical research on the effects of innovation is very broad. The innovation phenomenon, as previously seen, could be difficult to understand and its effects and consequences are still unpredictable for the most part. In this second chapter we will see which the patented inventions are (first section)[21]. In the second section we will see how it has been attempted to classify the most innovative firm, both from an international point of view (Forbes and Thomson Reuters rankings) and from a more localized sight, the Italian innovators ranking. The third section exhibits the findings that scholars have obtained from econometric research on the relationship between innovative activity and firms' performance. The fourth section is dedicated to the analysis of previous studies on innovative firms' financial structure and how this could be different in comparison with the classic firm financial theories; the last section explain some of the major econometric issues that are encountered in panel data analysis.

II.1 Which inventions are patented?

Since the studies of Mansfield and Audretsch in the late 80's, scholars have tried to understand the link between patenting and innovation. The research focused on the importance of patent system, in order to understand how much it was essential for the creation of innovations and to what extent firms use this instrument to protect the intellectual property. Mansfield, in 1986, sought to obtain information on the proportion of developed or commercially introduced inventions that would not have been created and sold in the absence of patent system. He investigated on a sample of 100 U.S. firms and the results obtained indicate that patent protection was judged to be essential for the development or introduction of 30% or more of the invention in only two industries: pharmaceutical and chemicals. In another three industries patent protection was

[21] This could be interesting in relation to the empirical work that is following. Indeed the sample selection will be based on the enterprises that have registered a minimum number of patents. See chapter 3 for further details.

necessary for the development of 10-20% of their inventions, namely petroleum, machinery and fabricated metal products (Mansfield, 1986). We know that not all patentable inventions are patented. Indeed, sometimes firms prefer to rely on trade secrets, because technology is progressing so rapidly that the patent itself may be obsolete before being issued. Then, in order to shed light on the usage of patents, another indicator was defined: the patent propensity. This, introduced for the first time by Sherer in 1965, has been specified in many different ways; several definitions of the patent propensity rate derive from the use of percentages of patentable inventions that are patented. Among them there is the Mansfield's characterization that measure differences in the reasons why firms choose to patent an invention, without interference from the productivity of R&D in terms of the number of innovations produced per unit of R&D expenditure. Indeed, he tried to understand which the percentage of patentable inventions that are patented is, and this research has been done through interviews and correspondence[22]. In his findings there is evidence of how in the remaining industries[23], where (according to the surveys) the patent system seems less important, over 60% of patentable inventions were patented. Thus, even though these industries believe that patent system is not essential, this does not mean that they do not use it. According to Mansfield interpretation of the data, the reason would be that the prospective benefits of patent protection exceed its costs. If this is true, then it is reasonable that the firm is going to patent the invention (as it happened in more than half of the cases).

A more recent study by Arundel and Kabla, in 1998, focuses on the sales weighted propensity to patent that differs across the innovation types: the rate is relatively lower for process innovation than for product innovations. The authors' explanation is that the propensity to patent innovations declines with the rising importance of secrecy and to prevent copying. Indeed while the markets for products are concentrated in areas where the patent protection is effective, the

[22] "Patentable" refers to the legal requirement for an invention to meet novelty, non-obviousness, and industrial application criteria.
[23] Primary metals, electrical equipment, instruments, office equipment, motor vehicles, rubber and textiles.

production areas may be located anywhere in the world and the process may be copied with low risk of legal consequences. This theory is confirmed even by the survey conducted by Cohen, that asked to the firms a specific question on what percentage of their innovation was patented (Cohen et al., 2000). The consequence of these findings is that in the areas where the trade secrets or other strategies to protect the intellectual property are a convenient alternative to patents, the research results could have been biased.

Further interesting findings of these research papers are the analysis on the link between patent propensity and size. One of the two Schumpeterian hypotheses is that innovation is promoted by large firms[24]; this feature has been tested by several scholars among which Mansfield: he finds out a positive correlation between the firm's size and the percentage of patentable inventions that are patented; this correlation is statistically significant in each of the three industries where patents seems to be the most important (pharmaceuticals, chemicals, and petroleum). According to the work of Acs and Audretsch on a sample of U.S. small business, the innovations (and then not the patents) are related to the features of the market in which the firms are operating; indeed they show that in industries that are capital intensive, concentrated, and advertising intensive, there is a relative advantage of large firm. On the contrary, in industries that are at their early stage of the life cycle, where total innovation and use of skilled labor play a large role, the smaller firms have an innovative advantage (Acs & Audretsch, 1987).

From a very recent work by Fontana et al. (2013), that focuses on the concept of patent propensity, we can find out more and up-to-date information. They worked on a dataset of awarded innovation that has a time frame that ranges since 1977 to 2004; the awards are assigned by the magazine *Research and Development*. It may be worth noting that the majority of innovations awarded are not patented. Indeed, from Table 1 we can see that there is, both in non-corporate than in corporate segment, a high percentage of non-patented

[24] The other one is that innovation is promoted by imperfect competition.

innovations. In this case, we can even see that the share of patented inventions is higher in corporate sector; the authors' explanation is that Universities and Public Research Organizations lack of the assets necessary for the commercialization of the patented products (Fontana et al., 2013).

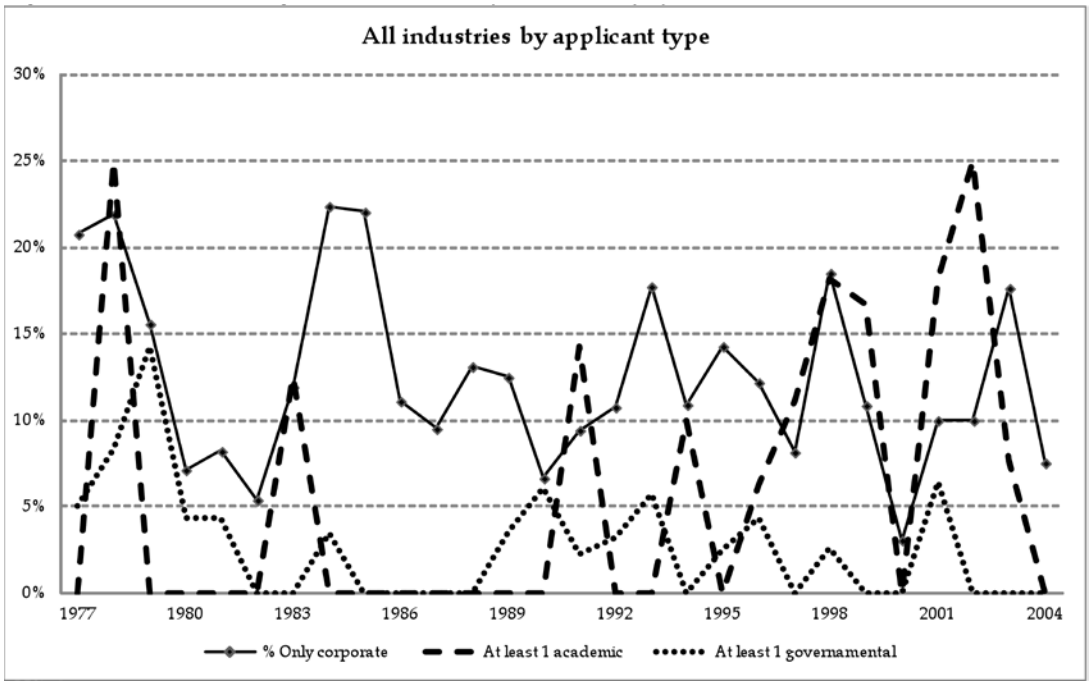
Table II-I Total awarded innovations and patents

Sample (1977-2004)	Awarded Innovations	Patented Innovations	Share not patented
All the sample	2802	255	90.9%
Non corporate	886	25	97.16%
Corporate only	1751	220	87.44%

(Fontana et al., 2013)

This is confirmed by the Figure 1 that shows the pattern of changes in patent propensity by type of inventor. Indeed, here again we can see how the private sector patents more.

Figure II-I Pattern of change in the propensity to patent by type of inventor



Source: (Fontana et al., 2013)

Continuing to look at the Fontana's work, we can find interesting data about how the patenting rates vary across the sector.

Table II-II Patenting Rates of the sample analyzed by Fontana

	All applicants		Only corporate	
	Innovations	**Share Patented**	**Innovations**	**Share Patented**
Electrical engineering	728	1.126	728	1.513
Instruments	1027	00.682	639	00.954
Chemistry, Pharma	176	1.420	123	1.703
Process Engineering	622	1.125	366	1.694
Mechanical Engineering	249	00.884	144	125
Total	2802	00.960	1728	1.336

Source: Adapted from Fontana et al. (2013)

The table shows how the percentage of patented innovation varies across sectors. Focusing on the results obtained by Fontana, we can note that the macro-sector with the highest propensity to patent is chemical-pharmaceuticals; this result is in line with the results obtained by Arundel & Kabla (1998), aforementioned. Even in the Mansfield's work we recall that the pharmaceuticals and chemical sectors were the ones that judged the patenting system to be essential for their intellectual property functions; then this could be viewed as another confirmation of Fontana et al study's validity. The authors recall that instruments are the macro sector with the lowest patenting rate and this could be linked to the public nature of most of the organizations active in this sector (and then with a low propensity to patent as explained before).

The last feature of patenting rates that we are going to analyze here is the distribution across countries. Table III shows the distribution patenting rates with a division for the three main economic regions of the world; it is worth noting that the awarded innovations from at least a U.S. applicants have a lower patent propensity than the entire sample, while a strong result is obtained by Asia (where most of the innovations are awarded to Japanese companies). Indeed the Asia's difference is +15.53% significant at 1% significance level and this confirms an aggressive use of the patent system by Japanese companies.

Table II-III Patenting rates by industry across countries

	Full Sample		USA			Europe		
Sector (OST 5)	Total	%Pat	Total	%Pat	Diff.	Total	%Pat	Diff.
Elec. Eng.	728	11.2%	597	8.21%	-2.99%*	16	0%	-11.2%
Instruments	1027	6.8%	876	5.58%	-1.22%	56	8.92%	+2.12%
Chemistry	176	14.2%	158	13.92%	-0.28%	8	0%	-14.2%
Proc. Eng.	622	11.2%	559	11.09%	-0.11%	17	11.76%	+0.56%
Mech. Eng.	249	8.8%	207	7.73%	-1.07%*	9	11.11%	+2.31%
ALL	2802	9.6%	2397	8.22%	-1.38%*	106	7.55%	-2.05%
	Full Sample		**Asia**			**Other**		
Sector (OST 5)	Total	%Pat	Total	%Pat	Diff.	Total	%Pat	Diff.
Elec. Eng.	728	11.2%	86	31.40%	+20.2%***	29	3.45%	-7.75%
Instruments	1027	6.8%	50	22%	+15.2%***	45	4.44%	-2.36%
Chemistry	176	14.2%	5	20%	+5.8%	5	0%	-14.2%
Proc. Eng.	622	11.2%	25	12%	+0.8%	21	0%	-11.2%
Mech. Eng.	249	8.8%	21	23.81%	+15.01%**	12	0%	-8.8%
ALL	2802	9.6%	187	25.13%	+15.5%***	112	2.68%	-6.92%**

Fontana (2013)

Difference is statistically significant at 1 %(***), 5 %(**) and 10 %(*) significance level. Innovations with multiple applicants from different industries are double counted in the table

Then, as seen in this first paragraph, not all the most important innovations are patented and the patent propensity varies through sectors and types of organizations. In the following section, we are going to see from a wider point of view, how the best innovative companies are selected (and awarded) and how the different sectors "produce" innovation.

II.2 Best Innovative companies

If we compare the various ranking of innovative firms, we can highlight a deep diversity in the evaluation methods. We will present two of the most important innovative firms classification – Forbes "World's Innovative Companies" and "Thomson Reuters Top 100 Global Innovators"- and then there will be a focusing on similar Italian ranking. We will try to explain how these firms are evaluated, according to each single method, and then which are the differences that cause fragmentation in this rankings' construction.

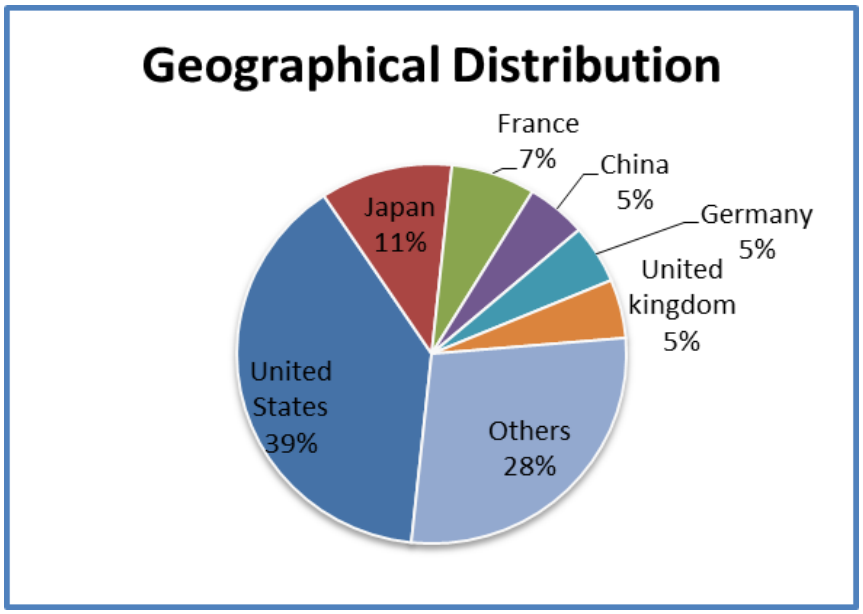
II.2.1 Forbes "World's Most Innovative Companies"

This is probably the most accurate ranking, since it is based on a set of parameters that provide an objective measure of the firms' features. This

magazine needs no presentation. It has been founded in 1917 by Bertie Charles Forbes and it is worldwide known for its annual rankings, of which the most famous are “World’s Billionaires”, “400 Richest Americans”, “Top Earning CEOs”.

The ranking that we are going to analyze is the “World’s Most Innovative Companies”; here, the magazine wants to highlight the 100 firms that, at a worldwide level, innovate better. The basic indicator is the *Innovation Premium* (it will be described in details later). This ranking was published for the first time in 2011, thanks to the joint work of Forbes specialists and the professors Jeff Dyer, Hal Gregersen and Clayton Christensen. The entry requirements for the evaluated firms are: $ 10 billion in market capitalization, seven years of public financial data and there is a threshold for R&D spending as a percentage of sales.

Figure II-II Country based distribution of Forbes “World’s Most Innovative Companies"



Source: Forbes.com

As we can see from the Figure II, the majority of innovative firms come from United States. In 2013, the podium is dominated by two firms that belong to “Software and Programming” sector, namely “Salesforce.com” (First place in ranking) and “VMWare” (Third Place). The second place is occupied by “Alexion Pharmaceuticals”.

II.2.1.1 Classification Methodology

Dyer and Gregersen (2012) in the article published on the magazine, affirms that *"Most innovation rankings are popularity contests based on past performance or editorial whims. We set out to create something very different with the World's Most Innovative Companies list, using the wisdom of the crowd. Our method relies on investors' ability to identify firms they expect to be innovative now and in the future."* (Dyer & Gregersen, 2013). The *Innovation Premium* is *"the difference between their market capitalization and a net present value of cash flows from existing businesses (based on a proprietary formula from HOLT/Credit Suisse). The difference between them is the bonus given by equity investors on the educated hunch that the company will continue to come up with profitable new growth"* (Dyer & Gregersen, 2013). This method, in practice, tries to determine the percentage of the market value of an enterprise that should be ascribed to its existing products and businesses; if the market capitalization has exceed this value, there would be an innovation premium for the enterprise. Hence, the sense is that the Innovation Premium measures how much the investors have "overvalued" the shares of the company in contrast with the present value of the firm's investments; this overvaluation should persist on the expectation of future innovative projects and results.

The estimation method of the Innovation Premium is composed of three stages. In this process there is the cooperation of HOLT, a division of the Swiss bank "Credit Suisse".[25]

1. In the evaluation of the NPV, HOLT determines, through a proprietary model, the cash flow of the two subsequent years (of existing businesses) with estimations of the profit and revenues that could be generated; these estimations are realized using the median of all the estimations.[26]
2. Then the analysts project the cash flow in the future for the next 38 years and forecast the cash flows with a specific algorithm, based on:

[25] For any further information on Holt division, visit "https://www.credit-suisse.com/investment_banking/holt/en/index.jsp"
[26] The method is called "I/B/E/S"-Institutional Brokers Estimate Systems".

   a. Estimation of the future ROI (Return on Investment): firms with higher profitability have higher profits also in the future, even taking account of the “return to mean” effect.
   b. Historical (over the previous five years) ROI volatility; the higher is volatility; the faster will be the “mean returning” effect.
   c. The company’s reinvestment rate; when a company is growing faster and is reinvesting consistent amount of money, the ROI will go back to its standard levels; this is because it is difficult to perform financially, especially with a faster growth rate.
3. The difference between the company’s total enterprise value (market value of equity plus total debt) and this *value of existing business* constitutes the innovation premium, expressed as a percentage of the enterprise value.

The indicator developed by HOLT and used by Forbes to create its ranking, is known as CFROI (Cash Flow Return on Investment). Since it mixes together actual values and forecasted values it could not be taken as a simple value measurement.

The main reasons for which investors give credit to the firms, buying their shares, are because of the expectations of a future growth: this requires innovation. This is why the creators of this indicator define innovation as a primary driving-force of growth, even though they know that it is not the only key factor.

Furthermore, this method could work only if the investors use all the information available (i.e. an efficient market). Indeed, in order to choose the best shares to buy, we have to suppose that the information research and use will be maximized. Information is not perfect, but it is integrated with the great quantity of data publicly available. Then, this parameter could be trustworthy, especially if compared to the surveys conducted to the top management, which is not motivated to use all the information on innovation and growth of the firm that they are evaluating.

II.2.2 The Thomson Reuters "Top 100 Global Innovators"

Thomson Reuters is a well-known Canadian company that provides information worldwide both to firms and people. Since 2011 the firm published for the first time its rank of the top 100 innovators, proposing a specific geographical and sector-based analysis in order to identify the key findings that are following.

The methodology followed by Thomson Reuters was developed by the firm itself and reviewed by several leading IP-centric organizations. In order to classify the firms, various indicators were used: "*Thomson Reuters Derwent World Patent Index®"*, a database that includes patents from the 44 main issuing authorities; the "*Derwent Patents Citations Index™*, the "*Quadrilateral Patent Index™"*, and the "*Thomson Innovation®*, that provides the international coverage of patents and of Intellectual Property of main sectors. Furthermore, a comparative analysis is done using the Thomson Reuters Advanced Analytics Platform, the single source for financial professional to turn information into action (Reuters, 2013).

The criteria for the awarding are:

1. *Volume*: is specific for companies that are responsible for generating a sizeable amount of innovation. The requirement to be included into the analysis is to register at least 100 patents in the most recent three years. The data are taken from the DWPI database, mentioned in the previous paragraph; in this case *"Basic Patents"* are used.
2. *Success*: This indicator measures the ratio of published applications (the patents that are filled and published by the patent office but not yet granted) to granted patents over the most recent three years.
3. *Global*: the protection of an invention in the so-called "Quadrilateral"[27] is a signal of value and credibility on the enterprise intellectual property. The number of patents that are registered "worldwide" is calculated form the

[27] Patent registered to the Chinese Patent Office, European Patent Office, the Japanese Patent Office and the United States Patent Office fall within the "*Quadrilateral"*.

"Quadrilateral patent index" and it identifies the firms that give the highest value to their portfolio in the most important world markets.

4. *Influence*: Another indicator that might reveal the impact of an invention on the state of the art can be determined by looking at how often it is subsequently cited by other companies in their inventions; through the Thomson Reuters Patent Citation Index database, citations to each organization's patents are counted over the most recent five years.

It is then clear that, in order to determine the top innovators, Thomson Reuters rely on one principal indicator: the patents. Indeed all the metrics used turn around this type of IP protection. Even though, from one point of view, it is corrected to link innovators and patents (in our analysis we will do the same), it is worthy to remember that not all inventions are patented (trade secret is often preferred, especially for process innovation that could be easily copied, as expressed in the previous section).

The rank of the best innovators is slightly different from the one presented by Forbes. Indeed it is a list of the firms which are all on the same level, in alphabetical order. As Figure III shows, from the 2013 report interesting findings emerge; there is a confirmation of the leadership of North America, 46 organizations (45 from U.S.), followed by Asia with 32 organizations (28 from Japan). According to document, there is a direct correlation between a government's commitment to innovation and its R&D tax policies that influence its ability to attract and retain innovative organizations. For example, U.S. R&D tax credits have created more robust innovation collaboration between government and private sector. A similar situation exists in Japan with the introduction of deductions for R&D expenses against corporate income, together with a range of incentives for joint R&D collaboration with public research institutes and universities.

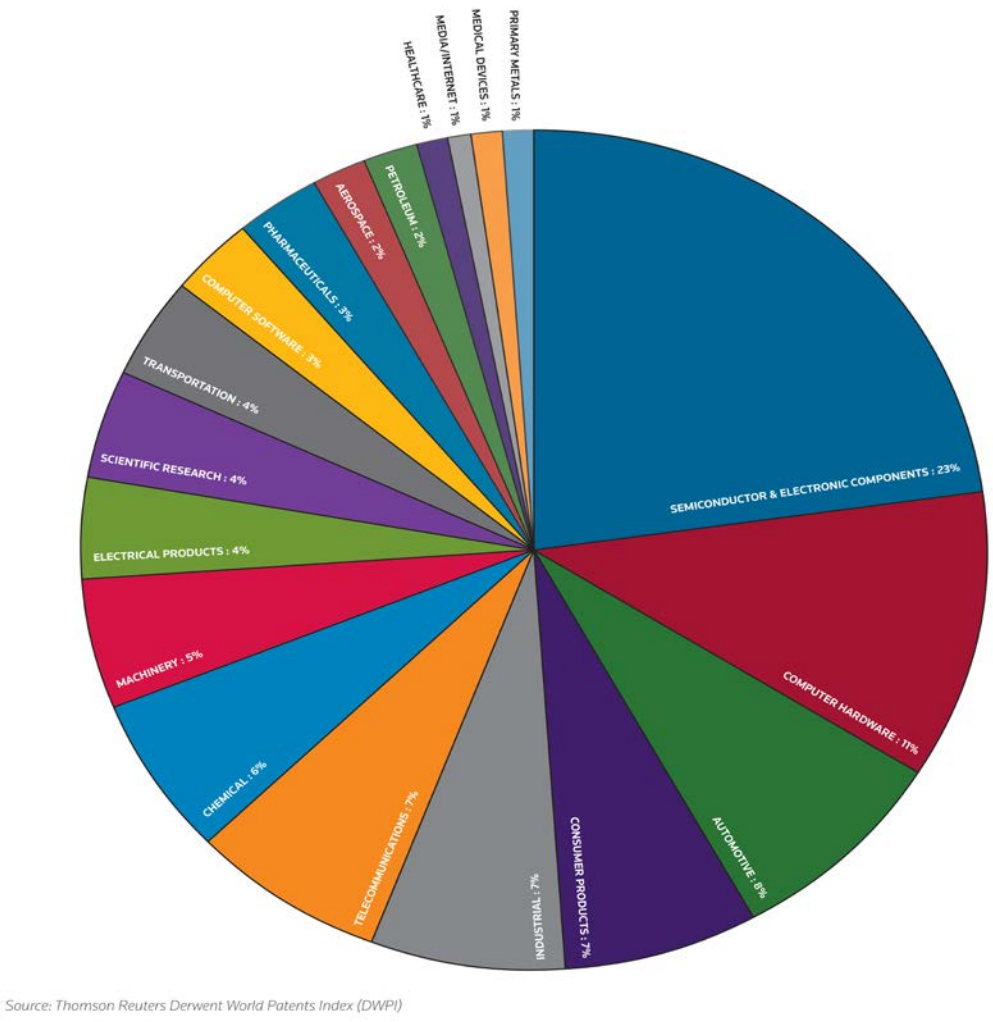
Figure II-III Geographic Distribution of 2013 Top 100 Global Innovators

Source: (Reuters, 2013)

For this rank, the industrial distribution is available, as shown in figure IV. In 2013 "Semiconductors and Electronic Components" prevails in its presence on the list, followed by computer hardware. A break out is observable of pharmaceutical industry (that triples its presence since the previous year).

In this way of judging innovative firms, the patent is seen like a bridge that connects innovation and economic growth. The authors of the report highlight that, whereas the patent was seen as a defensive tool in the last years, today it is going to be a vital component of the corporate offense and even become a solid source of revenues for the organization.

II-IV Industry Representation of Thomson Reuters 2013 Top 100 Global Innovators



Source (Reuters, 2013)

II.2.3 Italian's awards for innovative firms

Since that we are going to analyze a sample of Italian small innovative firms, it would be appropriate to focus on the Italian ranking of innovative firms. Italian firms are totally absent from the international ranking previously examined. This is not the place to discuss the reasons of this shortage, but for the sake of the argument we will give a brief explanation. A simple justification could be that all the rankings are drafted by American magazines or societies; or maybe it is just that Italian firms prefer not to invest in R&D projects. In the writer's opinion, the most suitable reason could be that, since Italian manufacturing sector is almost

totally composed of SMEs (99.9 % of firms in Italy are SMEs, according to SBA, 2012 – European Commission), it would be impossible for them to compete against the giant corporations of the other countries. In the next paragraph, we will present two awards that are conferred to Italian innovative firms: the prize "Imprese x Innovazione" (awarded by Confindustria) and the "Giornata Nazionale dell'Innovazione", a set of different awards supported by the Italian government. Furthermore, it is worth pointing out that the in the Italian accounting laws there is not separate indication for R&D expenses (and this is also a problem for researchers); as mentioned previously, the only possibility to understand if a firm has invested in R&D is from the balance sheet (when the management decides to capitalize these expenses). In contrast, in the Profit and Loss Statement no separate indication is expected[28].

II.2.3.1 Imprese x Innovazione

Confindustria[29] since 2008 sponsored this award, called "Imprese x Innovazione" (Firms for innovation), with the partnership of Mai Foundation and the APQI (Association for the Prize of Italian Quality). The 2013 edition aims to "valuing and spread the culture of innovation at a broad level and excellence, for competitiveness and development of the country" – adapted from Italian, (Confindustria, 2013).

There are two main categories of firm that can participate: Small and Medium enterprises and large firms.[30] Three different awards are appointed, namely: "Awards", "Prizes", and "Special Mentions". In order to participate, the firms should apply via web; but it is forbidden to participate to the winners of "Award" in one of the three previous editions to the one that they are applying for. The

[28] With the legislative decree *"Destinazione Italia"* (December 23, 2013, still waiting to be approved by the parliament) the Italian government is trying to incentive the firms that are investing in R&D with the minimum threshold of € 50,000 spent in these activities. This decree is based on the scheduling of European Structural Funds 2014-2020. The deductible expenses are related to: employees involved in R&D activities, depreciation charges of dedicated machineries, costs born in partnerships with university and public research centers.

[29] Founded in 1910, it is the main organization representing Italian manufacturing and Services Company. A total of 148,392 companies are voluntary members of the organization.

[30] Small firms occupy less than 50 people employed; medium firms have a workforce between 51 and 250 people. Large firms are split in two classes: the first one has 250-1500 waged; the second overtakes 1500 people employed.

firms that participate have to fill a questionnaire, after which a first rank (divided by dimension class) is arranged. At last, there is an evaluation of the documents by the Jury of the Prize in order to decide the winners. This process is managed by APQI, using the framework for innovation of EFQM (European Foundation for Quality Management).[31]

Table II-IV Winners of "Imprese x Innovazione 2013

"Innovazione x Imprese" 2013		
Prize	**Firm**	**Region (Headquarter)**
AWARD	Carlsberg Italia Spa	Lombardy
	Elica Spa	Marche
PRIZE	T&B e Associati Srl	Friuli-Venezia Giulia
SPECIAL MENTION	Arnaldo Caprai Soc. Agr. Srl	Umbria
	Essetre Spa	Veneto
	Gruppo Pragma Srl	Lazio
	Iacobucci HF Electronics Spa	Lazio
	Joint Engineering Srl	Umbria
	Opus Automazione Spa	Tuscany
	Tec.Inn. Srl	Umbria
	Tecno Srl	Campania
	Teknoweb Srl	Lombardy
	Vetrya Spa	Umbria
FINALISTS	Ghepi Srl	Emilia-Romagna
	Italtel Spa	Lombardy
	Novi Service Srl	Lombardy
	Nuova Solmine Spa	Tuscany
	QUI! Group Spa	Liguria
	Sol.Bat. Srl	Tuscany
	Studio Torta Spa	Piedmont

Source: Confindustria (2013)

The list of the winners in Table I shows how the geographical distribution tends towards North and Center of Italy, with the Lombardy as the most awarded region (four prizes have been won there in this edition).

[31] The EFQM Excellence Model is based on nine criteria. Five of these are "Enablers" and four are "Results". The "Enabler" criteria cover what an organization does and how it does it. The "Results" criteria cover what an organization achieves. For any further information, see www.efqm.org .

II.2.3.2 The "Giornata Nazionale dell'Innovazione" and "Premio dei Premi".

In order to improve the Innovation culture in the country, the Italian government has established, with the decree of the Prime Minister Romano Prodi in 2008, several events dedicated to innovation:

- "Giornata Nazionale dell'Innovazione" (National Day of the Innovation). In this occurrence, the public administration should hold a series of initiatives that aim to inform the public about innovation and its contents.
- "Premio Nazionale dell'Innovazione" (National Prize of the Innovation), so-called "Premio dei Premi" (Prize of the Prizes), that is a public acknowledgment for innovations realized. This is appointed in the National Day of the Innovation, to the winners of the prizes awarded in the country.
- "Convegno Nazionale sull'Innovazione" (National Conference on Innovation); this meeting is held in the National Innovation Day and it is organized by COTEC Foundation (National Foundation for Technological Innovation).

Then, since 2009, in Italy there is a day dedicated to innovation with a set of events that encompass all the subjects, from the research centers and universities, to the public administration, to the firms. This action has the specific purpose of explicit the importance that the government gives to the people, firms, and companies that contribute to the development of the countries through innovations. This importance is given because it is widely believed that innovation can enhance competitiveness of a country, along with a deep influence on both macroeconomic growth and firm level development. In the next section we will see, examining some empirical evidences, that this relationship is not always so obvious and there is a need of further research.

II.3 Innovation on Firm Performance and Growth: empirical findings

The literature on innovation often presumes a direct link between innovative activity and economic growth. The research on this topic is fundamental in order

to understand how much the resources spent in R&D pay back in term of profit (on a firm level) and of general economic growth (on a country level). Furthermore, empirical evidence on this topic can establish a strong base on which build government policies that support the investments on innovation both by the public and private sector. According to (Demirel & Mazzuccato, 2012) the studies on this relationship are quite conflicting. Indeed, whereas (Geroski & Manchin, 1992), (Geroski et al., 1997), (Yasuda, 2005) find a positive impact of innovation on growth, the findings of (Bottazzi et al., 2001), (Loof & Heshmati, 2006) show no significant impact and others even a negative impact (Brouwer et al., 1993).

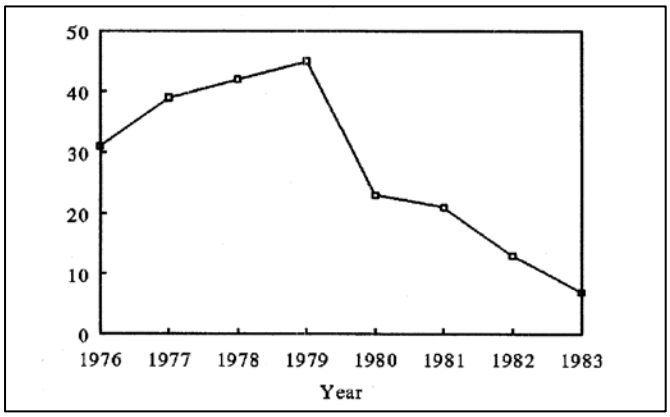
This disagreement can even raise a question about market selection; indeed both Schumpeterian and mainstream literature assume that the more innovative and efficient firms will grow more, because they will be selected by the market. If this is not happening for firms that innovate, it could be dangerous to ask them to spend more resources on R&D.[32]

The work of Demirel et al. focuses on the pharmaceutical sector, analyzing a set of U.S. firms between 1950 and 2008. He finds out that a key component that links innovation and performance is the "persistency" in patenting. There are no evident benefits for firms that patent sporadically. In this analysis, the (lagged) sales variable has a significant and negative impact and this suggests how smaller firms (measured by sales) have a tendency to grow faster.[33] The authors look also for difference in size, comparing small (less than 500 employees) and large (more than 500 employees). The results suggests that large firms R&D effort is more efficient as a driver of the sales growth, differently from small businesses where the R&D is worth only if the firms is patenting for a minimum of five years consecutively. Then the key for small firms, in pharmaceutical sector, is *persistency* that allows getting the maximum advantage from investments in innovation (Demirel & Mazzuccato, 2012).

[32] The European Commission, in the Lisbon Agenda, suggests that firms should spend more on R&D, with a target of 3% of GDP in aggregate figures.
[33] The dependent variable in the regression is growth measured as the annual change in logarithm of sales.

Geroski examines a set of 539 UK manufacturing firms over the period 1972-1983. These are large firms, all quoted in the stock market, and as a group represent the 50% of total UK manufacturing sales. The measures of performance used are profit margins (defined as net profit before tax and interests, divided by sales) and the rate of growth of sales turnover. It is interesting that the authors are focusing on both *product of innovative activity* (i.e. the specific product or process innovation that are produced by R&D departments) and on *process of innovation* (i.e. the way that a firm's research activities are organized and how they are integrated with the other activities of the firm). Regarding the former is important to remember that the profits from an innovation last until the innovating firm is able to maintain proprietary control; then in order to observe these effects, a focus on the introduction of a specific innovation is needed. By contrast, in the latter case, the transformation in the internal capabilities of an innovating firm might create deep differences between it and non-innovating firms, differences which can translate into higher profits or faster growth. According to the authors, these differences can affect both how these profits and growth are generated by the firms and the level of these measures themselves. In order to observe them, a match between innovating firms with similar non-innovating firms is needed, observing the differences in performance over time. The paper shows that differences in profit margins between firms are very persistent over time, while differences in growth rate are extremely unpredictable and rarely last for more than a few years. The final results indicate that innovating firms have profits 7.6% larger than non-innovating firms, and their growth rate is about 5.6% higher.

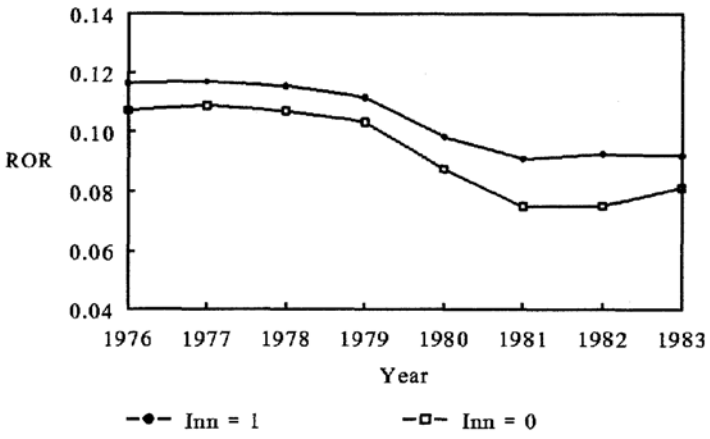
Figure II-V Total number of innovation in the sample



Source: (Geroski, 1992)

It might be worth to underline that, as shown in figure V, there is a slowdown of innovation production after 1979[34]; this should have as a consequence that the profit margins and growth between innovators and non-innovators should be narrower than in the early 1970's.

Figure II-VI Average profit margin for innovators and non-innovators



Source :(Geroski, 1992)

But this is not the case; indeed, looking at figure VI, we can see that innovators outperform non-innovators in almost every year of the sample period despite the fall of in innovative activity. Then, in Geroski's opinion, it is clear that these performance's differences are not closely linked to the timing of innovating activity. Here we can foresee that *the process of innovation* matters much more that *the product of innovative activity*. It seems that innovators manage to

[34] This is likely to be caused by the recession that hit UK manufacturing industry in the early 1980's.

maintain their profit margins and growth rates much betters that non-innovators do. The explanation given by the authors to this occurrence is that if we think about market selection as the mechanism that chooses the best firms and rewards them with profits and growth, it would be easy to deduce that the maximum pressure is applied in the periods of recession. When the firms have to cope with a recession, it is required to redefine the activities in a different way; if the process of innovation transforms the internal capabilities, this can be noted during the toughest period: i.e. the recession itself. The concept is that innovative firms are more flexible in adapting to the changes imposed by a difficult economic period and this might be the reason why they outperform innovators (Geroski & Manchin, 1992).

In a later study (Geroski et al., 1997) the authors develop the reasoning, investigating on what happens when a firm fails to innovate persistently and what causes innovation on a regular basis. They analyze two set of innovative records: patenting activity by UK and US firm overt the period 1969-1988 and UK major innovations over 1945-1982. In both cases there are very few firms that produce patents or major innovations on a regular basis. Of course in this case the attention is on minor technical or organizational innovations, all of which can occur on a routine basis and not on major innovation (this kind almost certainly occur on a highly irregular basis). Another aspect worth of consideration is that this study consider "innovation spells" on an annual basis and then this may exaggerate the episodic nature of innovative activity. On the data analysis results that most firms never patent, indeed the population is just a small fraction of the total UK manufacturing industry. The results from this research suggest the presence of "dynamic economies of scale" – *"the possibility that increases in the volume of innovation produced by a firm at any one time increase the likelihood that it will continue innovating subsequent to that time."* (Geroski et al., 1997, p.45).

A recent work from Yasuda (2005) on a sample of Japanese enterprises shed more light on the relationship between R&D expenses and firm performances.

The variables used in the regression are: a dummy variable for R&D spending on the total sample and R&D intensity (R&D spending/sales), R&D expenditure per employee, the natural logarithm of R&D expenditure for sub-samples. The R&D dummy coefficient is significantly positive for the total sample; the variable has positive effect even on a firm's "survivability". Looking at the sub samples[35], it is evident that the R&D expenditure is positively related to firm growth and survivability. Evidence of positive correlation is found also in the R&D intensity, but not in the selection equation. The author's explanation is that this phenomenon could be linked to labor productivity. Indeed it could be said that given a certain level of R&D expenditure, a firm that has a low level of sales has a greater probability of making an exit. Than a high level of R&D intensity might have two meanings: one is a high level of R&D compared to the firm's size (that results in high survivability) and the other is a low level of labor efficiency, which can result in a high probability of decline. Given that the R&D intensity is a mixture of these two features, a high level of this index can have even a negative side (Yasuda, 2005).

From the analysis of these three studies, we can conclude that the effect of innovations on growth goes through the persistency in patenting (especially for small businesses), but a crucial role is also identified in the indirect effects of innovative activity, that changes the internal structure of the firms making it more flexible. The importance of innovating persistently is confirmed by the presence of "*dynamic economies of scale*". A positive effect of innovation is also found on a firm's survivability.

Different results on this relationship are obtained by (Bottazzi et al., 2001). Also in this study, the focusing is on a set of 150 pharmaceutical firms. Skipping on the details of the study, that analyses the different kinds of pharmaceutical firm in the market context, we can point out that there seems to be no relevant influence of innovation on growth. The researchers analyze the relationship with two different indicators: introduction of new chemical entity (NCE) and patent

[35] Less than half of the sample carry out R&D

intensity of each given firm. The results are the same for both, namely that there is not an evident relationship between innovation and growth (Bottazzi et al., 2001).

On the basis of the four equation model by (Crépon et al., 1998), Loof et al. estimate a four equation model with the aim to shed light on the Rosenberg's *"black box"* (1982). As the study previously examined, also here no strong correlation can be established between innovation intensity and growth in profit (for both manufacturing and service sector) (Loof & Heshmati, 2006).

A discussion of evidence on innovating firm is provided by Klette and Kortum. Indeed they provide a list of stylized facts on innovation and discuss them. According to their argument, productivity and R&D across firms are positively related, whereas productivity growth is not strongly related to firm R&D. The authors underline how the first relationship has been verified on a number of studies on cross-sectional differences across firms, while the effect of innovation on productivity growth is still fragile and typically not statistically significant. Furthermore, patents and R&D are positively related across firms. This relationship has been investigated by (Griliches, 1990). He shows the presence of a strong relationship between R&D and number of patents received and that for larger firms the patents R&D relationship is almost proportional, while small firms exhibit high ratios compared to their R&D spending. Moreover, he notes that small firms use to do more informal R&D while reporting less of it and then providing the *appearance* of more patents for R&D dollar (Griliches, 1990, p.1676). R&D is independent of firm size; this relationship is investigated by (Cohen & Klepper, 1996) that state how across sectors has not been possible to reject the null hypothesis that R&D varies proportionately with size. But they also specify that the bigger is firm the more is likely to report positive R&D spending. It is also worth of consideration that the distribution of R&D spending is highly skewed (and a considerable part of these firms report zero R&D investments) (Klette & Kortum, 2004, pp.1010-12).

Furthermore, is interesting to note that in a previously cited article by Hall (1986), the research and development investment (in logs) is identified as a geometric random walk process with an error variance that which is small (about 1.5%) relative to the total variance of R&D expenditure between firms (Hall et al., 1984).

A different conclusion on the relationship between innovation and firm performance is reached by (Brouwer et al., 1993). In this paper, R&D is a proxy for innovation, and a link with the growth of employment at the firm level over a five-year period (1983-1988) is searched. After estimating using a Heckman model (Heckman, 1979) , with the condition that the firm did not close down, they estimate a PROBIT model in order to identify factors influencing the probability that a firm will not close down. The results are significant notably for firm size, sector dummies and sales related variables. Then an OLS model has been estimated; the negative coefficient for firm size (measured in terms of employees) implies that smaller firms have a favorable development of employment than their larger counterpart. The authors point out that the causal chain might run on the contrary, namely from size to employment growth. Although there is no *age* information in this sample, the role of this variable has to be considered along with the size, which is obviously correlated with the age itself. Here, surprisingly, the researchers find out that the R&D intensity of firms has an (insignificantly) negative influence on employment and the growth of the R&D intensity of firms had a significantly negative sign with employment growth. The explanation given by the authors is that this seems to confirm the argument that technical innovation leads to job destruction rather than job creation. It is widely accepted that product and process innovation have a different impact on employment. Then Brouwer included in a new estimation of the model the percentage of R&D dedicated to product R&D. Indeed the share of product related R&D has a significant impact on employment growth; firms that give priority, in early life cycle stage, to product improvement seems having a higher rate of growth compared to the firms which perform more process related R&D (Brouwer et al., 1993).

The correction term in PROBIT regression is negative but insignificant; according to the authors then, the results would have been the same without correcting for firm closures. They consider that the presence of the negative sign may indicate that firms which take a higher risk tend to have higher growth rates of employment, but of course have a higher probability of closing down. Concluding, Brouwer et al. state that the results on the relationship between innovation and employment growth largely depend on the chosen indicator. Indeed using a "raw" indicator as R&D intensity the relationship turns out to be negative, even though insignificant; but, as mentioned before, a refined version of the R&D indicator, that takes in account the differences between product and process innovations, shows that firms that invest in product improvement in the early stage of their life, experience a higher rate of employment growth.

Del Monte and Papagni (2003) examine the empirical literature on the relationship between innovation and performance; they note that, in line with the studies exposed previously, a clear link has not always been found. When research intensity is measured by the R&D/sales ratio, four out of seven works report a positive relationship; when an index based on patents is utilized, only two of eight works find a positive effect of innovation. Even a positive relation between innovation indicators on the survival rate is confirmed by several studies[36]. In the same paper, the authors research for empirical confirmation analyzing a sample of Italian small firms, using a survey by Mediocredito Centrale. They divide the firms in two groups, distinguishing the ones that declared to have employees dedicated to R&D and those who not. The firms that have implemented R&D, from the two samples comparison, exhibit lager size, higher growth rates, higher labor productivity, whereas the profitability (measured through return on sales) does not display significant differences. Furthermore, they estimate a panel data model with random effects and they find that some explanatory variables show little time variation and could approximate for fixed effects. They even test using the Generalized Method of Moments in

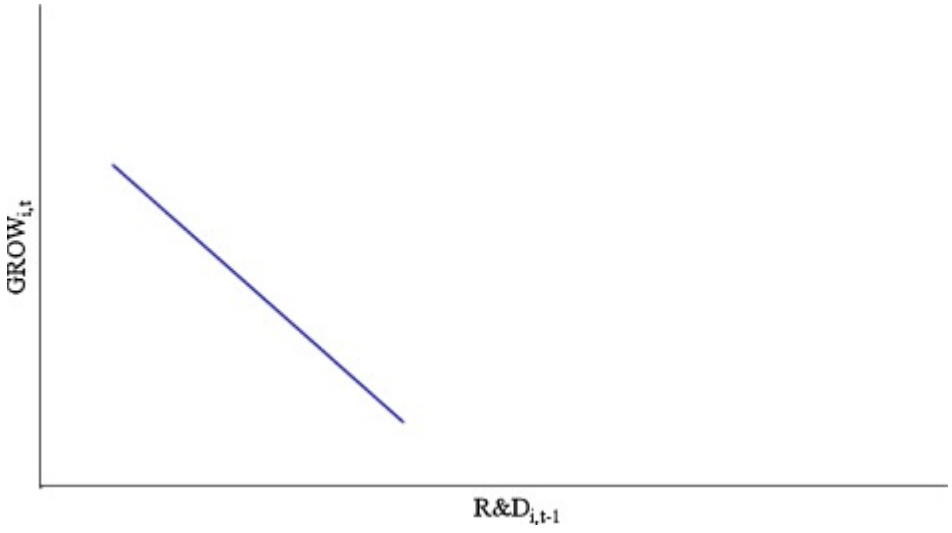
[36] For further details, see Del Monte and Papagni (2003).

order to have results' robustness to variables endogeneity and heteroscedasticity. Indeed, variables proxying for innovative efforts of firms could be endogenous. The contribution of innovation variables to the explanation of firm growth rate is significant. The R&D intensity is significant not only in the high technology sectors, but also in the traditional ones. The dynamic element (lags 1 and 2 of the dependent variable) has a first positive impact and a negative one in the second lag. The authors explain this as a statistical effect due to time aggregation which is probably important in estimates based on firm level data. The result of Del Monte and Papagni research suggest then the existence of a positive relation between variables measuring research intensity and growth rate; in contrast, no relation is found with other performance variables. They suggest that innovation, in their sample of firms, fail to create large barriers to entry; indeed large profits are absent because the innovators is immediately followed by many imitators; than an increase in market share is not translated into higher profitability. A result worth noting is that the effect of research on firm growth is greater in the traditional sectors than in high tech sectors. The authors address this to the peculiarity of Italian firms that in traditional sectors enjoy more competitiveness with respect to foreign firms. Than Italian firms that innovate manage to patents in a way such that they have a comparative advantage on both Italian and foreign non-innovating firms (Del Monte & Papagni, 2003).

Nunes et al. investigate a similar relationship analyzing a sample of Portuguese firms, high-tech vs. non-high-tech. They use two-step estimation method proposed by (Heckman, 1979); indeed this is considered efficient for solving the problem of result bias associated with the matter of survival. They estimate a Probit regression of survival in the first stage, considering both kind of firms. In the second stage, after calculating inverse Mill's ratio and including it in the regression, they estimate the relationship between determinant factors and growth of the whole sample, considering only surviving firms. They estimate the model using dynamic panel estimators (GMM) and given the relevance of second order autocorrelation tests to validate estimate results (Arellano & Bond, 1991), the firms in order to be considered, have to be in the sample for at least four

consecutive years. They decide to use GMM because this estimator allows better control for endogeneity, greater control of possible collinearity of explanatory variables and better control of effects caused by the absence of relevant regressors to explain the dependent variable. Indeed they try to estimate these regressions with classical fixed-effects and random-effects, obtaining biased results because of endogeneity problems. The GMM estimator allows for removal of non-observable individual effects, helping to eliminate the correlation between the error term and the lagged dependent variable. But these results can be considered valid only if the instruments are valid and there is no second order autocorrelation. The appropriate test is the Hansen Test. In this study, the GMM results are not robust, because it is not possible to reject the non-existence of second-order autocorrelation; then the authors decide to rely on Least Square Dummy Variable Corrected (LSDVC) estimator; refer to (Nunes et al., 2012) for further details. The result obtained in this research, shows that the relationship between R&D intensity and growth are of a different nature between high-tech and non-high-tech companies. A negative relationship between R&D intensity and growth in non-high-tech firms is found, as show in Figure VII.

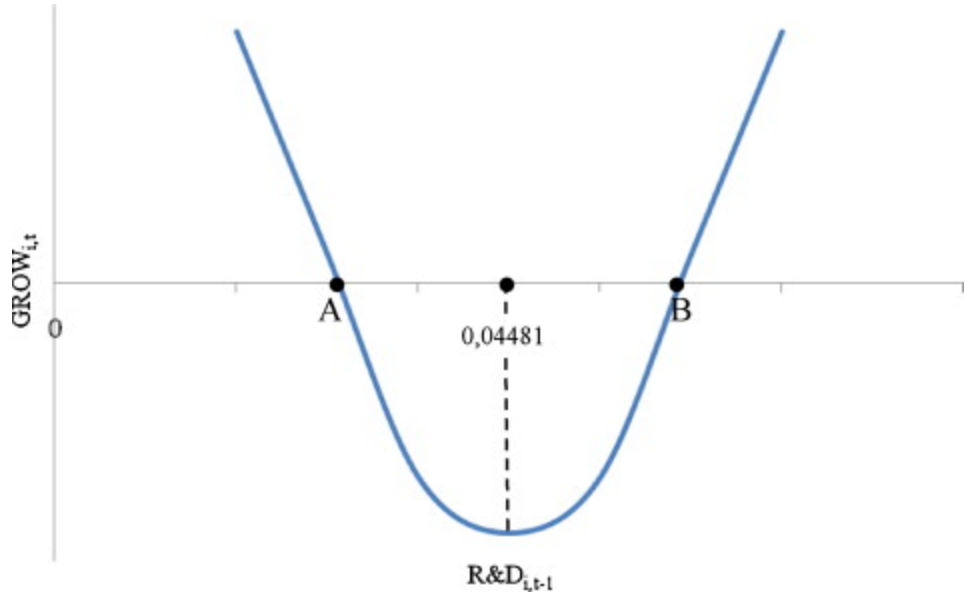
Figure II-VII Linear relationship between $R\&D_{i,t-1}$ and GROWi,t-1, in non-high-tech SMEs.



Nunes (2012)

On the other hand, in high-tech SMEs, they find a U-shaped quadratic relationship between R&D intensity and growth as in Figure VIII.

Figure II-VIII Quadratic relationship between $R\&D_{i,t-1}$ and $GROWTH_{i,t}$ in high-tech SMEs



Nunes (2012)

Then regarding non-high-tech, the authors find that R&D intensity is a factor that contributes to restrict growth; the contrary happens in high-tech firms, where after a certain level of R&D intensity, this factor begins to stimulate growth. Differently from other studies, then, they find that only at certain point R&D intensity plays a fundamental role in SMEs growth while the other studies that we examined did not find (or just did not searched) for this particular feature. Looking at the relationship for non-high-tech companies, we have to consider that the greater possibility to copying innovations in non-high-tech sectors may have a decisive role for R&D intensity not positive effect on non-high-tech SMEs' growth (Nunes et al., 2012).

From this brief review of empirical research, we have seen that the link between innovation and performance is not always so obvious and direct. When studying it, we should take in account several factors that at glance might not be so evident, namely the construction of the indicators that are used in our model, the way of selecting the sample of firms that we are going to analyze, the presence of a survivorship bias on the time horizon observed and of course the external conditions of the market in a given period of time. Furthermore, we have seen that from Nunes' work the presence of a liner relationship between innovation

and growth is not obvious (Nunes et al., 2012), and that innovation might have different effects in high-tech or non-high-tech sectors (Del Monte & Papagni, 2003).In the sequent sub-section, we are going to illustrate some of the empirical researches conducted on the financing ways of innovative enterprises and how they cope with the difficulties in raising external funds, given their specific nature.

II.4 Innovative SMEs financial structure

It is widely held view that R&D activities are difficult to finance in a competitive market (Hall, 2002). This is especially true for small innovative firms that encounter difficulties in raising external finance, mainly due to information problems and to the intangible nature of their assets and activities. The empirical evidence that we are going to see in this sub-section shows that small innovative firms rely heavily on internal finance (Hall, 2002) whereas large firms, even if they innovate, continue to rely on traditional instruments. The problem of researching this topic is a general lack of data. Indeed they are mainly collected for large and publicly traded firms. These data, especially R&D expenses, are available in detail for the Anglo-Saxon economies due to their accounting rules. In this kind of analysis, many factors have to be taken into account; the differences between the markets of each country and between taxes and bankruptcy codes play a fundamental role. Indeed, while the main European Continental economies are recognized as bank-based systems (France, Italy, German and Scandinavian countries), the UK and U.S. market have a so-called market-based system. Of course all these specific features have different effects on the market of capitals, and the financing of innovation is even more sensible to these issues and deserves more attention.

II.4.1 Financing innovation

Continuing to analyze the results obtained by (Hall, 2002) there is evidence that debt not the best choice to finance R&D investments. The analysis is conducted with a supply-demand model for R&D investment funds, in a cross country

analysis. According to the authors the US and UK economies, given their highly developed stock markets, seem to have more sensitivity and responsiveness of R&D to cash flow than Continental economies. The free cash flow plays a fundamental role in the R&D financing. Has we have seen in the first chapter, the agency problem arises when managers are inclined to invest in activities that benefit them instead of riskier R&D projects. A solution might be limiting the amount of free cash flow at their disposal. But this forces them to look for external and higher-cost funds to finance R&D (Jensen & Meckling, 1976). In a research by Cho, the author attempts to examine how management stockholding affects the R&D decision in a firm. He investigates the case where the manager as enough voting power[37] to guarantee his employment in the firm and has a compensation package so that the variation of his earnings would be small. The empirical results of this research show that R&D intensity raises as the importance of management stockholdings increases in the manager personal wealth. Here the agency theory and the role of management stockholdings are confirmed, given that the in a situation where the manager does not own (a certain quantity of) stocks, the agency theory presumes that he is reluctant to undertake the R&D projects in order to reduce the risk of his human capital and in order to avoid new ventures that require additional efforts (Cho, 1992).

Interesting empirical findings are provided by Aghion et al. that investigates on an unbalanced panel of 900 UK manufacturing companies, listed at the London Stock Exchange (Aghion et al., 2004). The regression on the debt/assets ratio[38] includes a dummy that identifies firms that report positive R&D expenditures. A positive and significant coefficient is found on the R&D firm dummy, and a significant negative coefficient on the R&D intensity variable. According to the authors, this suggests a non-linear relationship between the debt/assets ratio and the firm's R&D profile. Then firms with both high R&D intensity and zero R&D tend to use less debt finance than firms with positive but less intensive R&D

[37] The range of needed shares is identified between 25% down to 4% to maintain control.
[38] Book values are used and total debt includes liabilities with a maturity of less than one year, as well as longer term liabilities, but excludes trade credits and debits. Total assets include current assets, as well as tangible and intangible fixed assets.

activity. They even estimate allowing for fixed effects, which allow for unobserved heterogeneity across firms in their choice of capital structure. Also in this case a significant negative effect of R&D on the debt/assets ratio persists. Than for the same firm, an increase in R&D intensity reflects a lower debt/assets ratio; the negative coefficient is not just reflecting cross-sectional differences between the firms with low and high R&D intensities. A Logit regression on the probability of issuing new equity shows that this occurrence is higher for firms that report R&D compared to firms that do not report R&D and tends to increase with the increasing of R&D intensity. Again, reporting conditional or fixed effects Logit specifications, they continue to find a positive significant positive effect of R&D intensity even if the significance of firm size is lost. The paper investigates also the composition of debt[39]; the results indicate that firms that report R&D tend to borrow a smaller proportion of their total debt from banks, and the share of bank debt in total debt tends to decline as R&D intensity increases. On the other side, the proportion of unsecured debt is higher for firms that report R&D and rise further as R&D intensity increases. In this case the result of firms specific fixed effects are not robust, than it cannot be excluded that unobserved characteristic of firms may be driving the effect of R&D intensity. From this study we can see that innovative firms' behavior is different from less innovative. The explanation of the authors, in particular of the changings exhibited with the increasing of R&D intensity, is that more innovative firms may have more attracting investment opportunities and then rely on external sources of finance, but first prefer debt as it involves giving up less control rights than new equity; though, at a certain point a firm will necessarily issue new equity. This approach is valid for large firms, which have access to capital markets (Aghion et al., 2004); in the following subsection, we are going to see what happens when small firms are involved.

[39]The debt is divided as bank and non-bank sources, and secured and unsecured debt.

II.4.2 Innovative small firms financing

The European technology-based small firms, in continental economies, have been studied by several authors. The capital structure theories outlined in the first chapter estimate different effects on the impact of profitability and entrepreneurial talent. If the presence of a hierarchy is due to credit market failures, we should observe a negative correlation between access to credit and measures of entrepreneurial quality; in the pecking order theory, we would expect the best entrepreneur to avoid, how much as possible, bank loans. In the trade off model, in contrast, if there is abundance of human capital we expect larger start-up size and the larger demand for loans; the last, since the market is assumed to be efficient, would be totally available (Revest & Sapio, 2012).

The econometric strategy applied by researches is to regress measure of success in loan applications (collected through surveys), on variables which are in principle observable by lending institutes, including proxies for size, age, asset tangibility, education, R&D and innovativeness. The methodologies used are Logit, Probit and Tobit regressions due to the dichotomous or truncated nature of the dependent variables.

Colombo and Grilli (2007) provide an econometric analysis testing the hypotheses that:

- In a perfect (frictionless) credit market the loans supplied by banks will depend just on industry and firm specific factors (respectively economies of scale and entrepreneurial talent);
- In efficient markets the financial leverage of firms is random.

These hypotheses derive of course from the Modigliani and Miller's theorem, where is stated that there is no relation between a firm's investment decision and its financial structure and from the literature on finance, that in these perfect environment sees internal and external finance as perfect substitutes. Then new firms that operate in industries with greater scale economies and then with a need for greater initial scale of operations, will ask and obtain greater bank loans. A

similar reasoning has been made by the authors concerning the human capital and the founder's initial ability (Colombo & Grilli, 2007).

Furthermore, they test for the presence of imperfections in the credit market that would lead to a financial hierarchy; in this case they hypothesize that

- The amount of bank loan and the financial leverage will be inversely related to the amount of personal capital available to the founders.
- If these imperfections exist, as they will be greater, the loan supply curve will be steeper and the impact on the amount of bank loans of industry specific, firm specific and location specific factors will be smaller.

The dataset is composed of 386 Italian start-ups established after 1980s. The econometric analysis is divided in two levels. First, they consider the level of financial leverage estimating a double-censored Tobit[40] model conditional on the amount of total initial capital. There is (as often in this kind of data) an endogeneity bias[41] due to unobserved heterogeneity across firms, which the authors try to solve using two-step estimation method. The second approach is a bivariate Tobit model where the dependent variable is the amount of bank loans and personal capital used by firms. The explanatory variables are divided in three groups: human capital characteristics (that are expected to shift the demand curve), a second group that does not affect supply curve but shift demand curve and the third group may shift only the supply curve. The results show that the amount of the initial capital is greater in high tech industries and in highly developed countries. On the contrary, firms located in technology incubators start operations with less capital. This amount, along with the propensity to use internal funds opposed to debt also increases with founder's professional experience in the same sector of the new firm (with a particular importance for industry specific technical experience) and for entrepreneurs with education in economic and business. The results of the financial leverage equation support the

[40] The choice of this model is due to the nature of the dependent variable that takes continuous values between (0) and (100) (Colombo & Grilli, 2007).
[41] The amount of start-up capital and the level of financial leverage are simultaneously determined by firms.

view that personal capital and bank loans are no perfect substitutes. The hypothesis that financial leverage is random has been rejected, and then the presence of imperfections in the market can be assumed. Indeed, its level increases along with the predicted values of firm's total start-up capital. Then, *ceteris paribus*, the larger amount of total initial capital, the greater the likelihood that operations cannot be financed by personal capital alone; a greater financial leverage follows. Furthermore, the greater the amount of personal financing used by the firms, the lower the amount of bank loans; this supports the third hypothesis against the first one. To sum up, this paper shows the presence of a financial hierarchy in Italian TBSF, which resort to bank loans only when personal funds are exhausted. Moreover, empirical confirmation is found on the issue that TBSF suffer from credit rationing. The authors conclude criticizing the policies that provide indiscriminate support to the TBSF and they wish for the application of indirect measures of support, leaving the screening function to financial intermediaries (because of the existence of market imperfection, namely asymmetric information, that the government cannot exercise in an efficient way) (Colombo & Grilli, 2007).

Giudici and Paleari (2000) submitted a questionnaire to 249 Italian TBSF (obtaining 49 answers). The aim of the research is to investigate the kind of financial contracts that are likely to be signed by these firms and to understand why the entrepreneur chooses a particular mix of financial sources for the development of innovation. These firms turn out to exhibit a large percentage of graduated employees, to use a large portion of R&D funds for internal technology production and a close relationship with customers and suppliers. Even though they are TBSF, only the 33% of the firms registered a patent in Italy. The source of finance in the first stages is prevalently personal wealth (76%). In the owner-manager's opinion is dangerous to issue debt in the start-up phase because this may interfere with the future growth of the firm. None of the firm in the sample experienced a venture capital relationship.

Figure II-IX Importance of different sources of finance in the eralier development stage by macrosector;

Importance of different sources of finance in the earlier-development stage by macrosector[a]

Macrosector	Mechanics	Electronics	Information technology	Chi test	Total	
	%	%	%	(*p*)	No.	%
Self-generated profits	77%	73%	82%	0.45	33	79%
Entrepreneurs' personal savings	23%	18%	24%	0.98	9	21%
Equity capital from existing shareholders	54%	27%	59%	0.38	20	48%
New individual shareholders	23%	18%	6%	0.05**[b]	6	14%
New corporate shareholders	0%	9%	6%	0.57	2	5%
VCs or merchant banks	0%	9%	0%	0.25	1	2%
Short term credit	77%	45%	53%	0.10*[c]	24	57%
Commercial credit	54%	45%	41%	0.79	19	45%
Long term credit	31%	27%	29%	0.86	12	29%
Long term facilitated credit	38%	45%	6%	0.13	11	26%

[a] The percentages represent the number of firms who attributed the first two ranks in a three point scale, with higher scores indicating a higher perceived importance of the corresponding source.
[b] The difference is significant at the 95% level.
[c] The difference is significant at the 90% level.

Source: Giudici and Paleari (2000)

The importance of different sources by sector is reported in figure VIII. It is evident that the firms rely on internal finance at the most, along with the equity from existing shareholders in order to avoid dilution of capital that would follow if new shares are issued. Indeed, the results of the questionnaire underline that for these entrepreneurs, despite the scarce availability and high costs of bank loans, there is an aversion to resort to equity issues. When they have to choose, they prefer individuals to companies and this might be interpreted in the sense that outside equity finance is considered only in exchange for new competencies; like business angels and corporate investors, which in most of cases bring managing expertise to the young firm (Giudici & Paleari, 2000).

Italian investors then are not inclined to establish long-term venture capital relationship; this can be due to the low level of financial culture of the entrepreneurs given that they are very cautious in selling equity of their company. So not only banks and investors have to be blame for financial difficulties; indeed there is a shortage of demand along with difficulties in the supply functions. A confirm is found in the fact that none of these firm seem to consider listing at the official Italian Stock Exchange; few cases have shown interest towards foreign markets, which are positively considered for image purpose.

Giudici and Paleari estimate a regression, using a Probit model. They investigate how all the factors come to light are combined to generate capital constraints. The dependent variable is the entrepreneurs' judgment about financial constraint of their firms. The results show that age and size of the firms are negatively correlated with the difficulty of financing innovation. The business' lifecycle[42] is significantly positive; this means that firms that are in fast growing sectors are more easily to finance (Giudici & Paleari, 2000).

The analysis of this literature confirms the presence of a financial hierarchy, more specifically that the innovation in TBSF is financed primarily using internal finance, according to the theoretical argument presented in the first chapter. This is mainly due to the credit rationing that affects small firms; these results are in line with the research obtained on the US firms (Hall, 2002).

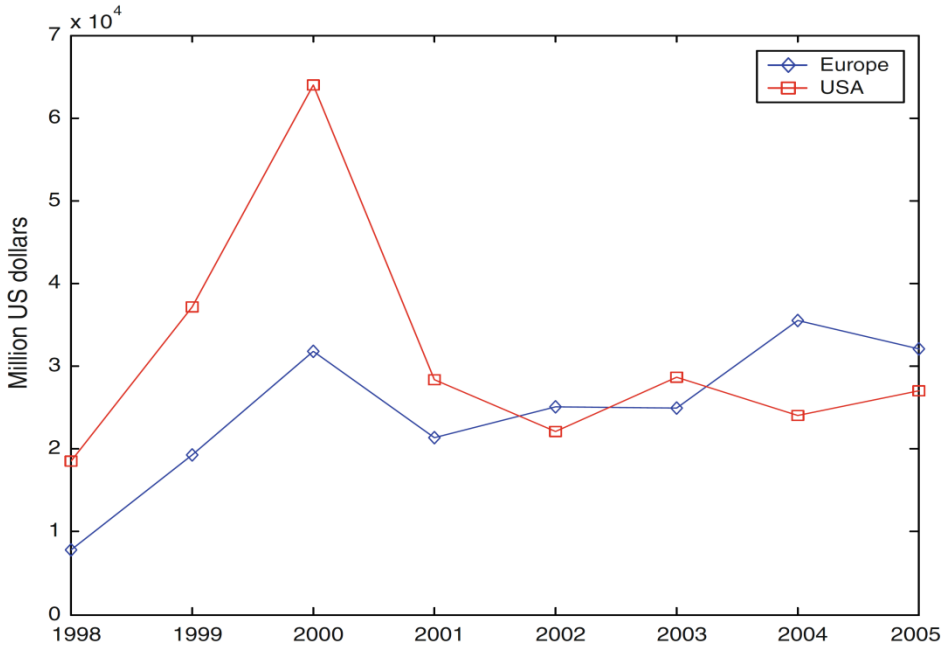
II.4.3 Venture capital as good substitute of "classic" equity

As aforementioned, the presence of credit rationing is not resolved optimally by intermediaries in bank-based and market-based systems. The Venture Capital, in recent years, is emerged as a possible substitute for improving financing conditions and reducing informational asymmetries. From the theoretical point of view exposed in the first chapter of this work, Venture Capital could be seen as a debt equity hybrid, since it gives greater control to the investor or the entrepreneur depending on the performance of the funded company. The empirical evidence that we are going to examine tries to shed light and give experimental support to the effects of VC's presence within the firms, with a focus on the European market. Indeed, being US and EU market so different, it has been investigated that there might be a gap, which in Europe could even exist between the national borders. Furthermore, we will mention empirical evidence of the effects of Venture Capital on the growth and visibility of the firms.

[42] This is a dummy variable that says if, in the entrepreneur's opinion, the firm is close to maturity or will grow further.

The Venture Capital (VC) industry fully emersion is dated back to 1990. The Figure VIII shows the comparison between USA and Europe Venture Capital investments.

Figure II-X Venture Capital funds disbursed in the USA and in European Countries: 1998-2005

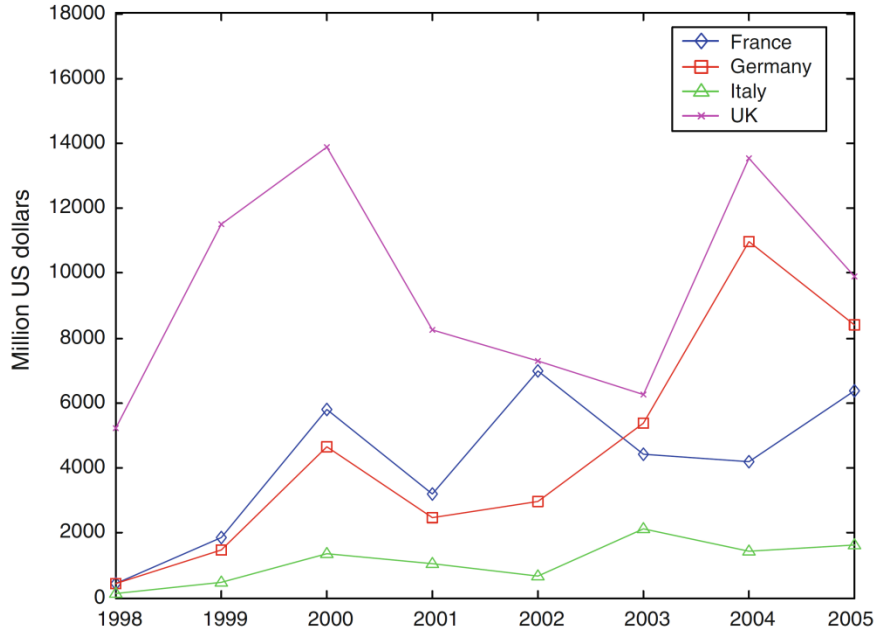


Source: Revest (2012)

From the data it is evident that there has been a catch-up by Europe at the end of 2002 and a similar pattern can be detected using data provided by EVCA (European Venture Capital Association) (Revest & Sapio, 2012).

An interesting question might be if the growth of European VC investments was balanced across countries.

Figure II-XI Venture Capital funds disbursed in France, Germany, Italy and the UK: 1998-2005.



Source: Revest (2012)

Figure IX shows the evolution of venture capital funds disbursed in France, Germany, Italy and the UK. From the chart is clear that, between 1998 and 2000, the UK has been able to attract venture capital at a faster rate than other major EU countries. Even after 2000, the UK remains the largest receiver of venture capital funds in the group. Subsequently during the Internet bubble in 2000, along with the UK, Germany has been the only country able to attract an increasing amount of VC's funds. According to Revest, this has to be attributed to the creation of Neuer Markt, of public venture capital funds, and to the fundamental role of German commercial banks. The gap between both US and Europe and UK and the rest of European countries has several explanations; indeed, an important role in venture capital market is played by pension funds that are not so much developed in continental Europe in comparison with Anglo-Saxons systems. Furthermore, there is a lack of exit opportunities. We know, from the first chapter, that the optimal exit choice for a Venture Capitalist is the IPO. Since the Continental stock markets are missing an active high-tech index like NASDAQ, the exit process might be difficult and discourage VC investments (Revest & Sapio, 2012).

Theoretical literature presumes that the presence of a Venture Capitalist in a company automatically imply better support for high tech firms. Indeed, a venture-backed TBSF may grow and innovate faster than non-venture-backed competitors because of the advices and competencies generated by the VC himself. Another effects attributed to VC is an improving of the firm's image against investors (the so-called *certification function*); the VC is seen as a guarantee of a good quality investment and might reduce the informational asymmetries. The financial literature relies on first-day IPO underpricing as an indicator of pre-listing information asymmetries; the *certification hypothesis* states that, because venture capitalists certify the company, venture-backed IPO should be characterized by less sever underpricing. According to the *conflict of interest hypothesis* the presence of the venture capital funds affiliated with major financial institutions can cause a conflict of interest, as the underwriting banks would be interested in setting a higher offer price; then the IPO's investors anticipate this conflict of interest and in order to compensate, seek more under-pricing (Revest & Sapio, 2012).

Chahine et al. perform an analysis on a sample of 444 entrepreneurial IPOs in the UK and in France. They define as entrepreneurial IPOs as those in which the original founders retain equity stakes and board positions. This paper tries to investigate the links between risk capital provider's investment patterns and the risk factors associated with the venture and its founders, focusing on the effect of VC's involvement on initial underpricing and on country-specific differences.
The 2SLS model results show that underpricing decreases in UK VC-backed IPOs whereas it increases in French VC-backed IPOs. The authors' explanation is that the UK more mature VCs provide firms with monitoring and certification functions; instead French VCs tend to collaborate with underwriters and cause higher underpricing (Chahine et al., 2007).

Coakley, in a two sample comparison between venture and non-venture-backed IPOs on London Stock Exchange, investigate underpricing focusing on the role of venture capitalists and underwriters. Furthermore, he highlights what happens

in the bubble years 1998-2000. His results show that the certification hypothesis can be accepted on the whole time horizon, but the bubble years. Indeed venture capitalists and underwriters play a certification role over the sample. The authors try to explain the different behavior during the two-year period 1998-2000. In that period the size of underpricing displayed an increasing trend especially in high tech sectors; this is consistent with speculative behavior by venture capitalists (Coakley et al., 2009)

Colombo and Grilli (2010) examined the joint effects of the founding team's human capital and VC investments on firm growth in a sample of 439 Italian start-ups. Leaving aside the empirical evidence of founders' education and previous technical experience as a cause of faster growth, their results show that VC investors are more attracted by TBSF where they can perform their *coach* role; but these firms are not always those that would benefit more from the presence of the VC. The VC may also perform a *scout* function, with high human capital entrepreneurs, whose companies have better growth prospects; but empirical research exhibits that they are usually more attracted by a *coaching* role. Then, the synergistic gains that can come out in the case of joint work of quality human capital of the founders and the competencies of the venture capitalist will remain unexploited because of (socially ineffective) sorting (Colombo & Grilli, 2010) (Revest & Sapio, 2012).

From these empirical works it seems that the VC role in Europe is still unclear. On one side the presence of conflict of interest and grandstanding suggest that the growth of funded companies is not in the European venture capitalists' objective function. On the other side we know that the VC can perform a *coach* function for the funded companies. In particular corporate venture capital usually offer strategic resources, such as technological synergies and brand image, whereas independent venture capital adds value by helping raise additional finance and professionalizing the company (Revest & Sapio, 2012). There are strong differences between EU countries and they are likely related to the different stage of development of stock markets.

II.4.4 Alternative pecking order theory: empirical findings

In the first chapter we have depicted the theoretical basis on which the alternative pecking order theory for innovative firms stands; to sum up we recall that when an innovative firm is at its embryonic stage (*seed)* the venture capital participation is not suitable. Since VC needs a thick market of small firms stocks and prefers to exit through an IPO, the seed stage is not likely to find financing with venture capital; furthermore, the *due diligence* that has to be run before entering in the shareholders has high cost, that put a downward threshold to venture capitalist participation. Usually the first forms of financing are *insider financing* and *business angel financing*. Then the theory states that after inside financing, innovative firms prefer the entry of business angel (informal investors) and when the firm's size is increased, the venture capital financing; then, after these, relying on bank debt and at last on issue of shares and bonds. From the point of view of *financing growth cycle*, the VC capital proves to be the most appropriate during the start-up stage.

Hogan and Hutson (2004) investigate the financial features of 117 Irish software producers. Ireland is the second software producer in the world and the response rate to the survey (about 46%) is impressive[43]; then it could be a trustworthy representation of the software industry in Ireland. From the questionnaire's results turns out that the TBSF are primarily self-financing at start-up (73% of firms less than three years old are financed internally). Most of these funding are provided by personal savings of the founders or by consulting services' cash flows. The outside equity for the start-ups is 23%; the majority of the entrepreneurs do not believe that banks are willing to finance their companies, confirming the hypothesis that firms whose assets are dominated by intangibles would find it difficult to get bank finance. 41% of interviewed entrepreneurs believe that venture capitalists would understand their businesses; while they consider that bank are inclined to finance only firms with fixed assets, this does

[43] According to the authors, response rates of 10 percent or less are commonly reported in mail surveys; they explain the strong response rate with the high educational attainment in the sample population.

not stand for venture capitalists, for whom the presence of this kind of assets it is not a prerequisite. The finding of this research show also that outside equity finance is used by Irish software firms in preference to bank loans, and debt is largely absent from their capital structure. For our purposes, it might be interesting that the respondents, to the question: "prefer to use retained profits and equity as much as possible" , forty-seven percent agreed, whereas more than half of the sample disagreed when it has been asked if they would use equity as last resort. These findings violate the assumptions of the *pecking order theory*, since only the internal finance find its collocation unchanged in respect with the original theory. The findings also confirm the perception of founders that there are severe informational asymmetries between themselves and banks. Then the entrepreneurs are willing to trade off ownership and control in exchange for the longer term goals of growth and value. The authors concluding pointing out that the *missing market for the financing of innovation* is real and that the lack of a well-developed risk capital market is a key obstacle to the development of innovative firms in Europe (Hogan & Hutson, 2004).

Coleman and Robb (2011) used the Kauffman Firm Survey data to examine a large sample (over 2004-2008 time period) of new firms in the USA[44], comparing the financing strategies of technology firms with those that are not technology based. Also here the finding confirms the importance of founders' previous experience in the industry and college or advanced degree education. In terms of performance, the tech firms in the sample were larger than all firms as measured by revenues and assets. Regarding financial structure, the results shows that whereas the dominant source of capital at startup for all firms in the Kauffman Survey is owner financing and outsider (or formal) debt, and only 16% of total financing come in the form of external equity, technology based small firms have dramatically higher percentage of external equity (44.4 percent) combined with lower percentages of owner financing (21 percent) and external debt (25 percent). Along with the increasing of external equity, it has been

[44] These firms started their activity in 2004.

observed that technology based small firms raised larger amounts of capital in their first year of operation than firms that were not technology based. The authors even create a subsample of high-revenues firms (more than $ 100,000) and find out that they attract a higher percentage of external equity compared to the rest of tech firms. Furthermore, high revenues tech firms used a lower percentage of external debt and raised substantially larger amounts of capital than high-revenues firms in general. The regression of financing ratios on firms' characteristics confirms that tech firms used a significantly higher ratio of owner financing during their start-up years, and subsequently a lower ratio of external debt. The results indicate that the TBSF exhibit a different pattern of financing than firms overall. These clearly rely less on external debt and more on external equity financing (even tough in this study the coefficient of external equity is positive but not statistically significant). Moreover, according to the authors, the owners with industry experience are more incline to use a higher ratio of owner's financing and a lower ratio of financing from other insiders. Owner with graduate degrees were significantly more likely to rely more heavily on external equity financing. Then even here the results are contrary to the *pecking order theory* and *lifecycle theory*[45] (Coleman & Robb, 2011). Let us examine another research and then draw concluding remarks on this topic.

Also Cassia and Minola (2011) investigated on the Kauffman Survey data, looking for the differences in funding sources of young novice TBSF[46] and more mature experienced TBSF. Indeed this paper attempts to associate human capital determinants with recourse to external sources of capital. The sample analyzed is based on a subset of the whole dataset, with one third made up of sole proprietorship and half of all firms home-based; the authors compare the 2004's data with 2007's data. Even if there is a high mortality rate (14%) on average firms have grown. It is worth noting that subsets with experienced owners show revenues ten time higher than for firms with young and novice owners.

[45] We recall that *lifecycle theory* states that due to informational opacity, new firms rely on internal rather than external sources of financing.
[46] These are defined as new technology based small firms run by owners under the age of forty with no previous entrepreneurial experience.

Furthermore, the experienced owners seem to be more ambitious in both high-tech and non-high-tech firms, suggesting that young owners adopt a *"soft start"* approach. From the analysis of the sources of finance, in 2004 the subsets exhibit an identical pattern regardless of entrepreneurs and technological background. Indeed the first source of finance is the owner capital and next comes external debt; the least popular choices are external equity sources. Turning to 2007, a completely reversed hierarchy emerges: of the fewer capital injections, the largest amount is still internal capital, but a large number of capital injections is made through equity than debt. The authors explain that, while the pattern is consistent with the revised pecking order theory, the evidence suggests that the stage of business maturity along its development cycle may determine whether a firm follows revised or traditional pecking order theory. From the results of the Probit regression run on the data, we it is suggested that the maturity of a firm is not particularly significant and that young firms are not biased towards a particular source of financing. Not surprisingly, the firms that are home-based are extremely unlikely to be access any form of outside financing and are very likely to be financed by internal capital. To sum up, this study finds the presence of a pecking order in the first year of life (2004), but this turns out to be reversed in 2007. No particular constraints were discovered regarding young firms (Cassia & Minola, 2011).

From the analysis of these empirical researches, we have seen that Venture capitalists (and business angels) are able to provide not only capital but also added value, and expertise. Furthermore, banks are not the most ideal sources of capital for technology based small firms because they require high collateral and are not able to entirely value the intangible assets and the potential of these firms. Then we have found empirical confirmations of the presence of a reverse pecking order of financial sources, where the venture capitalists and business angels come first than the external debt. The financing patterns of technology-based small firms are different from non-technology based firms. The latter follow similar patterns to those outlined by both the pecking order theory and the lifecycle theory. The results of Coleman indicate that the high-tech firms are able to attract

larger amounts of both external debt and external equity. Moreover the research by Cassia suggests that a different financial hierarchy may depend by the stage of development of the firm, and no further research has been done on this issue.

II.4.4.1 Econometric issues with panel data analysis

According to Revest, the robustness of the results in these empirical researches is under question due to methodological limitations (Revest & Sapio, 2012). Indeed the presence of sample selection biases, unobserved heterogeneity, endogeneity and dynamic adjustment of capital structures undermine the reliability of the researches. Most of them regard the general nature of the *panel data*, thus can be related not only on capital structure research, but also on the study cited previously and that need panel data analysis. Precisely, according to Elsas and Florysiak (2008) the difficulties on investigating capital structure are mainly due to three main issues:

- The panel nature of the data
- Endogeneity between the capital structure and potential determinants (namely explanatory variable in a regression context)
- Dynamic adjustment of leverage (Elsas & Florysiak, 2008)

Panel Data

Often the firms-specific variables are observed as panel data, with a large number of cross-section observations over a short period of time. Many studies do not adapt their econometric specification to the panel nature of the data, and then the information within the data is not fully exploited; moreover, the results can be biased. The study criticizes the application of OLS and Fama/MacBeth[47] procedures to this kind of data, because of a possible correlation of error term in financial data. Indeed, the error term of a time period may be correlated over the cross-section (the authors define it as cross-sectional correlation and state that it results, for instance, when the same macroeconomic factors are relevant for all firms in the sample). Furthermore, the error term for a given cross-sectional unit

[47] According to the authors, the Fama/MacBeth estimator is *"then again just the time-series average of cross sectional OLS estimates over the time periods"* (Elsas & Florysiak, 2008).

is likely to be correlated over time (observations of the same company over time tend to be similar to each other than observation across companies); this is called serial correlation; there is also the presence of some relevant variable that cannot be observed and this result in an endogeneity problem due to omitted variables. As a result, the authors believe that the Fama/MacBeth procedure should not be used with regression specification in a capital structure context, because the standard errors might be systematically biased and will produce too large test statistics , rejecting test hypotheses too often. The authors suggest then to use panel estimators. Indeed the standard fixed effect estimator controls for firm heterogeneity by allowing for firm specific intercept term in the regression, which corresponds to the inclusion of dummy variables for each individual in the sample. This estimator is consistent in a panel data context (Elsas & Florysiak, 2008).

Endogeneity

In econometrics, *"a regressor is said to be endogenous if it is correlated with the error term of the data generating process in the population"* (Elsas & Florysiak, 2008, p.17) This problem is usually related to omitted variables, measurement error of explanatory variables or is due to a causality between the dependent variable and the explanatory variables (namely the dependent variable causes some explanatory variables too). As a consequence of endogeneity, OLS estimators will be biased and inconsistent and this means that coefficient and inference will be invalid. Omitted variables are the common causes of endogeneity problems: it could happen that, if an important (in theoretical reasoning) is ignored or is not considered because of missing data, the variation of this variable is captured by the error term. Then if the omitted variable is correlated with regressor, the error term itself will be correlated with the regressor and will be endogenous. If the omitted variable is time-invariant, this issue can be solved with fixed effects estimation where the results will be robust. Indeed, the dummy variable included to control for individual effects will automatically control for any time-invariant variable. This is also a good reason

to use fixed (or estimators based on first differencing, as GMM) instead of random effect estimation, because the latter requires the regression's explanatory variables to be uncorrelated with the individual effects (Elsas & Florysiak, 2008) (Greene, 2012).

Errors in variables measurement are another source of endogeneity. This issue might come about using proxy variables that naturally measure the real variable with some error. This error can be captured by the error term and result in a correlation between it and the regressors. A solution to this is using instrumental variables estimation. A good instrument has to be correlated with one of the endogenous variables, but not with the others. But, since it is often difficult to find good instruments, a solution widely applied is relying on lagged value variables (Elsas & Florysiak, 2008).

Dynamic Adjustment

The presence of a dynamic element in the capital structure has to be taken into account when researching on capital structure; indeed adjustment costs can keep the firm away from their desired debt ratio, at least in short run. Leary and Roberts (2005) investigate the presence of these costs and criticize the persistence that (Baker & Wurgler, 2002) find in their empirical research and that is used to support the "market timing" theory mentioned in the first chapter of this work. Indeed they show that the presence of adjustment costs results in shocks having a persistent effects on leverage, despite active rebalancing by firms. They find out that "*the effect of Baker and Wurgler's key market timing variable on leverage attenuates significantly as adjustment cost decline, illustrating that adjustment costs appear to dictate the speed at which firms respond to leverage shocks*" (Leary & Roberts, 2005) and not then by the indifference toward capital structure (Leary & Roberts, 2005).[48]

[48]We recall that in "*market timing*" theory a specific capital structure is caused just by the market conditions in that specific moment of the history.

Then, in order to implement dynamic adjustment, the model needs to include a lagged dependent variable. While dynamic effects cannot be econometrically captured in cross-section data, panel data allows incorporating these partial adjustment issues; but traditional fixed effects estimation are biased when a lagged dependent variable is included in the data generating process (Arellano & Bond, 1991). In this case, the lagged dependent variable is correlated with the error term and then endogenous. This issue is not resolved taking first differences, as the fixed effects model does (Elsas & Florysiak, 2008). An econometric solution directly proposed by Arellano and Bond is using the so-called dynamic panel estimators, which rely on instrumental variables estimation in the Generalize Method of Moments framework (GMM). The authors take first differences of the panel data (and then wipe out individual effects), solving the endogeneity issue by using lagged levels and differences of the dependent variable as instruments in the GMM framework. This estimator is confirmed to be asymptotically unbiased for a large number of individual with a few time observations (i.e. panel data); even Elsas and Florysiak in their comparison of the different estimators that capture dynamic effects, confirm that the best results are given by Arellano and Bond estimator (Elsas & Florysiak, 2008).

III. A RESEARCH ON ITALIAN INNOVATIVE SMEs

III.1 Data and Methodology

In this section we are going to analyze a data set of Italian small and medium enterprises, composed of 249 innovating firms and 714 non-innovating firms on the time horizon 2002-2011. After descriptive statistics, we will test for mean differences and estimate a mixed model in order to test if innovation is a statistical determinant of firm growth, profitability and debt.

III.1.1 Sample selection

The selection procedure has been developed as following. In order to identify the innovative companies, all the patents application filed at European patent office in 2005 by corporation have been retrieved. These patents have been joined with balance sheet data and then they have been related to firm's size (2005's sales).

The results are summarized in Table I; as exhibited, the very small firms and large firms have been dropped from the sample, along with the missing values where sales data were not available. Then we have a total of 1549 SMEs from which we will extract our final sample.

Table III-I Classification of EPO's patenting firms.

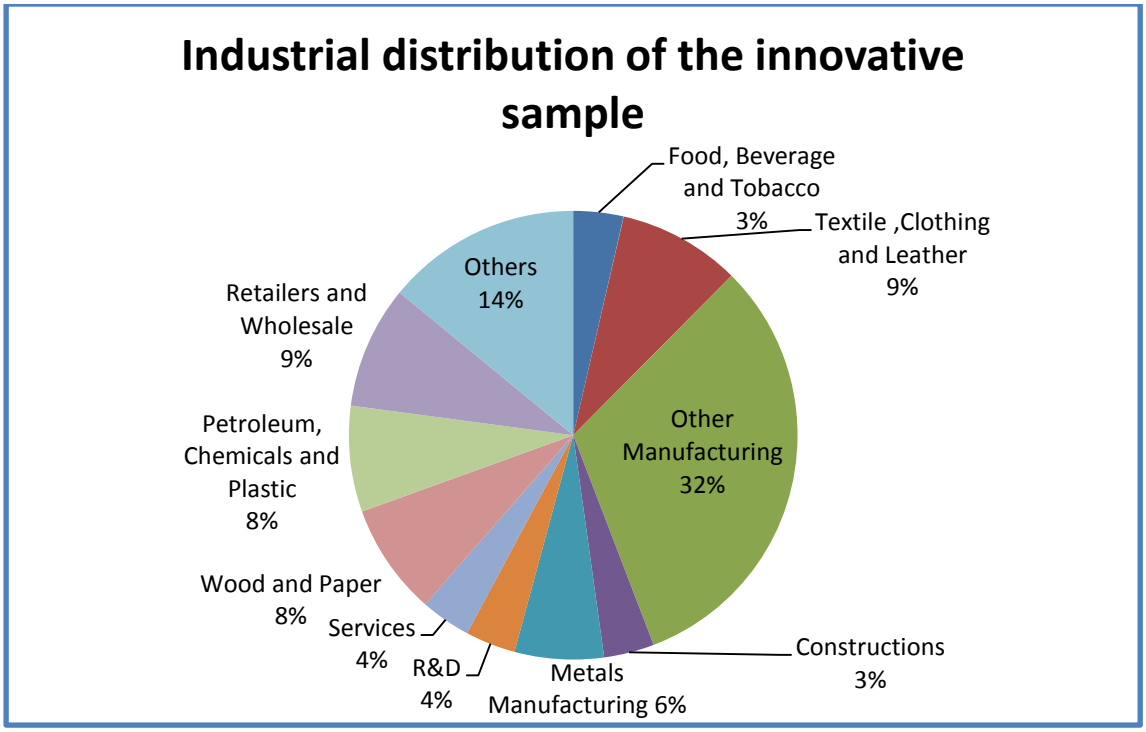
	Minimum	Maximum				
Sales (2005)	€ 0	€ 1.000	10,4%	227	Very Small	227
	€ 500.000	-	3,1%	67	Large	67
	Missing	-	15,4%	336	Missing	336
	1.000	**500.000**	**71,1%**	**1549**		**1549**

These 1549 enterprises have been divided in three subsets based on their size class.

- Class one: sales less than € 10.000.000;
- Class two: sales between € 10.000.000 and € 50.000.000;
- Class three: sales 50.000.000.

These firms have been sorted by the 2-digit ATECO code (with at least thirty firms included), in order to find an appropriate comparable in the successive step; then from these cluster, the best 3 firms have been selected, according to the ranking on the index "number of patents application on sales": it follows a sample composed of 249 innovative SMEs. In Figure I the industrial distribution of the total innovative sample is exhibited.

Figure III-I Industrial distribution of the innovative sample



In order to find a set of comparable firms, we applied a selection process that searches across a database[49] of Italian enterprises, according to the following criteria:

1. 4-digits ATECO code at first attempt, 3-digits ATECO code at the second attempt.
2. Age (years from the foundation)[50];
3. Legal head office: same province or same region or through the whole Italy database.

[49] The data have been retrieved from *Amadeus*, provided by Bureau Van Dijk®.
[50] The algorithm specified that firm born after 1990 could have a margin of plus/minus three years from the date of foundation; no constraints were provided for firms born before 1990.

Through this process 714 firms have been selected in order to have a set of comparable firms on which run statistical analysis[51]. With these premises we have a theoretical base to test for differences between the two samples.

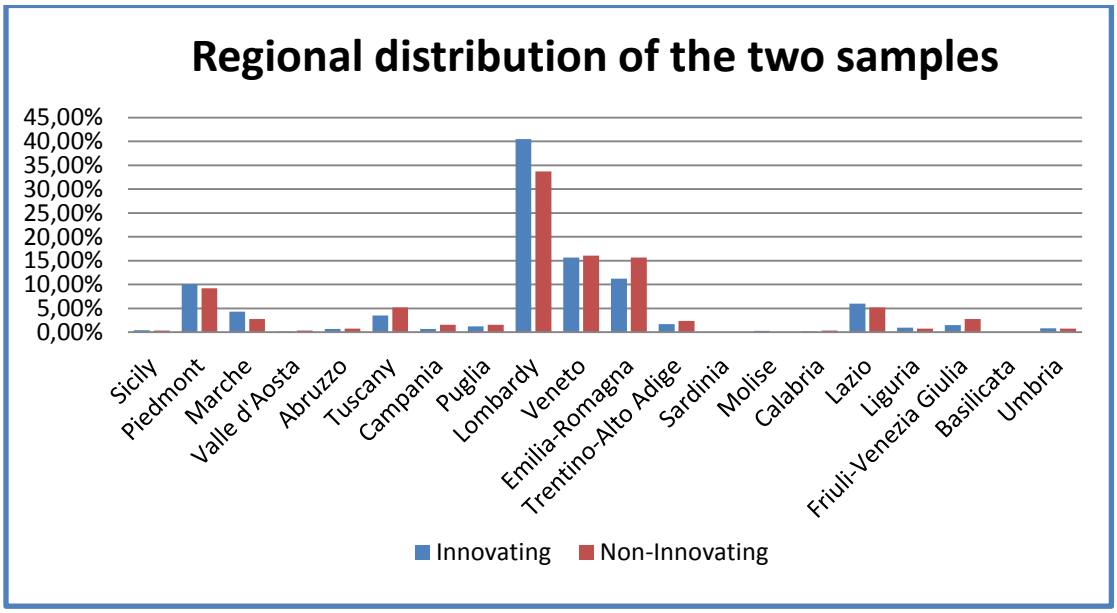
The independent variables used are, as in many researches:

i. A dummy variable with value 1 if the firm is innovative, proxied by detected patent applications;
ii. Age given by the logarithm of age in each year of the panel;
iii. Size given by the logarithm of total asset;
iv. Debt given by the ratio of total debt to total assets;
v. Operational cash flow, as a measure of internal finance given by the ratio of operational results before tax plus amortization to total assets, namely EBITDA (Nunes et al., 2012)
vi. A year dummy variable.
vii. Geographical distribution all over Italian peninsula (North, Center, South)
viii. Clustered Ateco classification
ix. ROI given by EBIT/Total Assets
x. ROE as net income on equity
xi. ROS as EBIT minus tax on sales
xii. Risk as absolute value of the first difference of percentage change of EBITDA over each year (Nunes et al., 2012); this variable will be used as a control variable in the Heckman selection model in order to avoid bias into the selection equation.

It might be worth providing graphs along with descriptive statistics of the sample. In Figure II the regional distribution of the two samples is exhibited; we can see how it is really skewed towards Lombardy, Emilia-Romagna and Veneto.

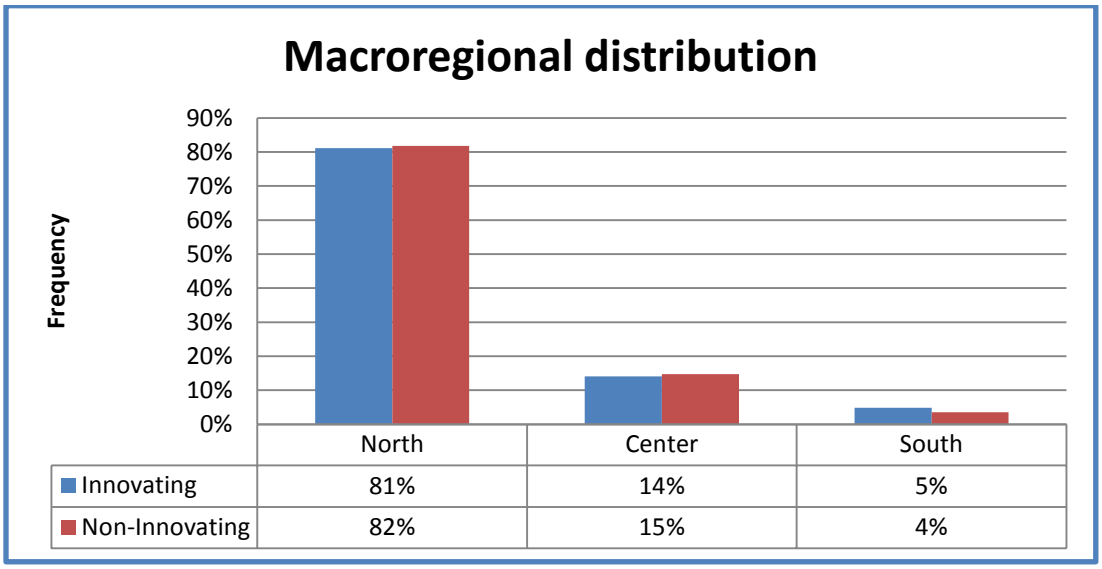
[51] The rules for selection follow this logical scheme: after an innovating firm is selected, non-innovating firms are identified with the same sector and similar age; then, between them, the firms with sales (in 2005) in a plus/minus 30% margin are extracted; from these last sample, a geographical proximity is searched, in the same province, then in the same region, and at last in the whole country.

Figure III-II Regional distribution of the two samples



This is as well reflected in the macro regional distribution, exhibited in Figure III with more than eighty percent of the firms with legal head office in the Northern Italy.

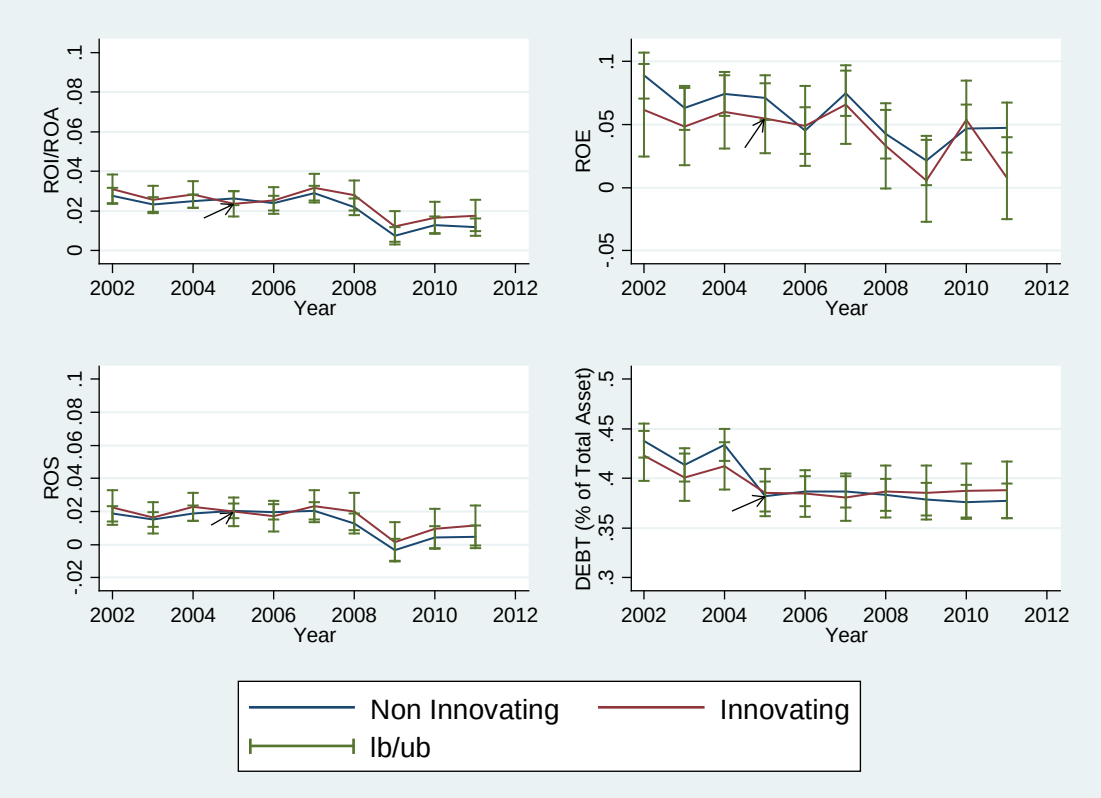
Figure III-III Macro regional distribution of the two samples



From the graphical perspective in figure IV we could see how the profitability indexes of the two samples move together; since the years of 2008's financial crisis are present in our time span, we should take into account that the decrease of the performance has to be seen in a context of global recession. ROI and ROS of innovating firms are over performing non-innovating even after 2008, and the

level of debt to total asset shows little differences. The base year (2005) for the sample selection is highlighted with an arrow.

Figure III-IV Profitability indexes and Leverage patterns, 2002-2011



More information is provided by the Figure V that shows in a single graph the difference between averages ROI of the two groups (Bars) and the mean ROI of non-innovating firms (Line). Here is clearer that after 2005 the difference between innovating and non-innovating firms increases; from this we could deduce that innovating firms are being more competitive on the market; this could be seen as the effect of the innovations introduced in 2005. This is consistent with the findings of Geroski and Manchin (1992); in that paper, recalled in the second chapter, the innovators are over-performing non innovators in the whole time horizon, after the introduction of new products and processes. This is highlighted also in Figure VI, which displays average ROS patterns and where mean increasing is more evident, even more when the average ROS becomes negative. This could mean also that innovating firms are exhibiting a

stronger resistance to the global economic recession, due to better production methods and technologically advanced products.

Figure III-V Average ROI patterns, 2002-2011

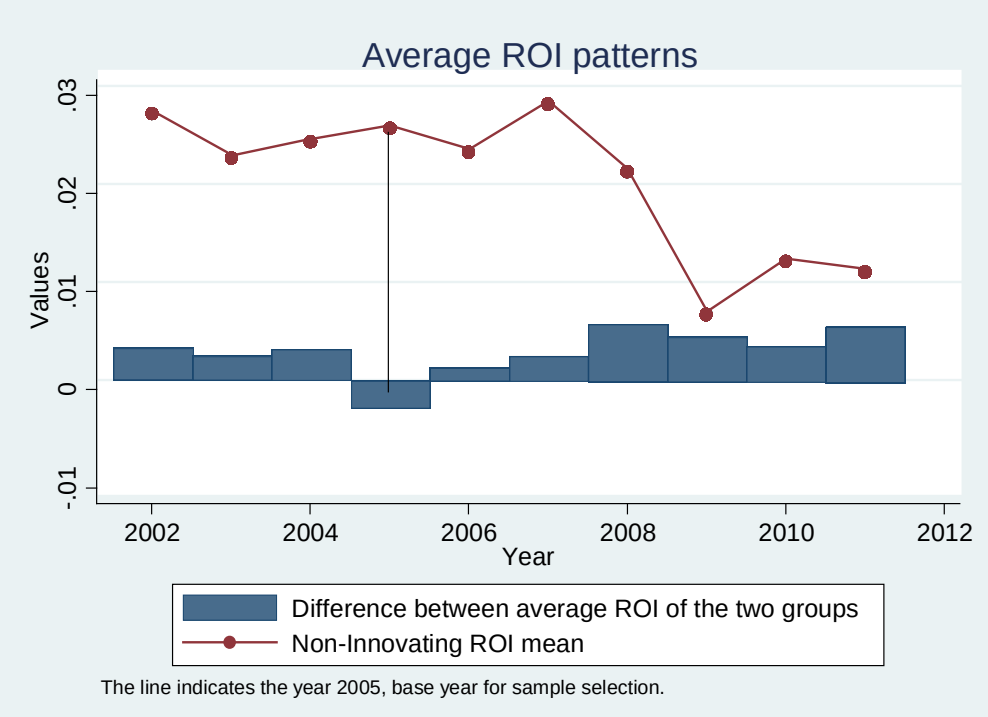


Figure III-VI Average ROS patterns, 2002-2011

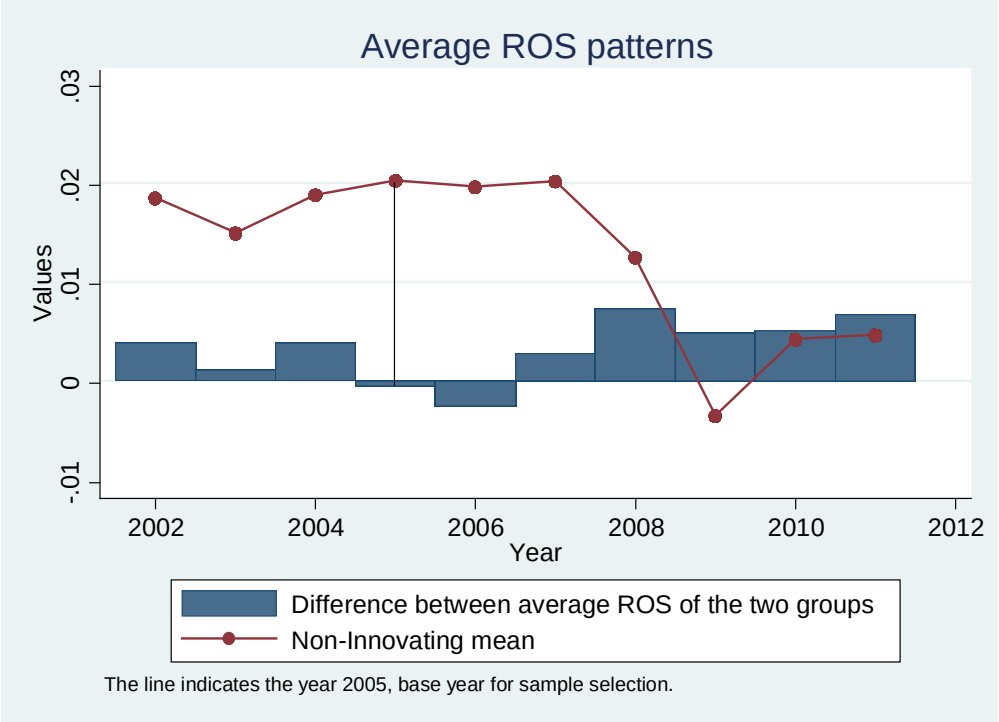


Figure III-VII Average Debt Pattern, 2002-2011

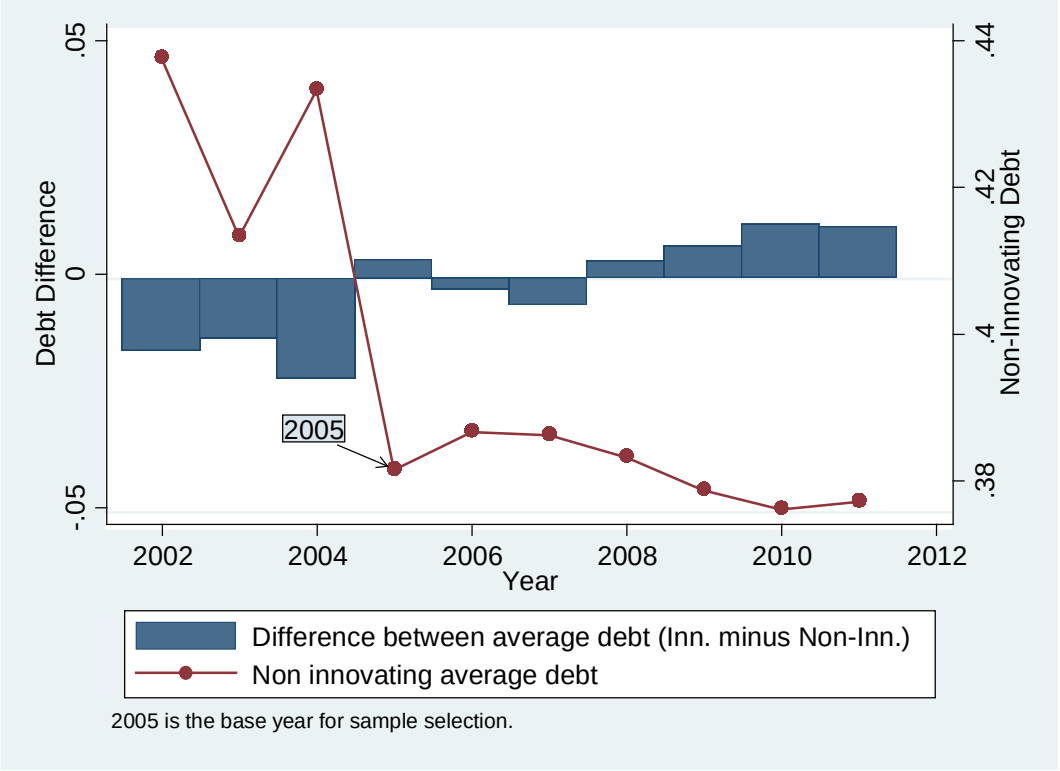


Figure VII exhibits the patterns of average debt levels of non-innovating firms (Line), along with difference between innovating and non-innovating average debt. The difference is not strong except for the period before 2005; then with the decrease of debt levels toward 2012 we can see that innovating firms are more indebted than their comparables.

Table II-III display the descriptive statistics for the variables that we have considered as likely determinants of firms' growth. We can observe that the innovating firms display greater mean growth's rate compared to non-innovating. Table IV exhibits the correlation between the variables.

Table III-II Descriptive Statistics of Non-Innovating Firms

Descriptive Statistics of Non-Innovating Firms

	Mean	***SD***	***Min***	***Max***	***Median***
Growth	.0100384	.2279112	-.5270138	.4436951	.0266819
Logarithm of Age	2.968268	.7268435	0	4.820282	3.091043
Size	9.39087	1.671848	1.39327	15.84449	9.458011
Debt	.3957223	.2120304	.0908709	.795776	.3922854
Cash Flow	.135315	.1499438	-.0853261	.4180851	.1154043
Interest on Debt	.1180296	.1344858	.0265602	.4678492	.0619827
ROS	.0135702	.0699125	-.1995962	.1432901	.0190714
ROI/ROA	.0212791	.051086	-.103062	.1295189	.0213219
ROE	.0576723	.2410203	-.5953741	.5408034	.0500448

Table III-III Descriptive Statistics of Innovating Firms

Descriptive Statistics of Innovating Firms

	Mean	***SD***	***Min***	***Max***	***Median***
Growth	.0166104	.2219001	-.5270138	.4436951	.0355768
Logarithm of Age	2.917385	.7331951	0	4.465908	3.044523
Size	9.850787	1.652725	1.764731	14.42035	9.778848
Debt	.393333	.1948196	.0908709	.795776	.3989714
Cash Flow	.136705	.1549923	-.0853261	.4180851	.1178336
Interest on Debt	.1141601	.1317443	.0265602	.4678492	.0619548
ROS	.0166091	.0792345	-.1995962	.1432901	.0267661
ROI/ROA	.024109	.0559863	-.103062	.1295189	.0247861
ROE	.0443565	.2439921	-.5953741	.5408034	.0404692

Table III-IV Variable correlation Matrix

	Ros	Roe	ROI	Inter. Debt	Cash Flow	Debt	Size	Age	Grow
Grow	**0.3099**	**0.1815**	**0.2934**	0.0034	**0.2791**	-0.0643	0.0623	-0.0506	1.0000
Age	-0.0324	-0.0469	-0.0344	-0.0401	-0.0410	0.0233	**0.2006**	1.0000	
Size	-0.0291	-0.0451	0.0267	0.0189	**-0.1642**	-0.0343	1.0000		
Debt	**-0.1351**	**-0.1261**	-0.0864	**-0.5493**	**-0.1766**	1.0000			
Cash Flow	**0.8947**	**0.5429**	**0.6899**	**0.1048**	1.0000				
Interest	0.0748	0.0549	0.0407	1.0000					
ROI	**0.8328**	**0.3808**	1.0000						
Roe	**0.5338**	1.0000							
Ros	1.0000								

These differences are explained better by the tests on means and medians. The Median Test performs a nonparametric K-sample test on the equality of medians, testing the null hypothesis that the samples were drawn from populations with the same median. We highlight when this hypothesis can be rejected and then the medians are statistically different from the medians of non-innovating firms reported in table.

Table III-V Tests of Means and Median differences, Total Time Horizon

Tests on Means and Medians

	2002-2011		
	Mean Diff.	T-stat	Median
Grow	0.657	(1.12)	0.02668
Age	**-0.0509****	(-2.98)	**3.09****
Size	**0.46*****	(11.38)	**9.45*****
Debt[1]	-0.239	(-0.47)	0.392
CF[1]	0.139	(0.38)	0.1154
Inter.[2]	-0.387	(-1.07)	0.0619
Ros(%)	0.304	(1.72)	**0.019*****
Roe(%)	**-1.33***	(-2.27)	**0.050****
ROI(%)	**0.283***	(2.23)	**0.021***
N	955		

Mean is computed on Mean (Innovating) – Mean (Non-Innovating); Median is the probability that the two samples were drawn from populations with the same median.

[1].Percentage to total assets;[2]Percentage to total debt

t statistics in parentheses * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table III-VI Tests of Means and Median differences, 2002-2003

Tests on Means and Medians

	2002			2003		
	Mean Diff	T-stat	Median	Mean	T-stat	Median
Grow	-	-	-	3.04	(1.75)	0.279
Age	-0.547	(-0.81)	2.890	-0.815	(-1.28)	2.944
Size	**0.396****	(2.88)	**9.16***	**0.561*****	(4.41)	**9.270****
Debt[1]	-1.52	(-0.91)	1.000	-1.27	(-0.79)	0.4188
CF[1]	-0.220	(-0.18)	0.141	0.201	(0.18)	0.1289
Inter.[2]	-0.282	(-0.22)	0.079	-0.377	(-0.30)	0.0730
Ros(%)	0.389	(0.77)	0.020	0.111	(0.23)	0.0185
Roe(%)	-2.75	(-1.43)	0.278	-01.50	(-0.86)	0.0232
ROI(%)	0.328	(0.83)	0.664	0.246	(0.66)	0.0454
N	*932*			*941*		

Mean is computed on Mean (Innovating) – Mean (Non-Innovating); Median is the probability that the two samples were drawn from populations with the same median.

[1].Percentage to total assets;[2]Percentage to total debt

t statistics in parentheses * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table III-VII Tests of Means and Median differences, 2004-2005

Tests on Means and Medians

	2004			2005		
	Mean Diff (%)	T-stat	Median	Mean Diff (%)	T-test	Median
Grow	-0.525	(-0.32)	0.0521	-1.45	(-1.00)	0.0475
Age	-0.540	(-0.91)	2.9957	-0..28	(-0.92)	3.044
Size	**0.419*** **	(3.43)	**9.354****	**0.484*****	(4.02)	**9.40***
Debt[1]	-2.12	(-1.36)	0.4305	0.401	0.00401	0.388
CF[1]	0.0425	(0.04)	0.1333	-0.748	(-0.68)	0.129
Inter.[2]	-1.29	(-1.19)	0.0581	**-2.24***	(-2.07)	0.0628
Ros(%)	0.388	(0.82)	**0.0204***	-4.73	(-0.10)	**0.0192***
Roe(%)	-1.45	(-0.83)	0.0599	-01.63	(-0.93)	0.0628
ROI(%)	0.318	(0.90)	0.0245	-0.278	(-0.77)	0.0229
N	960			*963*		

Mean is computed on Mean (Innovating) – Mean (Non-Innovating); Median is the probability that the two samples were drawn from populations with the same median.

[1].Percentage to total assets;[2]Percentage to total debt

t statistics in parentheses * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table III-VIII Tests of Means and Median differences, 2006-2007

Tests on Means and Medians

	2006			2007		
	Mean Diff. (%)	T-stat	Median	Mean	T-test	Median
Grow	2.13	(1.37)	0.0556	-0.181	(-0.12)	0.0521
Age	-0.570	(-1.08)	3.06	-0.526	(-1.09)	3.11
Size	**0.454*****	(3.71)	**9.536****	**0.452*****	(3.63)	9.54
Debt[1]	-0.226	(-0.15)	0.3856	-0.560	(-0.37)	0.399
CF[1]	-0.441	(-0.40)	0.130	-0.416	(-0.36)	0.139
Inter.[2]	-0.532	(-0.49)	0.0627	0.809	(0.72)	0.0713
Ros(%)	-0.254	(-0.53)	**0.193***	0.285	(0.54)	**0.022****
Roe(%)	0.359	(0.20)	0.050	-0.898	(-0.50)	0.0695
RO(%)I	0.135	(0.36)	0.0225	0.261	(0.67)	0.0272
N	962			*958*		

Mean is computed on Mean (Innovating) – Mean (Non-Innovating); Median is the probability that the two samples were drawn from populations with the same median.

[1].Percentage to total assets;[2]Percentage to total debt

t statistics in parentheses * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table III-IX Tests of Means and Median differences, 2007-2008

Tests on Means and Medians

	2008			2009		
	Mean Diff.	T-stat	Median	Mean	T-test	Median
Grow	1.94	(1.20)	-0.0109	2.39	(1.22)	-0.157
Age	-0.449	(-0.98)	3.13	-0.387	(-0.89)	3.17
Size	**0.455*** **	(3.64)	9.62	**0.445*** **	(3.49)	9.58
Debt[1]	0.354	(0.22)	0.375	0.675	(0.41)	0.366
CF[1]	1.03	(0.87)	0.106	0.485	(0.41)	0.067
Inter.[2]	0.817	(0.73)	0.072	-0.444	(-0.41)	0.052
Ros(%)	0.734	(1.19)	**0.021*** **	0.488	(0.73)	0.012
Roe(%)	-0.913	(-0.47)	0.046	-1.61	(-0.83)	0.025
ROI(%)	0.585	(1.38)	0.023	0.458	(1.03)	0.011
N	956			*956*		

Mean is computed on Mean (Innovating) – Mean (Non-Innovating); Median is the probability that the two samples were drawn from populations with the same median.

[1].Percentage to total assets;[2]Percentage to total debt

t statistics in parentheses * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table III-X Tests of Means and Median differences, 2010-2011

Tests on Means and Medians

	2010			2011		
	Mean Diff. (%)	T-stat	Median	Mean Diff (%)	T-test	Median
Grow	0.129	(0.07)	0.055	-1.77	(-0.98)	0.025
Age	-0.377	(-0.92)	3.21	-0.365	(-0.94)	3.25
Size	**0.444*** **	(3.32)	9.61	**0.483*** **	(3.47)	**9.57***
Debt[1]	1.14	(0.69)	0.364	1.08	(0.62)	0.3637
CF[1]	0.638	(0.54)	0.072	1.45	(1.17)	0.0828
Inter.[2]	-0.398	(-0.36)	0.038	0.149	(0.13)	0.0447
Ros(%)	0.514	(0.77)	0.015	0.681	(0.99)	**0.0159***
Roe(%)	0.677	(0.36)	0.041	-3.98*	(-2.04)	0.0393
ROI(%)	0.367	(0.84)	0.127	0.568	(1.29)	0.1253
N	955			*955*		

Mean is computed on Mean (Innovating) – Mean (Non-Innovating); Median is the probability that the two samples were drawn from populations with the same median.

[1].Percentage to total assets;[2]Percentage to total debt

t statistics in parentheses * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table V exhibits the t-tests on mean differences between innovating and non-innovating firms. We found that innovating firms are performing better in terms of profitability on investment, but the sign is inverted when coming to return on equity. From the tables VI-X we can see that the only variable for which the

difference is statistically significant over time is the firms' size (measured as logarithm of the total assets); this is due to the construction of the sample; indeed even if the sample selection criteria were constructed in a way such that the firms should have been selected with the same size, we find a statistically significant difference.

III.2 Hypotheses testing

As aforementioned, the relationship between innovation and firms' performance is not clearly defined. As highlighted in chapter two, according to Schumpeterian and mainstream literature, innovative firms should grow more because they enjoy a competitive advance, given by better processes or products; hence they should be selected by the market. We can expect a positive relationship between firms' growth and innovative features.

H1: Innovating firm are performing better in terms of sales growth and profitability.

According to (Yasuda, 2005) and other studies, smaller firm should grow faster than larger ones; since firms' size and age are positively correlated, we are expecting a negative relationship between firms' growth and age and between firms' growth and size.

Based on the above consideration, we can formulate the following hypothesis:

H2: Size and Age are negatively affecting firm's growth and profitability.

Furthermore, the economic theory suggests that the innovative firms face financial restrictions because of the presence of more intangible assets in comparison with non-innovating firms and are more indebted in order to finance innovating projects. Then we can formulate:

H3: The percentage of debt on total asset is negatively related with innovative activity.

III.3 Econometric Method

In order to test these hypotheses we are going to test the growth determinants using different models[52]. Given the panel nature of the data, we used a Mixed Multilevel model, with a random intercept on the individuals, as the following equation:

$$Y_{i,t} = \beta_0 + \beta_1 DUMYEAR_{it} + \beta_2 DUMINN_i + \beta_3 LOGAGE_{it-1} + \beta_4 SIZE_{it-1} + \beta_5 DEBT_{it-1} + \beta_6 CF_{it-1} + \beta_7 GEO + \beta_8 ATECO + u_i + \varepsilon_{it}$$

Or in brief:

$$Y_{it} = \beta_0 + \sum_{K=1}^{8} \beta_k X_{k,i,t-1} + u_i + \varepsilon_{i,t}$$

Results are presented in the following page. A robust OLS model, without the random component has been estimated as well, in order to have a comparable model. These estimation have been computed for Growth, ROIs and debt levels. All the *likelihood ratio tests* vs. a standard OLS estimation (not reported) confirm the better performance of mixed models estimations.

III.3.1 Estimation Results

Table XI exhibits the robust regression and mixed model estimation for the three dependent variables, controlling for year differences. We are searching for difference between innovating and non-innovating firms compared to 2005 performances and features. In our sample 2005 shows to have the maximum growth rate, since all the other years differences are negative. The differences between innovating and non-innovating firms are not statistically significant when we are controlling for firms' specific size, age, debt and cash flow.

[52] All estimations are performed with STATA®, version 12.

Table III-XI Regressions with yearly effects

OLS/MIXED	GROWTH		ROI		DEBT	
	b/se	b/se	b/se	b/se	b/se	b/se
2003	**-0.039*** **	**-0.039** **	-0.005	**-0.005***	**0.033** **	**0.037*** **
	(0.012)	(0.012)	(0.003)	(0.002)	(0.012)	(0.007)
200	-0.014	-0.015	-0.001	-0.001	**0.048*** **	**0.050*** **
	(0.011)	(0.012)	(0.003)	(0.002)	(0.011)	(0.007)
2005 (Base)	0.000	0.000	0.000	0.000	0.000	0.000
	(.)	(.)	(.)	(.)	(.)	(.)
2006	**-0.034** **	-0.034**	-0.002	-0.002	0.005	0.007
	(0.011)	(0.012)	(0.003)	(0.002)	(0.011)	(0.007)
2007	**-0.024***	-0.025*	0.004	0.003	0.008	0.010
	(0.011)	(0.012)	(0.003)	(0.002)	(0.011)	(0.007)
2008	**-0.092*** **	**-0.092*** **	-0.003	**-0.005***	0.010	0.009
	(0.011)	(0.012)	(0.003)	(0.002)	(0.011)	(0.007)
2009	**-0.228*** **	**-0.230*** **	**-0.017*** **	**-0.019*** **	-0.002	0.001
	(0.013)	(0.012)	(0.003)	(0.002)	(0.011)	(0.007)
2010	-0.002	-0.005	**-0.013*** **	**-0.015*** **	-0.017	-0.000
	(0.012)	(0.012)	(0.003)	(0.002)	(0.011)	(0.007)
2011	**-0.037** **	**-0.040** **	**-0.013*** **	**-0.016*** **	-0.012	0.003
	(0.012)	(0.012)	(0.003)	(0.002)	(0.012)	(0.008)
Innovating						
2003	0.027	0.028	0.004	0.006	-0.017	-0.021
	(0.017)	(0.018)	(0.004)	(0.004)	(0.015)	(0.016)
2004	-0.006	-0.006	0.005	0.006	-0.019	-0.023
	(0.017)	(0.017)	(0.004)	(0.004)	(0.015)	(0.015)
2005b	-0.016	-0.016	-0.002	-0.002	0.005	0.004
	(0.015)	(0.016)	(0.004)	(0.004)	(0.014)	(0.015)
2006	0.016	0.017	0.002	0.001	-0.000	-0.005
	(0.015)	(0.016)	(0.004)	(0.004)	(0.014)	(0.015)
2007	-0.005	-0.005	0.003	0.002	-0.005	-0.008
	(0.015)	(0.016)	(0.004)	(0.004)	(0.014)	(0.015)
2008	0.018	0.018	0.006	0.006	0.003	0.001
	(0.016)	(0.017)	(0.004)	(0.004)	(0.015)	(0.015)
2009	0.022	0.023	0.005	0.005	0.011	0.006
	(0.019)	(0.017)	(0.005)	(0.004)	(0.016)	(0.015)
2010	0.002	0.003	0.004	0.005	0.011	0.003
	(0.018)	(0.017)	(0.005)	(0.004)	(0.016)	(0.015)
2011	-0.018	-0.018	0.007	0.007	0.014	0.008
	(0.017)	(0.018)	(0.005)	(0.004)	(0.016)	(0.016)
AGE	**-0.008***	-0.007	0.000	0.001	**-0.024*** **	**-0.020*** **
	(0.004)	(0.004)	(0.001)	(0.002)	(0.003)	(0.006)
SIZE	0.003	0.002	**-0.001** **	0.000	**-0.007*** **	0.001
	(0.002)	(0.002)	(0.000)	(0.001)	(0.002)	(0.003)
DEBT	-0.007	-0.009	**-0.025*** **	**-0.017*** **		
	(0.014)	(0.015)	(0.003)	(0.004)		
CF	**0.064*** **	**0.037***			**-0.308*** **	**-0.177*** **
	(0.019)	(0.018)			(0.016)	(0.014)
Constant	**0.052** **	**0.063** **	**0.042*** **	**0.026*** **	**0.561*** **	**0.460*** **
	(0.020)	(0.020)	(0.004)	(0.007)	(0.018)	(0.028)
R^2	0.089		0.027		0.062	
BIC	-1610.766	-1608.964	-2.36e+04	-2.65e+04	-2779.081	-7408.269
N	7541.000	7541.000	7710.000	7710.000	7632.000	7632.000

Table XII exhibits Robust OLS and Mixed regressions for Growth, ROI and Debt, controlling for Size, Age, Debt and Cash Flow; we did not control for yearly differences between the two type of firms, but we have controlled for yearly differences against 2005 values.

Table III-XII Ols and Mixed model for dependent variables

	GROWTH		ROI		DEBT	
	b/se	b/se	b/se	b/se	b/se	b/se
OLS/MIXED						
2003	**-0.027****	**-0.028****	-0.003	-0.003	**0.028****	**0.030*****
	(0.010)	(0.010)	(0.002)	(0.002)	(0.010)	(0.006)
2004	-0.011	-0.012	0.000	0.001	**0.042*****	**0.043*****
	(0.010)	(0.010)	(0.002)	(0.002)	(0.009)	(0.006)
2005b	0.000	0.000	0.000	0.000	0.000	0.000
	(.)	(.)	(.)	(.)	(.)	(.)
2006	**-0.025****	**-0.025***	-0.003	-0.002	0.003	0.004
	(0.009)	(0.010)	(0.002)	(0.002)	(0.009)	(0.006)
2007	-0.021*	-0.021*	0.003	0.003	0.006	0.006
	(0.009)	(0.010)	(0.002)	(0.002)	(0.009)	(0.006)
2008	**-0.082*****	**-0.082*****	**-0.003**	**-0.004***	0.010	0.008
	(0.010)	(0.010)	(0.002)	(0.002)	(0.009)	(0.006)
2009	**-0.218*****	**-0.219*****	**-0.017*****	**-0.018*****	-0.001	0.001
	(0.011)	(0.010)	(0.003)	(0.002)	(0.009)	(0.006)
2010	0.003	0.001	-0.013***	-0.014***	-0.015	-0.001
	(0.011)	(0.010)	(0.002)	(0.002)	(0.010)	(0.006)
2011	**-0.037*****	**-0.040*****	**-0.013*****	**-0.015*****	-0.010	0.003
	(0.010)	(0.011)	(0.003)	(0.002)	(0.010)	(0.007)
INNOV.	0.004	0.005	**0.003***	0.004	0.000	-0.004
	(0.006)	(0.006)	(0.001)	(0.003)	(0.005)	(0.012)
AGE	-0.007	-0.007	-0.001	0.000	**-0.024*****	**-0.020*****
	(0.004)	(0.004)	(0.001)	(0.002)	(0.003)	(0.006)
SIZE	0.003	0.002	**-0.002*****	-0.000	**-0.007*****	0.001
	(0.002)	(0.002)	(0.000)	(0.001)	(0.002)	(0.003)
DEBT	0.015	0.015	**-0.031*****	**-0.009****		
	(0.014)	(0.013)	(0.003)	(0.003)		
CF	**0.069*****	**0.042***			**-0.308*****	**-0.177*****
	(0.019)	(0.018)			(0.016)	(0.014)
Const.	0.037	**0.047***	**0.057*****	**0.029*****	**0.562*****	**0.461*****
	(0.022)	(0.021)	(0.005)	(0.007)	(0.018)	(0.028)
R^2	0.088		0.033		0.062	
BIC	-1681.899	-1679.803	-2.37e+04	-2.66e+04	-2846.090	-7469.449
N	7547.000	7547.000	7716.000	7716.000	7632.000	7632.000

From the results in Table XIII we can see that:

- *Growth:* Innovative activity is not significant in both specifications; a positive effect on growth is found for cash flow. Furthermore, in the basic model we can see that Age is negative and statistically significant, whereas it loses its significance in the mixed model. Cash flow is a positive determinant of firms' growth in both models. Then innovating firms show no differences then, in contrast with the theoretical arguments that see them as more competitive and then selected by the market.
- *ROI:* In the OLS estimation the innovation dummy confirms that, with same age, size and debt, innovation is a positive determinant of ROI, but it loses its significance in the mixed specification. The negative relationship

between ROI and debt levels is highly significant in both model specifications. The significance of innovation dummy is a first clue that confirms how innovating firms are more profitable in comparison to non-innovating, as we will find in the next model specification.

- *Debt:* Also here innovation dummy turns out to be not significant. A strong and negative relationship is found between firm's age and size to the debt level. Cash Flow is confirmed to be in a negative relationship with a high significance level against debt levels.

Table III-XIII Models including sub sectorial and geographical effects

	GROWTH		ROI		DEBT	
	b/se	b/se	b/se	b/se	b/se	b/se
OLS/MIX						
2003	**-0.028****	**-0.028****	-0.004	-0.002	**0.026****	**0.029*****
	(0.010)	(0.011)	(0.002)	(0.002)	(0.010)	(0.006)
2004	-0.013	-0.013	0.000	0.001	**0.038*****	**0.040*****
	(0.010)	(0.010)	(0.002)	(0.002)	(0.010)	(0.006)
2005b	0.000	0.000	0.000	0.000	0.000	0.000
	(.)	(.)	(.)	(.)	(.)	(.)
2006	**-0.023***	**-0.023***	-0.003	-0.002	0.003	0.004
	(0.010)	(0.010)	(0.002)	(0.002)	(0.009)	(0.006)
2007	-0.022*	-0.022*	0.002	0.003	0.005	0.006
	(0.010)	(0.010)	(0.002)	(0.002)	(0.009)	(0.006)
2008	**-0.079*****	**-0.079*****	-0.003	-0.004*	0.008	0.007
	(0.010)	(0.010)	(0.002)	(0.002)	(0.009)	(0.006)
2009	**-0.222*****	**-0.223*****	**-0.017*****	**-0.018*****	-0.002	0.000
	(0.011)	(0.010)	(0.003)	(0.002)	(0.010)	(0.006)
2010	0.001	-0.001	**-0.013*****	**-0.014*****	-0.018	-0.003
	(0.011)	(0.011)	(0.003)	(0.002)	(0.010)	(0.007)
2011	**-0.038*****	**-0.040*****	**-0.013*****	**-0.014*****	-0.012	0.002
	(0.011)	(0.011)	(0.003)	(0.002)	(0.010)	(0.007)
INNOV.	0.007	0.007	**0.006*****	**0.006***	0.000	-0.006
	(0.006)	(0.006)	(0.001)	(0.003)	(0.005)	(0.013)
AGE	-0.007	-0.007	-0.001	0.000	**-0.022*****	**-0.017****
	(0.004)	(0.004)	(0.001)	(0.002)	(0.004)	(0.006)
SIZE	0.002	0.001	**-0.002*****	-0.000	**-0.006*****	0.002
	(0.002)	(0.002)	(0.000)	(0.001)	(0.002)	(0.003)
DEBT	0.009	0.010	**-0.031*****	**-0.011*****		
	(0.015)	(0.013)	(0.003)	(0.003)		
CF	**0.057****	0.036			**-0.312*****	**-0.177*****
	(0.020)	(0.019)			(0.016)	(0.015)
Const.	0.040	0.047	**0.043*****	0.016	**0.569*****	**0.467*****
	(0.036)	(0.042)	(0.006)	(0.017)	(0.034)	(0.078)
R^2	0.093		0.049		0.073	
BIC	-1481.005	-1473.020	-2.28e+04	-2.54e+04	-2710.940	-7089.224
N	7225.000	7225.000	7388.000	7388.000	7306.000	7306.000

In the estimation result exhibited in Table XIV we control for geographical and sectorial effects.

- *Growth:* Despite this control, innovation results still not significant as growth's determinant.
- *ROI:* Controlling for sectorial and geographical effects provides different estimation results for ROI; indeed, *ceteris paribus*, innovating firms turns out to be more profitable since the coefficient is statistically significant and positive in both OLS and Mixed model. Debt is confirmed to be in a negative relationship with ROI and profitability. No significance is found for size and age.
- *Debt:* In comparison to the previous specification, when controlling for sector and geographical allocation we find again significance and negative relationship of firm's size and age. Innovation is not significant in both models.

Table III-XIV Regression with variable interactions

	GROWTH		**ROI**		**DEBT**	
	b/se	b/se	b/se	b/se	b/se	b/se
OLS/MIX						
2003	**-0.027****	**-0.028****	-0.003	-0.003	**0.028****	**0.030*****
	(0.010)	(0.010)	(0.002)	(0.002)	(0.010)	(0.006)
2004	-0.011	-0.012	0.000	0.001	0.041***	0.043***
	(0.010)	(0.010)	(0.002)	(0.002)	(0.009)	(0.006)
2005	0.000	0.000	0.000	0.000	0.000	0.000
	(.)	(.)	(.)	(.)	(.)	(.)
2006	**-0.025****	**-0.025***	-0.003	-0.002	0.003	0.004
	(0.009)	(0.010)	(0.002)	(0.002)	(0.009)	(0.006)
2007	-0.021*	-0.021*	0.003	0.003	0.006	0.006
	(0.009)	(0.010)	(0.002)	(0.002)	(0.009)	(0.006)
2008	-0.082***	**-0.082*****	-0.003	-0.004*	0.010	0.008
	(0.010)	(0.010)	(0.002)	(0.002)	(0.009)	(0.006)
2009	**-0.218*****	**-0.219*****	**-0.017*****	**-0.018*****	-0.001	0.001
	(0.011)	(0.010)	(0.003)	(0.002)	(0.009)	(0.006)
2010	0.003	0.001	**-0.013*****	**-0.014*****	-0.015	-0.001
	(0.011)	(0.010)	(0.002)	(0.002)	(0.010)	(0.006)
2011	**-0.037*****	**-0.040*****	**-0.013*****	**-0.015*****	-0.010	0.004
	(0.010)	(0.011)	(0.003)	(0.002)	(0.010)	(0.007)
Not inn. Age	**-0.010***	**-0.010***	-0.001	-0.001	**-0.023*****	**-0.021****
	(0.004)	(0.005)	(0.001)	(0.002)	(0.004)	(0.007)
Inn. Age	-0.001	-0.000	-0.001	0.004	**-0.025*****	-0.016
	(0.007)	(0.007)	(0.001)	(0.002)	(0.005)	(0.010)
Not Inn. Size	**0.004***	0.003	**-0.002*****	0.000	-0.007***	0.001
	(0.002)	(0.002)	(0.000)	(0.001)	(0.002)	(0.003)
Inn. Size	-0.000	-0.001	-0.001*	-0.001	**-0.007*****	-0.000
	(0.002)	(0.002)	(0.001)	(0.001)	(0.002)	(0.003)
Not Inn. Debt	0.010	0.011	**-0.030*****	**-0.010****		
	(0.016)	(0.015)	(0.003)	(0.004)		
Inn. Debt	0.030	0.027	**-0.032*****	-0.007		
	(0.026)	(0.026)	(0.007)	(0.007)		
Not inn. CF	**0.047***	0.019			**-0.313*****	**-0.159*****
	(0.022)	(0.021)			(0.019)	(0.017)
Inn. CF	**0.123*****	**0.099****			**-0.293*****	**-0.226*****
	(0.033)	(0.032)			(0.027)	(0.027)

Constant	0.039	**0.050***	**0.058*****	**0.030*****	**0.562*****	**0.460*****
	(0.022)	(0.021)	(0.005)	(0.007)	(0.018)	(0.028)
R^2	0.089		0.033		0.062	
BIC	-1662.129	-1659.769	-2.37e+04	-2.66e+04	-2828.677	-7456.712
N	7547.000	7547.000	7716.000	7716.000	7632.000	7632.000

We specified this variable interaction model in order to look for difference between innovating and non-innovating firms within the control variables.

- *Growth:* we can see that cash flow for innovative firms has a strong significance compared to non-innovative, since the positive coefficient shows a p-value < 0.001. Then innovating firms might be more sensible to variations of internal finance; they could grow more thanks to a higher level of cash flow, or they could just create better products that provide them a higher level of cash flow.
- *ROI:* Estimating a variable interaction specification we find that in the OLS specification debt is confirmed to be in a strong negative relationship with the dependent variable. Then a higher debt is more related to lower profitability levels; from the other side we recognize that a lower level of debt could drive to higher profitability.
- *Debt:* The role of internal finance is negatively related to the debt level with a high statistical significance; innovating firms' debt levels are more sensible to cash flow changes; in the OLS specification, age and size negative effects on debt are stronger for innovating firms.

III.4 Survival Analysis

Table XV exhibits the sample number of firms that exit due to a bankruptcy or liquidation event or because they were absorbed by another firm.

Table III-XV Sample description

Survival analysis	High tech firms	Non high-tech firms
Firm exiting in the period 2000-2011	19	84
Firm that exit due to M&A	7	0
Total number of SMEs analyzed in survival analysis	**249**	**714**

It is evident that not all the firms are incumbent for the entire time period. Some of them experience bankruptcy or M&A operations. The Heckman selection model is widely accepted to correct for survivorship bias, then we will estimate a selection equation and after calculating the Mill's ratio[53], we will include them in the regression equation. In order to test the effect of innovation on firm's performance, profitability and debt levels, we will set the logarithm of sales growth, ROI and debt to total assets levels as dependent variable, as previously done.

III.4.1 Heckman Selection Model

After the OLS and mixed regressions we are going to taking into account the presence of a possible survivorship bias. As other studies have done, in order to solve this bias, we follow the recommendation of (Nunes et al., 2012) and use the Heckman two-steps estimation method (Heckman, 1979). In the first stage, considering all firms (surviving and non-surviving), we estimate a Probit regression in which the dependent variable has value of 1 if the firm is in the market and the value of 0 if it has left the market. The independent variables in this first step are the variables considered in the second stage (and detailed previously) that are believed to be determinants of firm's growth, ROI and Debt, and an additional variable in order to correct possible bias in the inverse Mill's ratio. The PROBIT regression that will be estimated in the first step of the model is:

[53] For the calculation of the Inverse Mill's ratio, see (Heckman, 1979).

$$\Pr(\delta_{i,t} = 1) = \tau_0 + \sum_{K=1}^{n} \tau_k Z_{k,i,t-1} + d_t + z_{i,t}$$

Where $z_{i,t}$ is a normally distributed error, $Z_{k,i,t-1}$ is the vector of variables that we consider to be determinants. The response equation is:

$$GROWTH_{i,t} = \beta_0 + \sum_{k=1}^{n} \beta_K X_{k,i,t-1} + \beta_\lambda \lambda_{i,t} + e_{i,t}$$

Where $X_{k,i,t-1}$ is the vector of variables that we consider being determinants, $\lambda_{i,t}$ are the Inverse Mills Ratio and $e_{i,t}$ are the normally distributed errors.

Table III-XVI Heckman selection equation (Bankruptcy)

PROBIT	BANKRUPTCY
AGE	**-0.233*** **
	(0.040)
SIZE	-0.021
	(0.016)
DEBT	**0.755*** **
	(0.127)
CF	**-1.050*** **
	(0.191)
Risk	**0.001*** **
	(0.000)
Constant	**-0.881*** **
	(0.195)
Inverse Mills Ratio	
Constant	**1.194*** **
	(0.237)
Ln sigma	
Cons.	**-0.992*** **
	(0.126)
R^2	
BIC	2921.814
N	5718.000

Table III-XVII Heckman Response Equation

OLS	GROWTH
	b/se
2005	Base year
2006	-0.067
	(0.038)
2007	**-0.098***
	(0.038)
2008	**-0.176*** **
	(0.040)
2009	**-0.235*** **
	(0.044)
2010	**-0.165** **
	(0.056)
2011	**-0.180** **
	(0.069)
INNOV.	**0.060***
	(0.027)
AGE	**-0.078*** **
	(0.023)
SIZE	0.009
	(0.009)
DEBT	0.146
	(0.079)
CF	-0.152
	(0.123)
Const.	**-0.462*** **
	(0.132)

The results of the PROBIT selection equation in Table XVI shows that the probability of bankruptcy is positively influenced by a higher level of debt and that older firms have are less likely to fail (negative and significant coefficient of Age). The Inverse Mill's ratios were not significant in the estimated models for debt and profitability. Indeed even LR tests, on the hypotheses that the correlation between the two model's errors would be zero, rejected the appropriateness of a Heckman selection model in the last two cases.

With a p-value of LR test < 0.01, we can accept the results from this model specification. From the results exhibited in Table XVII Innovative activity is then statistically significant and positive, then, *ceteris paribus*, innovating firms grow more than non-innovating. We also find a negative relationship of age with the growth level of the firms, which partially confirms H2.

III.5 Conclusions

The objective of this work is to analyze the firms that patent (using number of patents on sales as a proxy for innovative activity) and to understand if they are different in respect to growth and financial dynamics.

Literature has tried to determine the link between growth and innovation in different ways. The innovation indicator mainly used has been R&D expenses, but our approach has been different. Indeed we used the application for patents as an indicator of innovation and then we selected innovative firms and appropriate comparable, so that we hacked the lacking information of R&D expenses in Profit and Loss statements.

Then we decided to apply a mixed effects model because we want to consider both fixed and random effects on individuals.

Growth

Results bring is evidence of the innovative effort in 2005, which was related to through a major growth of innovating firms against non-innovating. The econometrics results do not generally confirm this hypothesis.

First, we started searching for yearly effects with differences against 2005 performance (Table XI). The regression results does not show statistically significant differences for innovating firms in comparison with non-innovating.

Then we run a Mixed and Robust OLS regressions where growth was controlled for basic determinants (Table XII). Our dependent variable is not a statistical determinant of sales growth, whereas cash flow is confirmed to be in a statistical positive relationship.

We controlled for sectorial and geographical effects (Table XIII), but still no significance of innovation come out. Variable interaction regression (Table XIV) shows that there is a difference in cash flow sensitivity for innovating firms. Indeed sales growth is positive and with high significance, which turns out in a more sensitivity of sales growth in changes in cash flow; they could grow more with a higher level of cash flow, despite this level could be determined by the better products sold that allow them a higher market share. These results are consistent with the results obtained by Bottazzi (2001) and Loof et al. (2006), which do not find significance of innovative activity.

At last we estimated a Heckman selection model in order to control for survivorship bias in the sample (Table XVI-XVII). If we take this issue into account the results are different from the previous estimation. The results yielded by PROBIT regression show that higher age is negatively affecting the probability of bankruptcy, while higher level of debt are positively influencing it. In the OLS estimation innovative activity coefficient turns out to be positive and statistically significant, showing that, ceteris paribus, and controlling for sample selection bias, innovating firms tend to grow more than non-innovating. The relationship between the inverse Mill's ratio and growth is positive and statistically significant. Based on these findings, we can conclude that inclusion of the inverse Mill's ratio in the growth regressions of non-high-tech SMEs and high-tech SMEs was effective in solving possible bias of the estimated parameters measuring relationships between determinants and growth in non-high-tech and high-tech SMEs. Not considering the inverse Mill's ratio in the

growth regressions of non-high-tech and high-tech SMEs would lead to undervaluing the estimated parameters measuring relationships between determinants and growth.

Since the results are conflicting we do not find a clear confirmation for the first part of H1, even if taking into account the survivorship bias give us a clue on better sales performance for innovating firms.

Empirical confirmation for H2 is found only when taking into account the presence of a survivorship bias, and only firm's age is negatively related to firms' growth of sales.

ROI

The same logic scheme has been followed for ROI determinants' research. Controlling for yearly differences does not yield any significant result. The plain estimation's results on firm's Return on investment show that innovation is a statistically positive determinant of ROI, but only in the OLS estimation. Controlling for sectors and geography leads to significance of the innovative activity; innovating firms, other determinants being equal, are more profitable. Cash flow is confirmed to be as an important negative determinant of debt levels; Interaction with innovative dummies confirms in the OLS specification that debt is in a stronger relationship with profitability for innovating firms; then a higher might be more related to lower profitability levels, whereas a lower level of debt could produce higher profits.. The Heckman selection model is rejected by likelihood ratio test.

We find empirical confirmation for the second part of H1, namely that innovation is a positive determinant of firm's profitability.

First part of H2 is not empirically confirmed by our estimation results.

Debt

Searching for yearly differences in debt is not producing significant results. Plain estimations' results on debt ratio do not yield significant results for innovation

dummy. The negative effect of cash flow on leverage is highly statistically significant. Controlling for sector and geographical allocation yields substantially unchanged results. The role of internal finance is negative and highly significant, confirming that innovative firms' debt levels are more affected by changes in cash flow. Heckman selection procedure is rejected by likelihood ratio tests. Then innovating firms are not indebted in a different way from non-innovating firms and H3 is rejected.

In this work we have found confirmation that innovative activity is a positive determinant of firm's profitability in all of our models; but when we analyze growth determinants, it is significant only when we take into account the presence of survivorship bias. No relationship is found between debt levels and innovative activity.

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