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TURN ON, TUNE IN, DROP OUT? EXPLORING THE VENTURE EMERGENCE IN TECHNOLOGY-BASED FIRMS

by

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Dedicated to my family and friends for their unconditional support and patience

Abstract

Despite the remnant promises that sustained technological progress offers to entrepreneurs eager to introduce disruptive technological innovations, we observe that only few of them live up to the expectations. In fact, economic and social policy actors' interest in promoting technology entrepreneurship, contrasts with the limited evidences of successful policies for high-growth companies, and a limited understanding on the factors underlying the transformation of promising technologies into viable organizations, and how they influence the decisions to turn on, tune in with the market, and drop-out or continue with their organizing efforts.

Prior entrepreneurship research has kept a focus on using the resource-based view to explore the influence of resources on new venture performance, in particular in situations where a demand already exists, and the entrepreneur takes the role of exploiting an opportunity to capture value as a new entrant. Nevertheless, when studying entrepreneurial activity built upon technology-based opportunities, we find difficulties to explain the venture performance only relying on initial resource combinations. In this sense, we propose to complement the understanding of the phenomenon from the resource-based view with additional perspectives that could help to identify factors that provide further understanding on the emergence of new technology-based firms.

Building on the theoretical conceptualization of entrepreneurship as a process, we adopt a mixed-method approach to combine an exploratory qualitative field work with a quantitative research approach. First, we gather insights on the factors and actions that are seen to be influencing the technology entrepreneurship process, from the initial opportunity to the creation of a stable business, focusing in particular on the influence of resources and actions taken by the entrepreneur. Then, we extend our initial theoretical framework on the technology entrepreneurship process to support the qualitative findings and build propositions, these are tested as hypotheses on a larger sample of technology-based firms. Finally, we combine the findings from the qualitative field work with the findings from the hypotheses test.

This research results suggest that technological resources have a complex influence on the emergence of technology-based ventures. Using the signaling theory we explain how some resources value goes beyond its direct impact on firm's performance, suggesting that they are also used for their symbolic value and the development of the initial market. In both, qualitative and quantitative results, we observe that technological assets need to be

transformed in order to generate value for the potential customers of the new venture. In this type of situations, marketing and human capital theory insights provide an explanation on how experienced entrepreneurs and their effort intensity to build a market presence are observed to positively influence the venture emergence of the new technology-based firm.

We contribute to the current understanding of new technology-based firms with the contributions from human capital, marketing and technology commercialization theory. Describing how the orientation of entrepreneur's actions and the early development of market capacities influence on the venture emergence of this type of firms. The results also have implications for entrepreneurs, investors in technology startups, and stakeholders in technology entrepreneurship; as they suggest that further attention should be given to the market actions of the entrepreneurs, regardless of their initial combinations of resources.

Keywords

Technology Entrepreneurship, Opportunity, Entrepreneurship, Panel Data Set

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Abbreviations and acronyms

KFS: Kauffman Firm Survey

NAICS: North American Industry Classification System

NTBF: New Technology-Based Firm

PSED: Panel Study of Entrepreneurial Dynamics

STATA: Software package for data analysis and statistics, owned by StataCorp.

VE: Venture Emergence

1. Introduction

The disruptive potential of new technologies in the hands of entrepreneurs attracts investors and governments alike (Lerner 2010). Technology-based firms are seen as a reliable contributor to the economic growth and innovation drivers, their role has been described as being the "spur" than helps to ignite the technology innovation in industries and regions alike (Lerner 2010). Nevertheless, there are little evidences to support that technological progress is quickly or smoothly transferred to the market by entrepreneurs (Schoonhoven et al. 1990; Brown & Mason 2014). In fact, the opposite seems to be the norm as technology commercialization has been identified as probably one of the most complex processes for a new venture (Gans & Stern 2003; Brem & Borchardt 2014; Hsu 2008).

Thus, for every few companies like Intel, Salesforce, Grifols or Tesla, there are many more that had a promising new technological development but did not find a place in the market, for example the cases of Segway or Iridium (Finkelstein & Sanford 2000). In other cases, we have seen how difficult is to stay tuned with the market and the technological change, some of them successfully managed this adjustments while other have survived after dramatic adjustments, as in the case of Kodak or Nokia (Lee 2013), or have almost disappeared, as in the case of Atari or Palm (Ziegler 2015). Thus, what can entrepreneurs launching new ventures learn from this past experiences?

New technology-based ventures are seen to face a situation where they have to deal with both technology and entrepreneurship development challenges (Hsu 2008). As a result it is often observed that promising new ventures that rely on a highly novel technology fail to exploit their opportunity, unable to move beyond the initial search for a valuable application or use of their product or service (Choi et al. 2008). The highly dynamic technology markets introduce an additional challenge to new technology-based firms (NTBFs), as buyers are weary of nascent entrepreneur's promises (Godley 2013; Gans & Stern 2003).

These findings contrast with the theoretical expectations from the resource-based view (RBV), that would propose that resources of the new firm would explain their ability to establish a competitive advantage (Barney 1991; Wernerfelt 1995). An explanation for this apparent limitation of the RBV would be that meanwhile unique combinations of resources would provide an advantage to firms in a situation to compete to capture value, the RBV might not help to understand the different performance of organizations in situations where value creation is needed at first (Alvarez & Barney 2010), as it is described to occur in uncertain and dynamic technology contexts (Teece 2010).

Thus, the assumption that the competitive capacity of the new firm would be a function of their resources, does not seem to fully explain the behavior and performance of new technology-based firms (Newbert et al. 2008). We argue that to get a better understanding of how entrepreneurs manage the tension between their technological resources and the market we need to introduce additional theoretical perspectives that provide an explanation of new firm performance beyond the resources the firm possesses. Thus we introduce insights from signaling, marketing and technology commercialization theories, that fit with the suggestion of complementing the understanding from the resource-based view with theoretical framework from the demand-side views of organizations (Priem et al. 2011). These complementary perspectives provide support to describe the market creation efforts of entrepreneurs (Godley 2013); insights from the marketing and signaling theory literature provide an explanation to the influence that entrepreneurial actions have on the market value of their products and services (Webb et al. 2010; Lam & Harker 2015; Priem et al. 2011).

In this study we use a mixed method approach (Venkatesh et al. 2013), combining both exploratory and confirmatory questions, gathering empirical evidences and proposing a set of hypotheses. After an initial literature review on the phenomena we completed an inductive field work with multiple-case studies. The exploratory work provided support for further in-depth literature review to build an extended research framework model. Finally, we tested the hypotheses of the research framework using a longitudinal data panel, assessing the robustness of the hypotheses test results and the overall theoretical model.

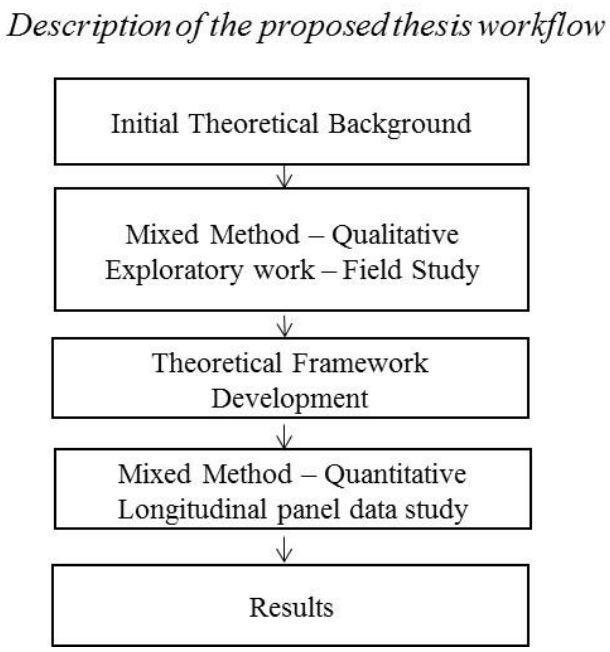
The results and findings of this research support the idea that technological resources in hands of entrepreneurs influence new venture behavior and performance in unexpected manners. Unique technological resources do not automatically translate into sustainable new technology-based firms (NTBFs); instead, the qualitative and quantitative results provide empirical evidences of the needed complementary factors to convert technological opportunities and resources into viable businesses. Additionally the venture emergence perspective enriches our understanding on how these type of firms evolve in the process of technology entrepreneurship.

This research has implications for both entrepreneurship research and practice. We contribute on the current understanding of new-technology based ventures emergence, incorporating marketing and demand-side view theories to provide answers to the observed difficulties to explain the venture emergence process of technology-based firms. Additionally we shed some light on previous insights on the impact of the duality between market and technology that has

been suggested to provide additional information on the venture emergence of technology-based firms. The findings also have implications for those engaged in entrepreneurship practice, particularly those dealing with technology, these conceptual insights could provide guidelines for entrepreneurs, investors, and stakeholders, on the linkages between entrepreneurial activities and performance outcomes.

The document is structured in five main parts (see Figure 1). The first part covers the initial theoretical background, describing how prior entrepreneurship research informs on technology entrepreneurship and the existent research gaps. The second part is dedicated to describe the research design to answer the identified research gaps, making special emphasis on the initial exploratory work that uses a qualitative method to gain a more fine grained understanding of the phenomenon. The third part is dedicated to extend the initial theoretical framework, focusing in particular in the description of factors and theorization on the potential influences on the venture emergence of technology-based firms. The fourth part is dedicated to describe the confirmatory, quantitative, research design were a longitudinal dataset is used to test the hypotheses and extract insights on the factors influencing technology entrepreneurship. Finally, in the concluding fifth part, the insights from the exploratory and confirmatory research designs are combined to extract and refine the overall findings, these findings are followed by the description of overall contributions, limitations, and conclusions of the document.

Figure 1. Detail on the structure of the dissertation



2. Literature Review

In order to establish the boundaries for the initial theoretical background of this research, we first start with the definition of technology entrepreneurship as a singular phenomenon. Technology entrepreneurship definition provides an anchor to then introduce the entrepreneurship theory that has been guiding the research on this phenomenon. Entrepreneurship research central focus is on the creation and exploitation of novel opportunities, the sub-field of technology entrepreneurship provides a fertile area to further develop our understanding on entrepreneurship in the increasingly dominant technology driven markets (Beckman et al. 2012).

Thus, the theoretical background starts with an introduction to the concept of technology entrepreneurship, discussing the different definitions and their implications for research. Then, it follows with a broader review the literature on entrepreneurship as a process and its characteristics. Finally, additional constructs and perspectives are introduced defining the initial theoretical framework and the research questions that guide this work.

2.1. The nature of Technology Entrepreneurship

Technology entrepreneurs are highly regarded as the most promising entrepreneurship profile (Lerner 2010), policy makers and investors alike attempt to reproduce the success of large technology firms that created regional wealth and economic growth (Parker et al. 2010). It is often used as an example the dynamic entrepreneurial activities in areas such as Silicon Valley, where spin-offs from companies and universities have helped to nurture and sustain wealth and economic growth.

The attempts to replicate the regional success (like the case of Silicon Valley) of dynamic technology clusters have urged policy makers to introduce entrepreneurship specific policies, aiming to foster the surge of “gazelles” or fast growth firms (Parker et al. 2010), that could become large organizations like Adobe Systems, Advanced Micro Devices, Oracle, or Cisco, as usual reference examples.

Nevertheless, the results gathered in the last decade show that successful technology entrepreneurship might need different, or at least fine-tuned, policy instruments in order to be effective (Shane 2009). Researchers have observed that public policies that aim to promote entrepreneurship might be effective to incentivize individuals to start their own business, but the type of businesses being created are not the expected high-tech “gazelles” (Brown 2013).

In general, it is argued that the lack of understanding on the technology entrepreneurship process could be the reason why policy makers struggle to design effective programs (Brown & Mason 2014). This problem is intensified in contexts where the policy making mechanisms in institutions are not aligned or in touch with the needs of entrepreneurs or new ventures, increasing the gap between the intended entrepreneurship policy effects and the observed results (Arshed et al. 2014).

In particular, researchers suggest that policies are often oriented to reduce hurdles and minimize initial starting costs (p.e. reducing taxes or subsidizing external support services), this type of measures might actually be incentivizing a new ventures that are likely to fail and have a rather limited economic impact (Shane 2009). Further analysis provides some clues on the potential reasons why policies expecting short term returns might not be working, technology-based entrepreneurs might follow different evolution dynamics, needing more time to develop their technology and find a market (Clarysse, Bruneel, et al. 2011). Overall, there is the perception that a better understanding of technology entrepreneurship and their growth processes would favor a more informed process of policy making (Brown 2013). Getting closer to the objective of having additional mechanisms to favor growth and dynamism in industries or regions (Lerner 2010).

2.1.1. Technology entrepreneurship definition

With the objective to address this initial challenge of better understanding technology entrepreneurship, we review the different definitions of the concept, aiming to establish the boundaries and central components of the phenomenon. As an introductory comment, we use the concept of technology entrepreneurship in reference to a process that has as a main actor the technology-based entrepreneur, and that can have as one of the possible outcomes a new technology-based firm (NTBF). Thus, we use technology (or technology-based) entrepreneurship outcomes and new technology-based firm or NTBF as equivalent concepts from now onwards.

Two elements that stand out as singular in technology entrepreneurship are the type of opportunities and the innovation-based processes of the new venture (Hsu 2008). Scholars identify that technology entrepreneurship opportunities come from advances in science and engineering (Beckman et al. 2012), and are linked to the technological knowledge and skills of the founder (Clarysse, Bruneel, et al. 2011). The development of technology entrepreneurship requires a technological innovation capacity (Brem & Borchardt 2014), as the new firm aims to

create and capture value (Bailetti 2012) in a nascent market, introducing novel products and services (Beckman et al. 2012; Clarysse, Bruneel, et al. 2011).

The expected outcomes of technology entrepreneurship are that high-potential, technology intensive firms, emerge; enabling, at the same time, the development of new markets, clusters or whole industries (Brem & Borchardt 2014; Beckman et al. 2012).

The different existent definitions have a shared view on the core concepts and singular elements (see Table 1), but there are substantial differences in the type of phenomenon or outcomes. Nevertheless, a point of common agreement among scholars is that technology entrepreneurship is a rather complex phenomenon (McKelvey 2004). The combination of the usual entrepreneurial challenges and the specific challenges related to technology development process (Hsu 2008) makes technological entrepreneurship a process with multiple options at each decision point. In other words, it is a situation where the entrepreneur's action is permanently subject to uncertainty (McMullen & Shepherd 2006).

Scholars have debated on the singularity of technology entrepreneurship (Hsu 2008; Brem & Borchardt 2014), suggesting that technology-based entrepreneurs often struggle to unlock the "product-market fit" (Maurya 2012), that would put together their new technology-based product or service with a market (Teece 2010). As described by Teece (2010), it is not uncommon for technology-based entrepreneurs to be working on a technological application that has still no clear defined demand, thus it is a cumbersome task to establish a clear target market, in particular if the product features and technology are still under development. Scholars have also identified that the degree of novelty of the new venture, unless coupled with the right market entry strategy (Zott & Amit 2008), could be negatively related to the new venture survival possibilities in competitive markets (Shepherd et al. 2000).

These observations are related to the examples of organizations that aimed to introduce a breakthrough technology expecting that customers would value the superior technological performance. An illustrative example of this situation is the story of Iridium, that was trying to bring to market mobile satellite-based telecommunications, despite the advance technological assets the company did not manage to survive in the market (Finkelstein & Sanford 2000).

Therefore, there are a collection of observations on the expected difficulties and complexities that technology-based entrepreneurs face. Nevertheless, these evidences do not provide information on the characteristics of the process, besides suggesting that it is difficult and complex. Therefore, we propose to review the extant literature on entrepreneurship to start

building the theoretical background to better understand the phenomenon and the potential causal linkages between the opportunities, the entrepreneur, and the observed outcomes.

Table 1. Review of selected definitions for technology entrepreneurship

Authors	Definition	Article objective and perspective	Type of Paper
Hsu (2008)	As a research field it draws from the study of technical innovation and of entrepreneurship. As a phenomenon, it is distinguished from other forms of entrepreneurial entry by being innovation-based, and it requires commercial and technical knowledge.	Describe the different academic perspectives on the phenomenon of Technology Entrepreneurship	Literature Review
Clarysse, Bruneel, & Wright (2011)	It is defined as companies which develop and commercialize new product/services based on proprietary technology or skills on which the founder or the different founders declared that they wanted to grow.	Explain growth paths of young technology-based firms, looking at resource portfolios and competitive environment	Multiple case-study, qualitative.
Bailetti (2012)	It is an investment in a project that assembles and deploys specialized individuals and heterogeneous assets that are intricately related to advances in scientific and technological knowledge for the purpose of creating and capturing value for a firm	Provide a definition of technology entrepreneurship, combining economics, entrepreneurship, and management perspectives.	Conceptual, Literature Review.
Beckman et al. (2012)	It is distinguished from mainstream entrepreneurship research by its focus on how opportunities are fostered through innovations in science and engineering. It is critically concerned with technical innovations and the nascent markets and novel products they often enable. It exists when developments in science or engineering constitute a core element of the opportunity that enables the emergence of a venture, market, cluster or industry.	Introduction to special issue on Technology Entrepreneurship	Conceptual, Literature Review
Brem & Borchardt (2014)	It is the setting up of new enterprises by individuals or corporations to exploit technological innovations. It involves identifying high-potential and technology-intensive	Define technology entrepreneurship and technology entrepreneur, propose success factors.	Conceptual, Literature Review

2.2. Theoretical perspectives to study technology entrepreneurship

The definition of technology entrepreneurship provided us with an identification of the key singular elements of the phenomenon, but with limited insights on the reasons why the entrepreneurs encounter challenges in the technology entrepreneurship process. Furthermore, the definition of the phenomenon does not clarify why the additional uncertainty or complexity of the technology entrepreneurship might impact on the behavior or performance of the new firms.

In order to address these initial theory needs, we rely on the established entrepreneurship literature. We adopt a broader perspective, benefiting from the many relevant contributions on the construction of the overall entrepreneurship's theoretical framework. In this literature review we are interested in the body of literature that can help to shed some light on technology entrepreneurship.

We start with a description of the literature on entrepreneurship as a process (Shane & Venkataraman 2000; Shane 2012), to then move forward to describe what we know on the role of the entrepreneur, the value of resources and specific capabilities related to the entrepreneurship process of transforming ideas into potential new ventures. The resulting initial theoretical framework is used to establish the gaps that we aim to cover with the research questions.

2.2.1. Entrepreneurship as a process

Although we often use entrepreneurship to talk about new businesses or young companies, it is actually a broader conceptualization that gives full sense to the entrepreneurship concept. Scholars have suggested that entrepreneurship is more than just new ventures, it should instead be regarded as a societal function: bringing ideas into the market in the form of new products, new services and/or new firms (Foss & Klein 2008). This view, offers the possibility to use the entrepreneurship concept to describe and explain many more realities that are related to the transformative process of ideas and opportunities into sustainable projects or organizations.

The perspective of entrepreneurship as a transformative process involves different activities, it has been described to include two central activities: opportunity identification (also described as "discovery" in Shane (2004)) and opportunity exploitation (Shane & Venkataraman 2000; Shane 2004; Shane 2012).

Before entering into the possible different activities and sequences, it is relevant to acknowledge that there are different epistemological views on the entrepreneurship as a process. This epistemological diversity, enriches our understanding but also makes it more difficult to consolidate and aggregate the prior research findings.

A recent review on the different research contributions on entrepreneurship processes used in entrepreneurship literature found that there are at least four different epistemological perspectives or ways of understanding the nature of the process (Moroz & Hindle 2012). First, the stage model suggesting that the process is organized in different activities or phases, and that the entrepreneur goes through them in sequential order till it manages to create the new firm. Second, the static framework aiming to identify the different factors that influence on the new venture creation and establish direct causal linkages. Third, the process dynamics view that describes different activities and linkages paying attention to the contextual influences. Finally, the quantification sequences perspective that proposes to describe the process by studying the combination of actions and their order, aiming to establish linkages between sequences and observed outcomes.

The summary table of these different views and their limitations can be seen below (see Table 2), each of the different perspectives have advantages and disadvantages, and each of them has contributed to a better understanding of entrepreneurship as a process (Moroz & Hindle 2012).

Table 2. Taxonomy of Entrepreneurial Process Models (Moroz & Hindle, 2012)

(1) Stage Model: proposes to break-down the process in tasks or phases, a major weakness is that it narrows the scope into the process activities, generates a sequential order, and a perception that there is no overlap between activities.
(2) Static Framework: does not examine the sequence of activities, it uses a limited set of variables connected by speculative causal links; process oriented but does not capture sequence of dynamics.
(3) Process Dynamics: built with qualitative methods, examines how and why variations in context and process shape outcomes; very context rich, as well as interpretative, temporal, and change oriented.
(4) Quantification Sequences: historical sequence-based approach of new venture creation process; does not allow to understand the dynamics of how antecedent conditions shape the present and the emergent future within the process.

For this research work we take the entrepreneurship process perspective described by Shane (2004), it combines elements from the stage model with process dynamics aspects. It allows us

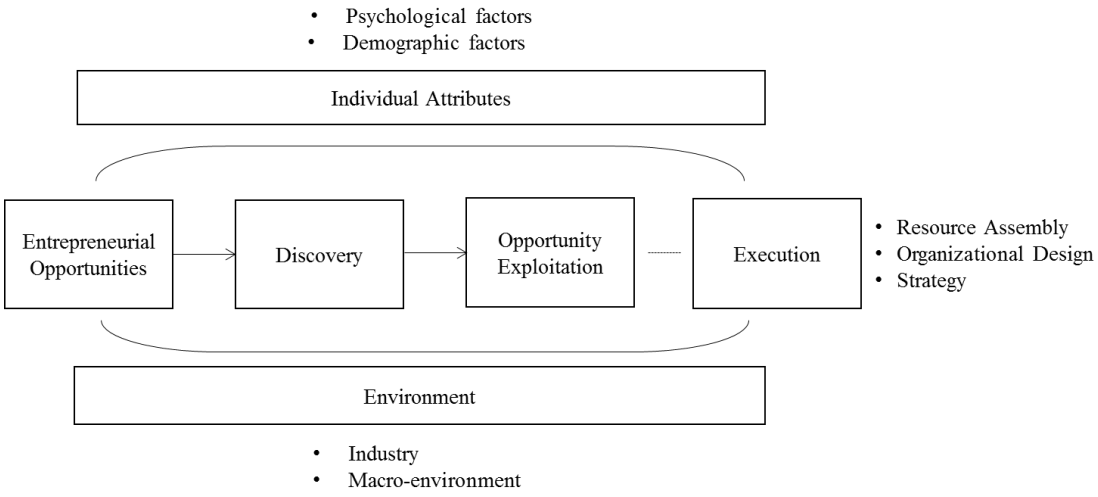
to build on a dominant perspective and include sources of additional variance such as the context or the individual attributes of the entrepreneur.

The graphical representation of this process perspective (see Figure 2) fits with the idea that there are entrepreneurial opportunities that are identified ("discovery" activity using Shane (2004) wording) by the entrepreneurs, who then move on the "opportunity exploitation", and the further development of the opportunity in the "execution" stage. This does not exclude though the possibility that some entrepreneurial opportunities are actually abandoned, or that some entrepreneurs do not manage to move to the opportunity exploitation. The activities that follow this central entrepreneurship development are: resource assembly, organization design and strategy; in this perspective these activities are increasingly adopted by the entrepreneur as it advances in the process.

An additional element of Shane's (2004) description is that it keeps, alongside the process activities, two other key elements: the entrepreneur's individual attributes (in particular the psychological and demographic factors) and the environment (including industry and macro-environment). These two elements are helpful to conceptualize the influence that the entrepreneur as actor has in the process, and how this process is situated in a determined context (environment) that also adds singularity to the process development.

This figure (see Figure 2) does provide a reference to explore the influence of technology in the entrepreneurship process, looking at the different activities, the linkages between them, and the interplay of opportunity, entrepreneur, and context.

Figure 2. Entrepreneurship process, adapted from Shane (2004)



This approximation also raises the first questions regarding the elusive nature of technology-based opportunities and on the role of the entrepreneur in transforming promising technological advances into products or services that are valuable for customers.

2.2.2. Entrepreneurs and opportunities

In an attempt to advance on the understanding of the nexus between the entrepreneur and the opportunity, scholars have been exploring how a given technology could generate different type of business opportunities depending on the individual's characteristics (Shane 2000). Building upon the resource-based view (RBV) theory (Barney 1991; Wernerfelt 1995) entrepreneurship scholars have explored how the resources of new entrepreneurial firms could help to understand the performance differences. For example, in Shane (2000) it was found that entrepreneurs prior knowledge could be seen as a valuable and unique resource that would explain why some individuals could identify specific entrepreneurial opportunities. The use of the RBV in the context of entrepreneurship helps to understand how existing unique and difficult to copy resources could help the entrepreneur to capture value (capture rents), but is seen to provide limited understanding on situation where first it is needed for value creation (rent generation) before being able to capture it (Alvarez & Barney 2010; Garcia 2016).

More recently, researchers have seen that in the particular case of technology-based opportunities this linkage is in general complex, suggesting that individual's knowledge, social context and cognitive frameworks might be needed to explain the differences in entrepreneurial performance (Gregoire & Shepherd 2012; De Carolis et al. 2009). Therefore, besides the academic interest on the identification of technology-based opportunities, arguably the exploitation of such opportunity (creating and capturing value) entails most of the challenges for the future entrepreneur, and holds the key for its venture survival (Shepherd et al. 2000; Gans & Stern 2003).

Despite our focus on the opportunity exploitation stage, in order to have a broader understanding of the entrepreneur and opportunity nexus we also need to cover the first activity of opportunity identification, described as "discovery" in Shane (Shane 2004) and in the Figure 2. The initial activity of opportunity identification has been subject to an intense debate in the last decades in entrepreneurship research (Shane 2012; Alvarez & Barney 2010; Alvarez & Barney 2007).

Table 3. Description of the assumptions behind the different theoretical perspective on the opportunity identification (Alvarez & Barney, 2007).

	Discovery Theory	Creation Theory
Nature of Opportunities	Opportunities exist, independent of entrepreneurs. Realist perspective.	Opportunities do not exist independent of entrepreneurs. Evolutionary realist perspective.
Nature of Entrepreneurs	Differ in some important ways from non-entrepreneurs, this happens ex ante.	May or may not differ from non-entrepreneurs. Differences may emerge, ex post.
Nature of Decision Making Context	Risky (Kirzner 1997)	Uncertain (Knight 1921)

In an attempt to consolidate the debate that sparked upon the initial conceptualization of the opportunity identification as a "discovery", assuming that entrepreneurial opportunities exist a priori waiting to be discovered by entrepreneurs (Shane & Venkataraman 2000; Shane 2004); Alvarez & Barney (2007) proposed that there could be two theories to explain the opportunity identification process: the discovery theory and the creation theory (Alvarez & Barney 2007), embracing two different perspectives on the nature of opportunities, entrepreneurs and their context (see Table 3).

The debate in the literature has caught the attention of scholars, in fact it has also encouraged a further revision of the conceptualization of the opportunity identification. In this line, Shane (2012) proposes that "creation" or "subjective" opportunities should be redefined as "business ideas". This would help to conceptually differentiate the externally determined "entrepreneurial opportunity" from the interpretation of the reality and resource combinations that the entrepreneur might propose, that should be redefined as "business idea" instead of "opportunity".

In the context of our research on technology entrepreneurship, discovery and creation theories could help to uncover valuable factors influencing the entrepreneurship process. As some scholars propose, they could be simultaneously used to provide a broader understanding of the opportunity identification and of the overall entrepreneurship process (Zahra 2008). For example, meanwhile the discovery theory takes opportunities with an objective nature (existing a priori), and focuses its attention on the ability of the entrepreneur to access the needed resources to exploit it. The creation theory puts emphasis on the ability of the entrepreneur to construct the opportunity from a subjective idea, regardless of the possible

discrepancy between entrepreneur's optimal and available resources to exploit the opportunity (Alvarez & Barney 2007).

Therefore, our interest does not lie in the epistemological discussion, but on the potential use we can do from this different views to study the opportunity identification and exploitation. We are interested in observing how entrepreneurs act upon opportunities, regardless of whether they require the discovery or creation lenses to explain its opportunity identification. In fact, we propose to adopt a broader and more relativistic understanding of opportunity as the "future situation which is deemed desirable and feasible" by the entrepreneur (Stevenson & Jarillo 1990, p.23).

2.2.3. Entrepreneurs' actions and venture emergence

From the discussion on the nature of opportunities and its relationships with the entrepreneur, scholars have proposed to develop theoretical insights on the concept of entrepreneurial action. As a first step, it has been argued that entrepreneur's actions and choices should be conditioned by the entrepreneur's perception of the context, and their entrepreneurial opportunity (Welter 2011; Alvarez & Barney 2007).

The entrepreneur's perception of risk or uncertainty (Knight 1921) would be related to different decision-making strategies, meanwhile the adoption of a-priori planning would fit well with situations where risk can be reduced through further information analysis (Shane & Delmar 2004; Liao & Gartner 2006); uncertainty perception, regarding the opportunity and the context, would actually open the number of options, for example introducing "improvisation" through combination of design and execution (Baker et al. 2003) and alternative mechanisms such as bricolage (McMullen & Shepherd 2006; Baker & Nelson 2005).

In a further effort to conceptualize the different paths or decision-making strategies, scholars have also observed how the individual's cognition might actually be related to such type of strategies or reactions (Baron & Ward 2004). As an attempt to relate all the elements in play, it has been proposed that individual's experience might be a factor influencing the decision-making strategy to cope with the entrepreneurial context, suggesting that experienced and novice entrepreneurs use different toolsets and have different decision frameworks (Dew et al. 2009). The identification of potentially different behaviors among entrepreneurs, as in different strategies and decision-making mechanisms inspired the idea of proposing that expert entrepreneurs could fit with an "effectuation" (Sarasvathy 2001) view of the reality and how to act upon it. Specifically, effectuation would describe those entrepreneurs that focus on

achieving their goals not by aiming to predict what resources are necessary to achieve them (this is described as a "causation" perspective (Sarasvathy 2001)) but actually acting upon the resources they have at hand to create the "effects" that they need in order to progress in their venture development. This theoretical developments point towards the need of further research to understand how the behavior of the entrepreneur could be an influence, regardless of their initial combination of resources.

Besides exploring the different combinations of actions that can be observed by studying the behavior of the entrepreneur, our interest is also on the outcome of the technology entrepreneurship process. As mentioned in the introduction of this section, if we take the inputs as the resources, the opportunity, and the entrepreneur; we then focus on studying the activities such as the opportunity identification and exploitation; at the end we also need to have an expected variable or measure to study the entrepreneurial outcome.

Consistent with this research approach of studying technology entrepreneurship steps from the initial steps to the potential full development, scholars have proposed to use an outcome construct that can reflect the different evolutionary stages of the new venture (Tornikoski & Newbert 2007). The conceptual idea that the outcome of the process is the emergence of an organization (the new venture) offers support for the adoption of this perspective, venture emergence would capture the progress of the entrepreneur in bringing to market its technology-based idea or opportunity (Dimov 2010).

Although there are other measures of performance in entrepreneurship research, for example the creation or not of an startup, the level of revenues or number of employees, among others (Davidsson & Gordon 2011); the use of venture emergence of an outcome construct for the technology entrepreneurship process offers a better fit with the expectation that this is a complex process and that might need to take into account changes across time (Clarysse, Wright, et al. 2011).

Therefore, using venture emergence as the construct to observe the outcome of the technology entrepreneurship process provides the needed reference for this initial theoretical framework.

2.3. Research questions, a theoretical framework on technology entrepreneurship

This revision of the literature offers a broad perspective on the theoretical background to study and describe the technology-based entrepreneurship, but also illustrates the open debates on entrepreneurship research that impact on our understanding of the phenomenon

under study. Meanwhile, the entrepreneurship theory based on the adoption of strategic management theories such as the resource-based view (Barney 1991; Wernerfelt 1995; Foss et al. 2008) have greatly contributed in our understanding of the phenomenon; the current debate on the nature of opportunities and its identification, the suggested absence of a relationship between the possession of resources, entrepreneur's actions, and entrepreneurial performance (Newbert et al. 2008), as well as the limited understanding of the particularities of high-growth technology-based start-ups (Hsu 2008; Brown 2013) open opportunities to expand and consolidate the theoretical framework.

Therefore, using as reference examples of the application of the resource-based view (RBV) in entrepreneurship (Coleman et al. 2013), we could propose to answer to a research question that would be aligned with a RBV on technology entrepreneurship such as:

- Do initial resources configurations influence on the technology entrepreneurship and its outcomes?

Unfortunately, we would be obtaining answers for a question that we actually do not fully understand, as we would be missing the linkages between the initial resources, the actions of the entrepreneur, and probably how the entrepreneurial opportunity was modified as it moved through the identification and exploitation processes. In order to avoid this potential problem, we first need to gain a better understanding of the specific elements that could determine technology entrepreneurship outcomes.

This need for a better understanding of technology entrepreneurship is also consistent with the initial introductory discussion on the need for a closer observation of the challenges derived from having to deal with both technology and market development (Hsu 2008), thus expecting to have to introduce further theoretical lenses to explain its development process (Brem & Borchardt 2014).

Therefore, we would propose to advance with a more exploratory approach of the phenomenon that allows for further theoretical development, using the following research questions:

- Are there specific factors that influence on the technology-based entrepreneurship process?
- How do the entrepreneurs' actions influence on the technology entrepreneurship process?

In the next section, we explore those factors and their possible influence on the entrepreneurship process and its outcomes. To do so, we require a research design that benefits from a complementary use of exploratory inductive research methods (answering to "how" and "why" questions), together with hypothetic-deductive research methods (to assess the influence of new possible factors in the entrepreneurship process).

3. General research design: a mixed method approach

In order to address our research questions ambitions we need a research design that can help to answer the "why" and "how" technology entrepreneurship process unfolds. But, we also aim to be able to gather evidences on whether those potential influences or singular factors "do" impact on the new venture behavior and performance. Therefore our research questions require for a more complete research design that has an explorative, interpretative, part; but also a confirmatory, evidence-rich, part.

3.1. Epistemological options

The entrepreneurship research is rich in epistemological discussion on the nature of the phenomenon under study; from the critical realism perspective to explain how opportunities are discovered, to the use of evolutionary realism to argue that opportunities are a result of a creation process (Alvarez & Barney 2010). These different epistemologies on the nature of opportunities are an insight on the importance of acknowledging the theoretical perspective and assumptions we make when we do research in entrepreneurship.

There are examples of the different approaches in recent contributions in technology entrepreneurship, for instance Zhou (2013) adopted the interpretative perspective to complete an inductive field work to propose how opportunities are created in technology entrepreneurship. A recent example of a positivist research method, could be the study by Gruber et al. (2010) describing how human capital endowments would influence the opportunities identified in technology startups. Meanwhile in the first study we would have as a result a new sequence of activities and the identification of unexpected influencing factors, in the second we could learn on the influence of the different factors on the number of market opportunities that the entrepreneur could identify.

In line with the nature of our research questions, we have the challenge to combine both elements, first gather information and insights on the technology entrepreneurship process and then aim to assess the strength and validity of these potential causal relationships. In practical terms, this involves to complete an inductive qualitative field-work and then a quantitative study with a larger sample to be able to garner additional empirical evidence on the qualitative insights, and if possible, support the proposed theoretical developments.

3.2. A mixed method research design

The two-step research structure to provide answers to the proposed research question is described as mixed-method (Cameron 2011), it has also been described as an alternative to the exclusive use of qualitative or quantitative research methods. The use of the combination of methods could be done concurrently (validating the findings as they appear) or sequentially.

In line with the structure of the research question and current state of the art, we propose to follow a sequential approach where we first complete a qualitative inductive study (QUAL), and then we use a quantitative deductive study (QUAN) to within the research limitations, validate the theory insights. At this point it is relevant to take into account that using mixed-methods opens multiple possibilities to the researcher, Molina-Azorin (2010) propose to use a 2 by 2 matrix to acknowledge the type of mixed-method being used (see Figure 3).

Figure 3. Different approaches of mixed method designs (adapted from Molina & Azorin 2010)

PRIORITY	IMPLEMENTATION: Simultaneous	IMPLEMENTATION: Sequential
Equal	QUAL + QUAN	**QUAL → QUAN** QUAN → QUAL
Different	QUAL + quan qual + QUAN	qual → QUAN QUAL → quan quan → QUAL QUAN → qual

The two dimensions of the matrix are priority and implementation; priority describes whether the different research methods are given equal or different weight in the overall research design, implementation describes whether the methods are used simultaneously (as repetitive iterative enriching process) or in sequential order. In this research design we give equal weight to the two methods (priority) and follow a sequential implementation (QUAL-> QUAN). Thus in the matrix table we would place the research design in the upper-right box (see Figure 3).

Although the terms of mixed methods and multi-method research have often been used to refer to similar research structures, there are some relevant differences in the two terms. In other words, a researcher could be using multiple methods of research without having to commit to a mixed method research approach (Venkatesh et al. 2013); for example, a multiple-method research could have used two different quantitative methods (an experiment and a survey) to test the causality between two constructs without any mixed methods approach ambitions. As a result, the adoption of a mixed method perspective requires to combine (sequentially or concurrently) qualitative and quantitative "worldviews" in order to generate a multidimensional understanding of the phenomenon under study (Venkatesh et al. 2013).

The purpose of adopting mixed method in this research is to benefit from the "developmental" powers of this approximation. As described by Venkatesh et al. (2013), there are up to seven different purposes that justify the adoption of mixed-methods (see table 4). The "developmental" purpose is described as: "questions for one strand emerge from the inferences of a previous one, or one strand provides hypotheses to be tested in the next one" (Venkatesh et al. 2013, p.6); for example, completing a qualitative study to identify constructs and propositions, and then a quantitative study to test the hypotheses (QUAL -> QUANT).

Table 4. Description of types of mixed methods depending on their purpose (Venkatesh et al. 2013)

Purposes	Description
Complementarity	Mixed methods are used in order to gain complementary views about the same phenomena or relationships.
Completeness	Mixed methods designs are used to make sure a complete picture of a phenomenon is obtained.
Developmental	Questions for one strand emerge from the inferences of a previous one (sequential mixed methods), or one strand provides hypotheses to be tested in the next one.
Expansion	Mixed methods are used in order to explain or expand upon the understanding obtained in a previous strand of study.
Corroboration/Confirmation	Mixed methods are used in order to assess the credibility of inferences obtained from one approach (strand).
Compensation	Mixed methods enabled to compensate for the weaknesses of one approach by using the other.
Diversity	Mixed methods are used with the hope of obtaining divergent views of the same phenomenon.

The use of a mixed-method requires to complete the qualitative and quantitative with the usual rigor in the application of the methods and in the interpretation of the data, but it also

introduces specific additional requirements (Molina-Azorin 2010). The main additional requirement is the need to introduce “meta-inferences”, described as stories or theoretical statements on the research questions. Meta-inferences should fully integrate the findings from the qualitative and quantitative parts of the research (Venkatesh et al. 2013).

In the case of the "developmental" and sequential approach we follow, the meta-inferences approach is to establish linkages between the qualitative and quantitative findings; also described as "bridging" (Venkatesh et al. 2013). This “bridging” approach provides: (1) a further consensus to the qualitative findings, (2) helps to understand the boundary conditions related to the research models and the context. Among other aspects, to ensure the validity of the meta-inferences, it is recommended to keep them aligned with the original research questions and establish what aspects could be transferable to other settings. As a result, when developing the meta-inferences, we keep a close attention to our research questions: first, exploring how and why technology impacts on the nature of opportunities, and second, whether there is an influence on the entrepreneurship process, looking for factors that could influence on the technology-based entrepreneurship process.

Following the mixed method guidelines (Venkatesh et al. 2013), we provide with specific details on the research design for each of the methods being used. This means that we separate each of the different parts of the research work, thus before entering in the qualitative or quantitative work description, there is a dedicated section to describe the options and to justify the selection of the proposed research method to advance in our research questions.

As per the overall structure of the mixed method design, we start first with the description of the research design for the exploratory approach of the qualitative section, and then, after the qualitative results are described, we present the second research design section for the confirmatory approach that uses a quantitative method to assess the set of hypotheses we propose.

4. Exploratory approach research design: understanding Technology Entrepreneurship

Consistent with our exploratory objective, we draw upon an inductive field-study design (Yin 2003). The interpretative nature of the method fits well with the intention to capture entrepreneur's perception of the process, from the first insight on the potential business idea, to the opportunity exploitation or abandonment. Thus, at this point we are more interested in questions that relate to the "how" and "why" of the entrepreneur's behavior. This initial research effort also aims to capture contextual elements related to the specific environment where technology-based entrepreneurs are acting. The contextualization efforts are seen as a potential avenue for further theoretical development in entrepreneurship research (Zahra 2007).

We enter the field without a preconceived theory or idea to test, open to gather data and build ideas through an interpretative inductive process. This does not exclude the use of key references to guide our research question exploration. In this sense, we use the conceptualization of entrepreneurship as a process (Shane 2004) to guide and structure our research (see Figure 2).

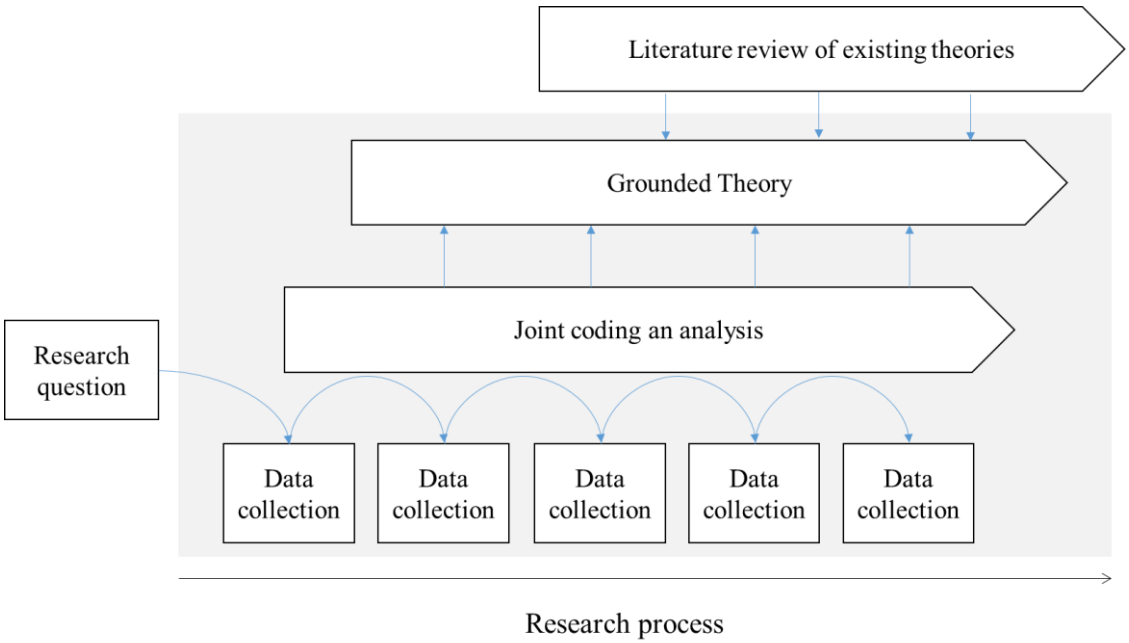
The description of the entrepreneurship process offers a high level perspective on the key actors in the process: the individual (the entrepreneur), the opportunity, and the environment or context (in our setting high-tech industries). The exploration of the interplay of these different elements, from a process perspective – starting in the identification of the opportunity until its exploitation – guides the development of our field work. Following this orientation, the aim is to study different cases of the entrepreneurship process that generate insights to understand the interplay between the individual's attributes, the technological opportunity, and the development of new venture.

4.1. Description of method and data

The exploratory approach is implemented with an approximation that follows the grounded theory method guidelines (Glaser & Strauss 1967; Glaser 2002). Thus, we enter into the field without the intention to validate a set of hypotheses, but to gain a better understanding on a phenomenon that the current literature is not fully grasping (Brem & Borchardt 2014; Brown 2013).

In line with the research method selected, we keep regular reviews on the data collected and contrast it with literature on entrepreneurship, aiming to establish what elements can be explained and which ones are new (Wagner et al. 2010). The regular revision cycles of further data gathering and emerging concepts (see Figure 4) or themes bring us to a saturation point after interviewing 21 new venture's entrepreneurs (see Table 5).

Figure 4. Conceptual representation of the process of generating grounded theory (adapted from Wagner et al. 2010)



The theoretical sampling selection we followed aimed to capture expected potential sources of variance on the technology-based entrepreneurship phenomenon (see the entrepreneur's cases sample Table 5). Based on existing research in the field, we pay specific attention to gather information from individuals with different type of prior entrepreneurship experience (if any), as this was suggested to be an influencing factor on their future behavior (Politis 2008; Hsu 2007; Miralles et al. 2015); another expected source of variability is specific industry context, thus we are interested in including different industries in the technology entrepreneurship setting (Welter 2011).

Additionally, taking into account our interest in exploring the complexities of the entrepreneurship process when dealing with technology-based opportunities we strive to have a high representation of firms that intended to commercialize technological products, avoiding to solely rely on consulting or other services organizations that are expected to face challenges more similar to any other type of service company (Gans & Stern 2003).

Table 5. Description of the new technology-based firm's sample

Nascent venture name	*Industry*	*Entrepreneur Profile*
P01 - Electonix	Electronics	Novice
P02 - Usability	Internet	Novice
P03 - HHRR Software	Software	Novice
P04 - Medical Coding	IT services	Novice
P05 - Innovation Services 1	IT services	Experienced
P06 - Venturing	IT services	Novice
P07- eRecovery	eHealth	Novice
P08 - TDTBox	Digital TV	Experienced
P09 - WaterPower	Renewable Energy	Novice
P10 - ChinaTravel	eTravel	Novice
P11 - Laserpower	Optic devices	Novice
P12 - Contengia	IT services	Novice
P13 - Security Systems	IT services	Novice
P14 - Creativity	IT services	Novice
P15 - UbiquousWifi	Telecom devices	Novice
P16 - Outsourcing	IT services	Novice
P17 - Innovation Services 2	IT services	Novice
P18 - ElectroComputer	Electronics	Experienced
P19 - Data Secure	Software	Novice
P20 - Ebusiness	IT services	Experienced
P21 - DigitalDevices	IT services	Novice

4.1.1. Sample Description

The resulting sample used for this research work (see Table 5), captures information from entrepreneurs that have different levels of entrepreneurial experience (novice or experienced). The sample also offers information from new technology-based firms that operate in different industrial sectors, including electronics, software, and IT services among others. The type of entrepreneurial opportunities in the sample are also diverse, some of them are built upon disruptive or radical scientific advances and technological innovations, while others are built upon less significant improvements. Nevertheless, common to all of them are the prevalence of new technological products commercialization challenges (see sample description Table 5).

The entrepreneurs interviewed are based in Spain, in particular in the area of Barcelona, most of them have connections with La Salle Technova (the innovation park at La Salle Campus Barcelona), either because they used their startup support services (advice on funding, public grants, IP management) or have been incubated in the innovation park (some of them were still in the incubation park). Other firms like: ChinaTravel, HHRR Software, Venturing,

Creativity, Outsourcing, ElectroComputer, DigitalDevices had not connections with La Salle Technova, but were reached through personal contacts and selected with the intention to capture the different sources of heterogeneity that we wanted to capture in our theoretical sampling.

For the initial field-work study the whole sample of cases was used, the subsequent more detailed studies were done using the technology entrepreneurship cases that could help to better understand the research objectives of each of the exploratory work studies (Eisenhardt 1989).

4.1.2. Data Collection

The data collection process begins with an interview (with length varying from 45 to 80 minutes) with the entrepreneur (see profiles in Table 5), and is complemented with secondary information on each venture (publicly available information such as investor's presentations and venture press releases). The interview followed a semi-structured outline, covering the entrepreneur's perspective on the conceptualization of the business idea, the development of the opportunity, the first clients, and the current development status (see structure of the interview in the appendix I). All interviews were recorded, transcribed, and coded with the intention to identify significant activities and factors that would influence the technology-based entrepreneurship development. The codes were checked and validated with the help of another researcher in the field of entrepreneurship, with the objective to avoid potential misinterpretations or coding biases. In the appendix II there is an example of the coding strategy, key points, concepts and emergent categories.

The coding process followed a different approach as the research project advanced. We started following an open coding approach (Corbin & Strauss 1990) as our aim was to be able to enter with a fresh perspective, not limited by predefined categories, thus we started coding for key sentences that would be related on how the process of technology entrepreneurship unfolded, from the initial idea to the first customers (if any).

The first cases were used to start mapping out codes and emerging concepts, this initial coding efforts were used as a reference for the following coding. As we advanced through the cases, a more selective coding approach was used, looking for anomalies and new insights that could require to use new codes or emerging concepts (Corbin & Strauss 1990).

5. Results from the exploratory work on the Technology Entrepreneurship

We begin the presentation of the exploratory work results following the guidelines set by the research questions on whether there are specific factors influencing on the outcomes of the technology entrepreneurship process, and how the entrepreneurs actions and the technological nature of opportunities could influence on the entrepreneurship process.

We follow the structure of the field-study questions to present the results. First, we cover the peculiarities of the technology entrepreneurship process. Then, we move into the different elements that play a role in the process, covering the construction of the opportunity, the role of the entrepreneur, and its interactions with the context. The exploratory work results were also presented as four articles, see Table 6 for the correspondence between the research questions, position in the results presentation, and related article.

Table 6. Overall structure of the field-study results

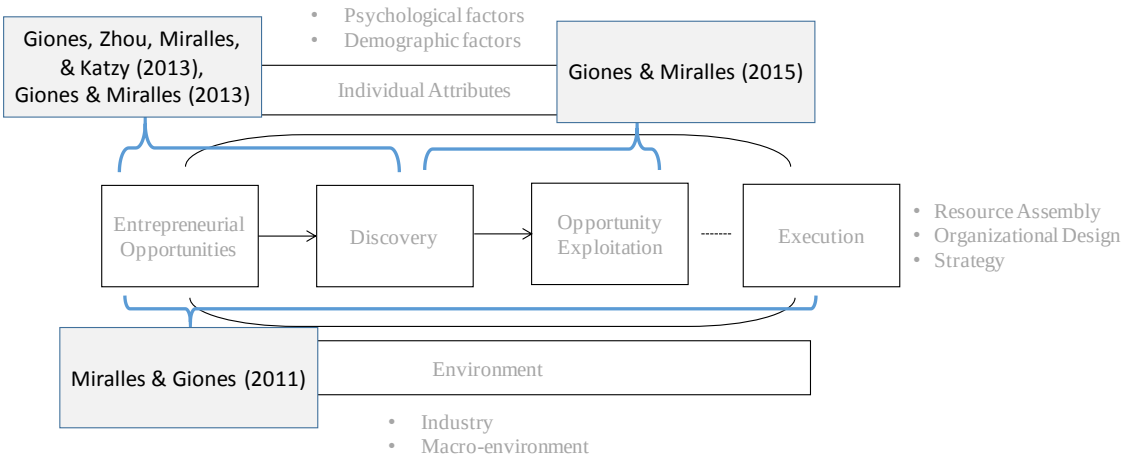
Area of study	Field-study guiding question	Results section title / article	Reference
The technology entrepreneurship process	How entrepreneurs act upon their initial technology-based business idea?	5.1. Exploring Entrepreneurial Action Theories in Technology-based Nascent Ventures	(Miralles & Giones 2011)
The construction of the opportunity	How does the entrepreneur - opportunity nexus work in Tech-based entrepreneurship.	5.2. From Ideas to Opportunities: Exploring the Construction of Technology-based Entrepreneurial Opportunities	(Giones et al. 2013)
Entrepreneur as an individual, cognitive perspective	How and why do entrepreneurs act on their tech-based opportunity?	5.3. Do great technological ideas make great business opportunities? Entrepreneur's self-regulatory focus in opportunity building	(Giones & Miralles 2013)
Interaction of the entrepreneur with the context.	What factors influence on the tech entrepreneurship process? How do they influence?	5.4. Do Actions Matter More than Resources? A Signaling Theory Perspective on the Technology Entrepreneurship Process	(Giones & Miralles 2015)

Using as references the entrepreneurship process figure from Shane (2004), we can also describe how the different research questions and research results touch different aspects of the overall process description (see Figure 5). Meanwhile the first article describes the results of the study on technology influence on the technology entrepreneurship process (Miralles & Giones 2011), the other articles with results from the exploratory field work touch either the first stages of the process: “Entrepreneurial Opportunities”, “Discovery”, and “Individual Attributes” in the technology context (Giones et al. 2013; Giones & Miralles 2013); or cover the development steps from opportunity discovery to “Opportunity Exploitation” in technology entrepreneurship (Giones & Miralles 2015). The conceptual mapping of the different

exploratory work results on the entrepreneurship process (Shane 2004) can be seen in Figure 5.

In the published version of the articles there is additional detail, including more in-depth information and quotations from the entrepreneurs, as well as a further developed description of the theoretical background, method, and results of each of the field studies performed.

Figure 5. Conceptual mapping of the field-work



5.1. Exploring Entrepreneurial Action Theories in Technology-based Nascent Ventures

The initial exploratory work gathers data from the technology-based entrepreneurs to advance in the research question on how the technological component influences the entrepreneurship process. Using as reference the entrepreneurship process framework (Shane 2004), this first analysis collect stories and perceptions from the initial entrepreneurial opportunity identification till its exploitation. The coding process of the data gathered lead to the identification of four elements that were perceived to have an impact on the technology entrepreneurship process:

- **Entrepreneurial experience and the decision-making processes**. The identification of different decision-making mechanisms, including formal planning, bricolage-like, and improvisational mechanisms, in line with prior research in this area (Baker et al. 2003). To illustrate this diversity of decision-making mechanisms Electonix's entrepreneur said: "*with the available resources you realize that the best way to do money is another one, if you are in a position to do it, you do it*". Additionally, the use of these mechanisms was not linked with a specific profile or entrepreneurial experience (Baron & Ensley 2006), but it influenced the perceived ability to identify the

opportunity, as the entrepreneur leading DataSecure said: "*If I hadn't had experience in this industry, I wouldn't have (created) this company*".

- **The technological nature of the opportunity.** The technological and innovative nature of the opportunity introduces further uncertainty (almost remnant) and difficulties to define the value proposition to create revenues (Teece 2010). As described by LaserPower's entrepreneur: "*you are reaching the end of a phase, so that particular uncertainty disappears, but new ones come in...When you are reaching the horizon, there is a new horizon further ahead*". This generates frustrations when struggling to meet deadlines for development, as Electonix's entrepreneur described: "*our product is highly technological, it needs a lot of time to actually become a marketable product*".
- **The technological context dynamism influences on the actions and decisions.** There is an apparent paradox between the planning mechanisms that are perceived as institutionalized (p.e. complete business plan to have access to external funding (Karlsson & Honig 2009)) and the internal management mechanisms that require agile decision-making, in the words of Creativity's entrepreneur: "*It is very difficult to put some things in the business plan, for example if the business depends on this or not...the inputs you receive shape a new path too frequently*". This created the perception in some entrepreneurs that the utility of business planning is unrelated to the actual "business plan" document that they are "forced" to produce in the initial stages of their entrepreneurial opportunity development, as described by the Medical Coding entrepreneur: "*We did the business plan to get the validation from the (incubator) personnel, so that we could get the office space*".
- **The technological component and the access to firm funding.** Although technology resources are perceived by investors as valuable assets (Hsu & Ziedonis 2013), it is difficult to explain the expected value of those resources, in the word of Electonix's entrepreneur: "*it is very difficult to talk in technical terms to investors*". Those resources are seen by entrepreneurs as of little value, unless a clear application is found for the technological resource, as mentioned by Ubiquous Wifi's founder "*we have overcome this stage and now it is the client who will buy the technology*". Suggesting that some of the value of these resources is more symbolic than factual, and it actually does not directly help to find a value proposition that fits with the market needs, as described by ElectroComputer's entrepreneur: "*we still haven't found it yet, different customers see it in different ways, so we want to spend time in that*".

This initial analysis work, which had the broad ambition to identify how entrepreneurs cope with the technology related challenges in the entrepreneurship process, helped to identify the areas where we could gain further understanding with more in depth analysis and secondary data that would complement the initial field-work data.

The exploratory field-work continued with the objective to gain a more in-depth understanding on the remaining questions on how are technological ideas transformed into opportunities, including the role of the entrepreneur, and its interactions with the context.

The following three sections cover more specific parts of the entrepreneurship process (see Figure 5) and aim to advance in the open questions on technology entrepreneurship.

5.2. From Ideas to Opportunities: Exploring the Construction of Technology-based Entrepreneurial Opportunities

In order to understand how entrepreneurs would transform their initial technology-based ideas into viable businesses, and how the context would influence in this process; we further analyze this iterative development process.

The data collected provided insights on the differences between the initial idea of the entrepreneur and the opportunity that was finally identified, suggesting that besides their technological idea or invention, part of the process of discovering or creating their opportunity was conditioned by their interactions with the context, creating a sometimes long transformative process (Clarysse, Wright, et al. 2011). As a result, we needed a theoretical perspective that would allow us to describe these dynamic elements in the entrepreneurship process (see Table 2). The constructivist view (Wood & McKinley 2010) provided the theoretical lenses to describe these evolutionary and transformative changes in the entrepreneurship process of the technology-based entrepreneurs in the sample.

The constructivist view in entrepreneurship (Bouchikhi 1993) draws from the evolutionary theory and proposes to observe the motivations and effects of social interactions to explain the causes of the changes that occur in a process such as the opportunity development (Wood & McKinley 2010). Thus, it proposes to observe the actions taken by actors in the process to identify potential clues of the evolution of the process, therefore it could complement the resource-based view perspective where factors are expected to have a direct effect on firm performance and behavior (Barney 1991).

We also build upon the insight from early exploratory work on the additional complexity that the technology-based entrepreneur has to find an application for its technological product (Teece 2010); combined with the assumption that there is an expected positive influence of socialization through market and stakeholders interactions in the process of giving objectivity or realism to the opportunity (McMullen & Shepherd 2006).

For this analysis three of the cases of the exploratory qualitative work were selected (Ubiquous Wifi, Electonix, TDTBox) as they would offer insights on how high potential technological ideas were transformed into business opportunities.

Table 7. Description of the entrepreneurs and ventures

Venture Name	Entrepreneur Profile	Technology	Initial Idea	Objectified Opportunity
Ubiquous Wifi	Novice entrepreneur: academic/technology background	Communication protocol	Communication protocol for emergency data exchange	Proximity communications solution to engage retail customers
Electonix	Novice entrepreneur: academic/technology background	Design for integrated circuits	Low power asynchronous chip design	New chip design for mobile devices (design method training and full solutions)
TDTBox	Experienced entrepreneur: technology and market background	Digital television broadcast coding	Digital television changes needs in the broadcaster-user systems	Technological platform to support broadcasters and viewers needs for tailored content on demand

The results of this study provided clues on the different activities that would be part of the construction of the opportunity, thus in line with the constructivist view of the entrepreneurship process we could describe the actions of the entrepreneur and the contextual influences (Giones et al. 2013). The results and main findings of the analysis are:

- **The ideation process in technology entrepreneurship relies on idea iteration with knowledgeable peers.** These iterations are done mostly using existing direct personal ties, for example as Electonix's entrepreneur mentioned: "*talking with an entrepreneur in integrated circuits design that I knew from prior joint-research projects*". Only in the case of experienced entrepreneurs a selection strategy of information exchange partners was observed, for example as TDTBox's entrepreneur relied on using prior contacts: "*It was my previous business partner that insisted on exploring together the*

changes that Internet and digital TV would produce in the industry". This is in line with the work of Wood & McKinley (2010) that suggested that peers influence in the initial stages of opportunity social validation is greater when the entrepreneurs trusts and assesses their feedback and observation as coming from a knowledgeable and experienced peer.

- **The construction of the opportunity objectification was done through consensus building**. In particular, two sub-processes were observed, technology assessment and market sensemaking (Weick et al. 2005). This suggests that the technological nature of the opportunity requires the introduction of an additional activity in the process of entrepreneurship. Suggesting that there is a necessity to gain internal and external assessment on the potential and functionality of the technology, for example as described by Ubiquous Wifi's entrepreneur: "*we started to look for people with reputation in the field as advisors*". This exacerbates the importance of building consensus in the social network of partners, potential customers, institutions, and context in general (Wood & McKinley 2010); otherwise the technology-related uncertainty hinders the technology entrepreneurship process.
- **The process of opportunity conceptualization is context dependent**. Entrepreneurs that had chosen to relocate their ventures had to reengage in consensus-building activities with their new network and stakeholders. As suggested by Welter (2011) the influence of context in entrepreneurship, in particular in the early opportunity development activities, is rather relevant, for example Electonix's entrepreneur described: "*here (Spain) we are more conservative, we study it more, it is a much longer process*". Surprisingly, the fact that some of the entrepreneurs perceived that their process of opportunity enactment (Wood & McKinley 2010) was co-created with their social context, provides evidences on the lengthy process of building the opportunity in technology entrepreneurship, something that contrasts with other types of opportunities that could be more easily described objectively, and that do not require the participation of multiple agents in their construction.

The observation of the relevant role of the entrepreneur's individual attributes (see Figure 5) as a potential source of heterogeneity in how the technology process unfolds, guided the following step in the exploratory field work.

5.3. Do great technological ideas make great business opportunities? Entrepreneur's self-regulatory focus in opportunity building

As described in the general framework of the exploratory field-work, one of the research questions that we aimed to advance upon is how the individual entrepreneur's decisions would influence in the technology entrepreneurship process. The description of the technology entrepreneurship context as highly uncertain has been suggested as a reason to propose that technology opportunities could be explained from a creation perspective (Zhou 2013; Alvarez & Barney 2007). Thus it is suggested that we need to further study how technology-based entrepreneurs would deal with uncertainty, institutional pressures (Karlsson & Honig 2009), and still manage to advance towards the opportunity exploitation. Scholars suggest that entrepreneurs might rely more on market interactions to further advance in their opportunity conceptualization, than in their internal resource base. In this settings, we could understand the suggested positive influence of networking or other exploration activities (Tornikoski 2007; Wood & McKinley 2010) on the new venture performance.

In order to explore whether the entrepreneurs uncertainty perceptions and their actions upon the technological opportunity would uncover missing insights, we introduce the self-regulatory theory in entrepreneurship (Hmieleski & Baron 2008) lenses. This perspective should help to explain why resources alone do not explain the performance of the entrepreneur, pointing towards a needed fit between the decision making of the entrepreneur and the dynamism of its context.

The self-regulatory theory (Kuhl 1992) is developed from research in the cognitive processes of individuals. It proposes that individuals have different self-regulation mechanisms, meaning that when presented with an new opportunity, some individuals would tend to focus on minimizing losses or avoid setbacks, maintaining their initial plan (prevention focus); meanwhile, other individuals would be motivated by the possibility of achieving something new or for the potential growth derived from that opportunity (promotion focus). Prior entrepreneurship research has used self-regulatory theory to explain how entrepreneurs self-regulatory focus (prevention or promotion) would influence the successful development of their entrepreneurial opportunity in stable or dynamic markets (Hmieleski & Baron 2008; Baron 2007).

In order to advance in the specific research questions of this study, we selected three cases that provided information of the perceptions of the entrepreneur, its decisions and the pressures from the environment. We selected three cases that shared a common context,

expecting that this would help to control for potential differences introduced by institutions or other context elements. All the three cases had also similar radical technologies that required a development time until reaching market maturity, offering a lengthy development time that could be subject to multiple opportunity choices by the entrepreneur on how to further develop the technology and the technological opportunity.

The three cases were: TDTBox, Ubiquos Wifi, and Security Systems. The data analysis was focused on the development of the opportunity and the decisions made by entrepreneur (self-reported), an additional process of coding was followed in order to establish with acceptable certainty the type of self-regulatory focus that could be dominant in each of the different phases of the development of the opportunity, discriminating between promotion and prevention focus (Hmieleski & Baron 2008).

Table 8. Description of the idea-to-opportunity transformation and the changes in the entrepreneur's self-regulatory focus

Description of the idea to opportunity evolution	**TDTBox**	**Ubiquous Wifi**	**Security Systems**
Technology idea situation	Technological idea emerged from prior industrial research developments	Potential application of a scientific research outcome to the industrial context	Existent technology transferred to another context
Initial transformation process	*Promotion focus* Oriented exploration – no major changes of search path	*Promotion focus* Pivoting around the central technological idea	*Promotion focus* Different paths explored in parallel to find the business opportunities
Business opportunity development	*Prevention focus* – dealing with investors pressure and consolidation of the market opportunity	*Promotion focus* is moderated – in search of additional opportunities	*Promotion focus* is moderated – selected new technologies and new opportunities
Degree of change in the industry/market	Stayed in the initial market of the technological idea	Moved sequentially exploring different markets	Explored different markets in parallel

The coding and concept analysis process allowed to observe the entrepreneurs in the sample, instead of having a single, consistent, self-regulatory focus, they actually were observed to be able to adjust it depending on the setting and the development stage of the entrepreneurial project (Giones & Miralles 2013). In more detail, the results and findings of the study were:

- **Promotion focus dominates in the initial stages.** In the early stages of the opportunity development, when the entrepreneur is in search for an application for the

technology-based product or service, the self-regulatory promotion focus (Hmieleski & Baron 2008) provides a framework to describe the perceptions and actions of the technology entrepreneur, in the words of Ubiquous Wifi's entrepreneur: "*I started looking for potential applications for the communication system I was developing*". It is observed that it is rather common to introduce changes in the development direction, for example as TDTBox's entrepreneur mentioned: "*the product has suffered multiple variations and adaptations*". This could involve changes in the target market and/or the key features of the product, mostly depending on the interactions and comments received through the interactions with potential customers, and other stakeholders.

- **Prevention focus is adopted with incremental institutional pressure.** As the technology-based entrepreneur gets closer to the market, and requires for further support from stakeholders or investors (be it endorsements or access to additional resources), a change in the dominant self-regulatory focus is observed, as explained by TDTBox's entrepreneur "*as you advance, you look more carefully at potential opportunities*". In most of the cases, the perception that there was an external pressure or norm on how to act and behave - as it would happen when being requested to follow the initial business plan (Honig 2004) - would make the entrepreneur adopt, at least when communicating with external partners and stakeholders, a behavior that would fit with a self-regulatory prevention focus, as suggested by TDTBox's entrepreneur: " *before I would make opportunistic decisions, now I take my time to (first) assess the financial return*". Displaying publicly its intentions to be committed and follow the plan to exploit the opportunity.
- **Entrepreneurs could adjust their self-regulatory focus.** The results suggest that there could be an ability to adjust, or shift the individual self-regulatory focus, similar to a morphing reaction to fit with the institutional logic pressures towards the exploitation of a clearly defined opportunity (Karlsson & Honig 2009), and this happens as the entrepreneur becomes aware of how this change could impact on the venture survival options, as described by Security Systems' entrepreneur "*for the venture to survive we needed to achieve clear goals*".

At this point, evidences had been gathered on how the technology component would influence the opportunity identification and first steps of the new venture. Nevertheless, we still could not come out with a clear answer to the question on why unique technological resources (for example patents) are considered valuable by entrepreneurs and stakeholders, if there is a limited direct causal influence of the entrepreneur's actions and outcomes. Thus we

developed an additional analysis aiming to explore the research question on whether some of the resources could actually be influencing factors in the performance of the new venture, and what type of influence they had, assuming that it might not be a direct influence as we would hypothesize with the resource-based view (Barney 1991).

5.4. Do Actions Matter More than Resources? A Signaling Theory Perspective on the Technology Entrepreneurship Process

The last area of the qualitative exploratory work targets the transition from the identification of the opportunity to the exploitation of it. Meanwhile the previous qualitative studies had focused the analysis on the interplay between the entrepreneurs, the context and the opportunity development (see Figure 5). In this last research work, we advance towards understanding the influence of the technological component as the entrepreneurs aims to complete the transition towards opportunity exploitation (Shane 2004; Hsu 2008).

For this analysis we recoded the data gathered in three of the cases studied (TDTBox, Electonix, and Security Systems), they were selected with the intention to capture different types of product, technologies and resources combinations (see Table 9). The aim of this research work was to shed some light on the value of resources in technology entrepreneurship (Hsu & Ziedonis 2013), expecting to clarify whether there was a perceived direct impact on performance, or whether resources had additional functions such as providing symbolic value to entrepreneurs or stakeholders.

Table 9. Description of the new technology-based ventures in the study

	Descriptive Variables		
Venture Name	**Product**	**Technology**	**Key Resources**
TDTBox	Value-added services to digital television broadcasters	Software to broadcast digital television and middleware for set-top boxes	A strong network including technology and institutional partners
Electonix	Low-consumption circuits	Designs for elastic clocks in integrated circuits	A leading international research group on electronics
Security Systems	Software to prevent data leakage	SaaS solutions for data analysis using new proprietary algorithms	Prior knowledge of market and technology and a strong software development team

In order to capture and understand the potential alternative uses of the resources as symbolic elements we turned to signaling theory (Spence 1973). The signaling theory was introduced to explain how job applicants would decide to openly disclose specific details about themselves, expecting that those would be interpreted as signals of their "quality" by recruiters. Although it emerged in the human resource literature, it has been widely adopted by other researchers in management (Connelly et al. 2010) as theoretical framework to describe how in situations where there are information asymmetries between the different sides involved in a transaction, there are incentives for the "good quality" actors to engage in activities that could generate signals to the other side (receivers), on the otherwise not observable quality (in a broad sense) of their products, firm or management capabilities.

The application of signaling theory in different management fields has generated relevant insights for marketing (Kirmani & Rao 2000) and finance (Reuer et al. 2012), among other fields. More recently it has also started to be used in entrepreneurship, but mostly adopting the application of signaling theory done in the finance research stream (Busenitz et al. 2005; Hopp & Lukas 2014).

Table 10. Actions as signals in the new technology-based firms in the study

Venture	Signals and Related Actions in the Technology Entrepreneurship Process	
	Opportunity Exploration	Opportunity Exploitation
TDTBox	*Social Capital signals*: networking *Technology signals*: patenting	*Market signals*: brand building actions *Social Capital signals*: pilot experiments with endorsers
Electonix	*Technology signals*: Patenting and R&D development actions	*Social capital signals*: Endorsements from investors (VC) *Technology signals*: visibility to R&D progress actions
Security Systems	*Market signals*: brand building actions *Technology signals*: visible updating of technology resources	*Market signals*: beta customer actions Social capital signals: networking

The results of the study (see Table 10) provided support for the assumption that there was an information asymmetry in the market of the technology-based entrepreneurs, and offered evidences of how different types of resources were used so that they could be perceived as signals by other interested parties (potential customers, investors or other stakeholders). The main results and findings on technology entrepreneurship influencing factors beyond resources were:

- **Entrepreneur's market interactions reduce information asymmetry.** The opportunity exploitation requires market interaction (Hsu 2008), and this situation displays the existence of an information asymmetry between the entrepreneur's perspective and the perspective of the first potential buyers (Godley 2013). As Electonix's entrepreneur described: "*you are nobody, you don't have a brand, (therefore) we cannot work with you*". From an information economics perspective (Stiglitz 1985), the limited available information on the technology under development, the still underdeveloped reputation of the new firm, and the limited experience in interacting with customers, generates additional uncertainty to these potential customers that could be interested in the entrepreneur's products and services.
- **Resources and actions as signals.** Some resources and specific actions could be actually useful as signals for the market, they are valuable factors as TDTBox's entrepreneur described: "*elements that help the market to discern you from the others*". The technology entrepreneurs were seen to rely on three different types of resources to build their signals: market, technology and social capital. As also observed in the adaptation of signaling theory in the marketing literature (Kirmani & Rao 2000), the use of symbolic elements could positively influence in reducing the perceived uncertainty of the customer and or stakeholders, in words of Electonix's entrepreneur: "*Investors evaluate their decision based on whether there is (already) another investor with good reputation (that has already invested) in the company*". In particular if such elements were seen as credible signals of the potential of the firm and the commitment of the entrepreneur to deliver upon his promises (Connelly et al. 2010). For example using registered patents as quality signals of the technology under development, investing substantial financial resources in building a brand to show long term commitment, or using team member's credentials or institutional endorsements as quality signals, as TDTBox's entrepreneur explained: *"(it) worked as a public certification that we had the technological and financial resources to complete our technological development*".

The identification and description of the use of resources as quality signals opened up the possibility to study how entrepreneurs activate additional sources of value from existing resources. These findings are in line with the observation that very specific firm resources, such as technological resources (patents), could actually have more value as quality signals (p.e. for investors aiming to select the startup with more potential) than its intended use as a legal protection against potential competitors (Hsu & Ziedonis 2013). The observation that

regardless of their initial resource position, entrepreneurs are seen to influence the technology entrepreneurship process through their actions (including the signaling use of resources), provides an opportunity to extend our understanding of the phenomenon.

5.5. Objectives for the theoretical framework development

This exploratory field-work started with a study on the technology entrepreneurship following a process perspective, from this point, the subsequent research questions were explored providing a more general perspective of how technology entrepreneurship unfolds and the linkages between resources and actions. The analyses and results presented offer evidences and insights on some of the potential sources of variance and complexity that the technological component introduces in the entrepreneurship process.

In this sense, the different field studies have helped to better understand how technological ideas are transformed into opportunities, how different individual cognitive traits could impact on the opportunity development, as well as how entrepreneurs used resources as symbolic elements, regardless of their direct, short term, functionality or value.

This qualitative exploratory work provides valuable insights to engage in an extension of the initial theoretical framework, with the intention to bring theories and perspectives that can help to better understand the technology entrepreneurship phenomenon.

In line with the mixed method approach (Venkatesh et al. 2013) the exploratory qualitative field-work provides the insights to define the objectives to extend the initial theoretical framework, and build the hypotheses for the confirmatory quantitative section. The objectives are the following:

a) Find theoretical concepts that fit with the observation that the technology entrepreneurship process requires a lengthy process of development; capturing the changes in the evolution of the new technology-based firm (NTBF) and the frequent setbacks in its development (Miralles & Giones 2011; Giones et al. 2013).
b) Assess whether the Resource-based View (RBV) can provide a complete explanation of the evidences and cases observed in the qualitative field work. In particular, on the value of resources like individual's experience in entrepreneurship or knowledge on the market (Giones & Miralles 2013).
c) Establish the linkages and complementarities between the RBV and other theories that could help to theorize from the findings of the exploratory work, for example the

function as quality signals of some of the entrepreneurs actions or resources (Giones & Miralles 2015).

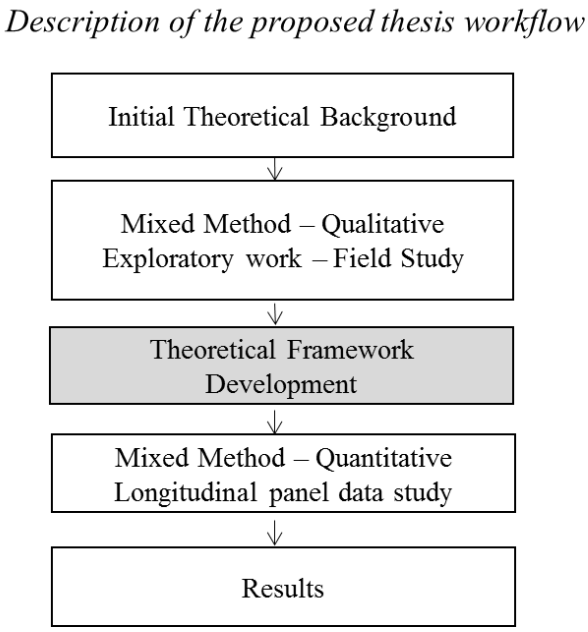
d) Identify theories or theoretical perspectives that could help to understand the impact of entrepreneurs' actions, regardless of their initial resource configurations, and their influence on the opportunity exploitation (or market performance). The objective is to have a reference theoretical framework to explain that some of the initial resources that influence on the opportunity identification, might not be enough to explain the opportunity exploitation and the further development of the entrepreneurship process (Giones et al. 2013; Giones & Miralles 2015).

In order to deal with the proposed research opportunities, a further revision of the literature has been conducted with the intention to support an extended theoretical framework that captures the qualitative insights and allows to further develop them into a testable set of hypotheses.

6. Extended theoretical framework and hypothesis development for venture emergence in technology entrepreneurship.

This section has a central position in the thesis workflow, it links the initial exploratory work results with the quantitative study (see Figure 6). The results of the exploratory work point towards different opportunities to extend our understanding on the differential elements of technology-based entrepreneurship. In the exploratory work we have found evidences on the complex process of enacting and exploiting opportunities in technology entrepreneurship. In addition, it has also been observed that the process of technology entrepreneurship is highly dependent on both the resources and actions taken by the entrepreneurs and their context.

Figure 6. Detail on the section position in the thesis workflow



Thus, the insights gathered in the exploratory work guide the definition of the objectives for the theoretical framework extension, the table below provides a conceptual linkage between the two parts (see Table 11).

Table 11. From exploratory work to theoretical framework development

Objectives from exploratory work	Theoretical framework development
a) Need for a theoretical concept to describe the organizational development of the new firm in the long and complex development process of technology entrepreneurship.	Introduce venture emergence as a theoretical perspective to describe the changes in the development of the new technology-based firm.

b) Explore whether established theories such as the RBV can provide an explanation for the factors observed to influence in the technology entrepreneurship process	Review prior research using RBV in similar context, and explore whether individual level theories such as human capital can also provide support for the hypotheses development.
c) Explore theoretical linkages between resource-based theories and other theoretical perspectives on the influence of resources in hands of the firms or the entrepreneur.	Building on RBV, aim to extend this perspective and justify additional sources of value from the resources of the entrepreneur.
d) Complement the resource-centric perspective to be able to explain why market-oriented actions are observed to be influencing the development of the new technology-based firm.	Assess whether complementary views to the RBV, could actually offer further understanding on the market creation efforts (such as marketing or demand-side perspectives) could further support the hypotheses development.

Therefore, this section starts with a detailed introduction of the venture emergence concept and a review of the prior literature on this concept. Then, different options to extend the existent theoretical framework are proposed. Starting with a description of the insights from the resource-based view on the influence of human capital. It follows with a description of possible factors related to technology resources value and technology commercialization. Finally, using a market creation perspective, that combines marketing theory and demand-side view, additional factors are introduced. This section concludes with a presentation of the complete theoretical framework, including the hypotheses that are brought to the quantitative analysis.

6.1. The Venture Emergence perspective for technology entrepreneurship

The development of venture emergence as a research concept in the entrepreneurship literature is introduced to respond to the necessity to understand the question of how organizations come to exist (Katz & Gartner 1988), the relevance of this question is still considered to be one of the most complex organizational areas of research (Lichtenstein 2014). The seminal work of Katz & Gartner (1988) describes that there are different elements that can help to identify the evolution in the process of an organization that is coming to exist: intention, resources, boundary, and exchange. The first element is intention, it is used to describe that organizations are led by an individual actor that has the goal of creating a new organization. Secondly, the element of resources is used to characterize the human, financial capital and other endowments that are the building blocks an emerging organization uses,

combines and organizes production activities with (Brush et al. 2008). The third element of boundary is used to portray how emerging organizations also build boundaries, for example through contracts, or physical spaces; they are also established with the information and material transactions between the emerging firm and its environment. Last, the exchange element illustrates the activation of transactions in the organization, it involves combining internal inputs that are transformed into valuable outputs.

These four elements, were later used as reference for an empirical work on how would new ventures emerge (Brush et al. 2008). One of the conclusions of that research was that these four elements were present in emerging firms, and were necessary for firm survival; additionally, they also identified that those firms that complete their organizing activities at a slower pace, are also more likely to outlive the ones that do it faster.

The idea of speed of the organizing activities and its relationship with the emergence of organizations has been explored with the introduction of complexity science (Lichtenstein et al. 2007). As observed by Brush et al. (2008) the number and pace of organizing activities influence the emergence of organizations, instead of looking at whether there is a sequential linear number of activities, scholars observed that there are “emergence events” (Lichtenstein et al. 2006) that have a significant impact on the likelihood of the new venture emergence.

Similarly, in a more recent work Rasmussen et al. (2011) propose to study how entrepreneurial competencies impact on the venture emergence, and how the evolution in these entrepreneurial competences can be related to the emergence of the new venture.

There have also been further efforts to establish measures for the “emergence events” (such as achieving the first commercial transaction or hiring the first employee) that can fit with an evolutionary perspective of the venture emergence. As a result, different venture emergence levels are described depending on how many of those events the venture has gone through (Dimov 2010; Tornikoski & Newbert 2007).

A summary of the different research articles on the venture emergence of new organizations is presented in Table 12.

Table 12. Selected articles on the Venture Emergence concept in the entrepreneurship literature

Authors	Aims	Theoretical Perspective	Data & Method	Key Findings
Katz & Gartner (1988)	Clarify how and why samples of new organizations are identified and selected. Aim to describe the interaction between entrepreneurship and organization theory to generate an understanding of the properties of emerging organizations.	Traditional organization models, and creation models. Linkages to Population Ecology and Entrepreneurship.	Conceptual paper	Provide a framework to identify and select new organizations, using four properties: intention, resources, boundary, and exchange. Introduce the concept of emerging organizations or pre-organizations, as a valuable concept to advance in the question of "how do organizations come into existence?"
Lichtenstein, Dooley & Lumpkin (Lichtenstein et al. 2006)	Explain how different modes of organizing change in organizational emergence.	Entrepreneurial dynamic processes, using references from sensemaking (Weick 1993), and effectuation (Sarasvathy 2001).	Single, in-depth, longitudinal case-study.	Three different models of organizing: vision, strategic organizing and tactical organizing. Identification of the concept "emergence event": punctuated, coordinated shift in multiple modes of entrepreneurial organizing at virtually the same time. It generates a qualitatively different state – a new identity – within the nascent venture.
Tornikoski & Newbert (2007)	Contribute to the understanding how would-be entrepreneurs can successfully create a new organization.	Legitimacy perspective, highlight the importance of process and action in understanding	Test a set of hypotheses using PSED data.	It is the active search for legitimacy, as opposed to the reliance on passive resource endowments that increases the likelihood that it will emerge.

		organizational emergence.		
Tornikoski (2007)	Understand why some nascent firms make the transition to new operational firms (firm emergence) while other do not.	Legitimacy perspective and resource dependence theory.	Surveyed the participants of a business plan competition. Used PSED structure as reference.	Legitimacy behaviors are highly relevant for firm emergence. Networking and resource combination activities were found related to firm emergence. Highlight importance of proactive action to acquire legitimacy from the environment.
Lichtenstein, Carter, Dooley & Gartner (2007)	Offer a complexity science approach to the study of organization emergence, to provide new explanation for how and why new firms are established, and why some founders are more successful than others.	Complexity science.	Used PSED data, using event histories to calculate rate, concentration and timing of activities.	More organizing activities is likely to lead to venture emergence. There is a continuous "flow" of system-wide dynamic processes that area as likely to influence emergence that other more classic factors.
Brush, Manolova & Edelman (2008)	Provide an empirical test to the Katzy & Gartner (1988) framework of emerging organizations properties.	Dynamic process perspective, constructivist view on organizations emergence through interaction.	Used longitudinal PSED database, test of hypotheses on the importance and sequence of emergence properties.	All four properties (intentionality, resources, boundary, and exchange) are necessary for firm survival in the short-term. Firms moving quickly through the process are less likely to continue organizing than those moving slowly.
Dimov (Dimov 2010)	Conceptualize the nascent entrepreneur judgement of the opportunity and examine its implications for venture	Human Capital, and decision-making (early planning efforts).	Uses the PSED to test the proposed set of hypotheses on the variables interplay.	Articulates opportunity confidence as a factor in the nascent entrepreneurial process. Introduce a differentiation between opportunity-specific dimensions of the

	emergence.			entrepreneur's human capital. Provide insights on the influence of planning in entrepreneurship, suggesting the use of planning as a learning tool.
Rasmussen, Mosey & Wright (2011)	Clarify which entrepreneurial competencies are needed for nascent academic spin-offs. Provide information on who provides these competencies and how are they developed.	Competencies view on the entrepreneurship process. Evolutionary perspective.	Longitudinal multiple case study.	Identify three competencies of opportunity refinement, leveraging, and championing as keys for a successful university spin-off launch. Need for competencies evolution to allow for repetitive reconfiguration to balance the changing needs of investors, partners and potential customers. The objective is to be able to frame the innovations commercially.

Thus, building upon the existent literature on the venture emergence in entrepreneurship, we aim to uncover the influence of some of the factors and mechanisms that are suggested to influence the technology entrepreneurship process. To do so, we propose to enrich the current theoretical framework build upon the resource-based view with alternative theoretical lenses that could provide additional insights, including those that could complement the resource-based view with more demand and informational-view elements such as technology innovation theory, marketing and signaling theory.

6.2. The resource-based view perspective and human capital theory on venture emergence

The dominant perspective on entrepreneurship research contributes in the understanding of technology-based venture emergence by giving theoretical support to the expected influence of resource-like factors such as human and organizational capital (Newbert 2005). Technology-based entrepreneurs that lead new technology-based firms (NTBFs) are often endowed with limited resources, actually the knowledge and skills of the entrepreneur and its team members are often the more visible resources in a new firm. The combination of knowledge and skills, defined as entrepreneur's human capital (Davidsson & Honig 2003), and its influence on the entrepreneurial behavior and entrepreneurship process has been subject to extant research in the entrepreneurship literature (Rauch & Rijsdijk 2013).

Either using a more general resource-based view perspective (Colombo & Grilli 2005) or from a human capital theory perspective (Becker 1975), in both cases we expect that prior exposure from the entrepreneur to situations related to the exploration and exploitation of opportunities would have resulted in learning outcomes that generated valuable knowledge (Politis 2005).

These knowledge reservoirs on the industry, the technology, the challenges of developing and entrepreneurial opportunity, and managing an emerging organization, are expected to have a positive influence on the new firm emergence (Widding 2005). Prior research using this perspective has found that individual's prior knowledge could influence on the different types and dimensions of opportunities that entrepreneurs can identify from a given technological idea (Shane 2000); and could provide the entrepreneur with a better understanding of the market and customer needs (Shepherd et al. 2000).

Nevertheless, it is not clear how the human capital resources might influence on the venture emergence of the new technology-based venture. Although, as previously mentioned, prior research has observed the positive influence of individual's experience (either entrepreneurial

or industrial) in the intention to engage in the venturing efforts (Dimov 2010), there is limited evidence on its impact on venture survival or performance in the market (Dimov 2010; West & Noel 2009).

At this point it is relevant to identify the different sources of the entrepreneur's human capital, aiming to decompose the factors that could contribute to generate this potentially valuable resource for the entrepreneur. This approximation offers the possibility to "disentangle" (Colombo & Grilli 2005, p.801) the effects generated by the different possible components of Human Capital, separating the influence of overall work experience, from the knowledge gained through prior entrepreneurial experiences, either in the same industry or in other business contexts (Colombo & Grilli 2005).

Having work experience is seen as a valuable potential contributor to the human capital of the entrepreneur; overall, it is expected that more years of work experience would have resulted in more opportunities to learn from being exposed to challenging situations, and a better understanding of the business practices and usual challenges associated with running a business. Additionally, work experience might also include a broader network of valuable contacts and potential references (social network), as studied in more depth in social capital research in the context of entrepreneurship (Carolis et al. 2009). We expect that work experience of entrepreneur should translate into human capital and positively influence the venture emergence of the new technology-based firms (NTBF from this point onwards).

Therefore we propose that:

H1a: Founder's human capital (in years of work experience) has a positive influence on the new technology-based venture emergence.

A different dimension of human capital that has particular importance in the entrepreneurial context is being an "experienced entrepreneur" (Hsu 2007). The exposure to situations that include activities related to opportunity recognition and exploitation are seen as potential generators of the specific knowledge reservoir of entrepreneurial knowledge (Politis 2005; Widding 2005). This entrepreneurial knowledge is defined as the conceptual and analytic understanding needed to recognize and act upon entrepreneurial opportunities (Miralles et al. 2015).

Prior research has proposed that experienced entrepreneurs, those that have had the opportunity to develop the entrepreneurial knowledge reservoir, actually follow different decision-making processes when assessing entrepreneurial opportunities and their

exploitation (Dew et al. 2009). Thus, in this case, instead of providing the entrepreneur with specific knowledge on the technology, customer needs or other elements that could fit with explicit knowledge related to the new business; the entrepreneurial experience generates a more tacit knowledge related to how to organize, and how to act in an entrepreneurial context (Fisher 2011).

Therefore, it is argued that the learning outcomes from prior entrepreneurial experience will make the entrepreneur more prepared to cope with the liabilities of newness (Stinchcombe 2002), thus we hypothesize that she would have developed the capability to adjust their mechanisms and decision-making structures to the uncertainty and dynamism of technology intense markets (Read et al. 2009).

Thus we suggest that:

H1b: Founder's human capital (as entrepreneurial experience) has a positive influence on the new technology-based venture emergence

On the other hand, industry experience has been observed to be valuable to identify opportunities (Shane 2000), as well as to provide with initial understanding on the problems and needs of the clients (Gregoire & Shepherd 2012). Although in dynamic environments this advantage might not be enough to secure the new technology commercialization, it could influence positively in the decisions surrounding the first product or service launch (Schoonhoven et al. 1990). Some of the reasons that justify this expected positive influence are that experience in the same industry should favor the capacity of the firm to develop business relationships with customers and suppliers, as they should share similar needs and follow similar processes as experienced by the entrepreneur. In fact, prior research has observed that there was a positive association between business performance and the similarity of customers and suppliers with prior experiences of the entrepreneur (Gimeno et al. 1997). Although most of past research does not specifically study the influence of having entrepreneurial experience in the same industry, we expect to see similar effects to the observation of Colombo & Grilli (2005) on the positive influence on firm performance of industry-specific work experience.

Therefore we would suggest the following:

H1c: Founder's experience (as prior startup experience in the same industry) has a positive influence on the new technology-based venture emergence.

6.3. Technology innovation perspective on venture emergence

Using a resource-based view perspective, we would expect that firms with larger portfolios of technological resources would be more likely to generate and capture value and become new fully emerged firms. Nevertheless, other scholars suggest that actually the novelty of the products and services offered by technology-based ventures could actually be hurdle for their future their future (Shepherd et al. 2000).

The technology innovation perspective helps to clarify this apparent paradox. In most of the NTBFs "the main problem is not so much invention but commercialization" (Gans & Stern 2003, p.333). Even if technological resources (such as patents) are seen as one of the key assets that these type of firms can leverage to build their competitive advantage (Hsu & Ziedonis 2013), it is not obvious how to do it (Brem & Voigt 2009). The successful commercialization is not only dependent on the novelty of the technology, but also on the ability to understand the technological market environment and position their product accordingly (Gans & Stern 2003; Brem & Voigt 2009).

This provides an insight on why sometimes the most promising start-ups that rely on breakthrough technological developments, still struggle to find a successful commercialization strategy (Teece 2010; Brem & Borchardt 2014; Gans & Stern 2003). It is suggested that it is not enough to be endowed with a large portfolio of technological resources in the start of the new venture, but that there are additional elements, such as sustaining a technology orientation, that influence on the future growth of the new firm (Gans & Stern 2003). In high technology markets, new entrants are in a weaker position compared to established players, even if they compete in different market segments or with different combinations of products and services: the limited information available on the product, team, and past performance, makes them a riskier choice for a potential customer (Godley 2013).

This idea of uncertainty that the potential customer perceives when interacting with the NTBF is described in the literature as an information asymmetry (Stiglitz 1985). It is a situation where the seller (in our case the NTBF) aims to activate a transaction with a buyer (a potential customer), but where seller and buyer do not share the same information on the product “quality”. In this situation the seller has “insider” information on the functionality of the product or service, on the capacity of the management team to execute or on the actual stage of development of the new technology. In this type of situation, NTBFs that believe that they have “high quality”, are interested in conveying this information to the potential customer through visible clues that can reduce the perceived uncertainty.

This type of market dynamics are described using signaling theory (Spence 1973). Originally developed to explain how job applicants would disclose details on their work history, so that they would be interpreted as signals of their "quality" by recruiters, it has been used in many different management contexts (Connelly et al. 2010). In the context of technology entrepreneurship, the entrepreneur can act as a signaler, and has the option to issue or not, visible and observable signals regarding, for example, the technological quality of the firm's products. As Godley (2013) describes, in uncertain contexts, with important information asymmetries, visible resources and actions could convey the additional information on the quality of the products, reducing uncertainty on the technological capabilities of the firm, and overall raising its legitimacy.

Thus, combining the insights from the resource-based view on the expected value of the heterogeneous and unique technological resources (such as patents), with the idea that this technological resources can also be used as visible signals of the quality of the products and services that the new firm will deliver, we expect that sustaining a technological orientation should have a positive effect on the emergence of the new venture. Therefore, there would be support to argue that both technology factors and a technology-push orientation (Brem & Voigt 2009) could favor new technology-based firms emergence.

In order to discriminate between the two possible positive effects related to technology, we separate technology outputs (as visible factors, such as patents) from technology capacity inputs (as technology intensity or orientation) as suggested by Hsu & Ziedonis (2013) findings. It could be, that some firms have low levels of visible technology outputs (low number of patents) but sustain a strong R&D intensity that favors applied technological innovations in their market. As a result, we build on the perspective of the resource-based view to propose that technological knowledge resources (such as patents) will positively influence on the venture emergence. Not only because they are sources of knowledge for internal use, but also because they provide clues (visible signals) to potential stakeholders and customers on the quality of the new venture.

Thus we suggest that:

H2a: Technology factors would positively influence venture emergence.

We are not only interested in the influence of the R&D outputs, but we are also interested in understanding whether sustaining a technology orientation, for example a continued effort in developing novel technology-based products, would have an influence on the venture emergence in this context. Prior research on the concept of the R&D intensity as a descriptor

of the inputs on the technology innovation process (Blonigen & Taylor 2003; Lin et al. 2006) provide the specific support to propose this more concrete hypothesis. These past studies on the positive influence of sustaining an R&D intensity for firms in high technology industries, share context similarities with the phenomenon we are studying; in both cases technological development is seen as a differential resource that favors the competitive capabilities of the firm.

As a result we propose that:

H2b: Building a technology capacity would positively influence venture emergence.

6.4. Marketing theory and demand-side view on venture emergence

The resource-centric perspective of the RBV provides support to explore the value of very specific technological resources that some NTBFs might have, nevertheless it offers little support to explore how resources are organized in conjunction with the market development process that is observed in the NTBFs' emergence. In broad terms, in this part of the theoretical framework we offer alternative views to the RBV perspective, introducing insights from the marketing theory (Srivastava 2001), and proposing an operationalization that fits with demand-side view on technology entrepreneurship (Priem et al. 2011).

The difficulties in achieving conclusive results on the influence of resources on the venture emergence (West & Noel 2009) has brought interest in exploring alternative perspectives to resource centered views. The adoption of alternative theoretical lenses should bring light beyond the limited explanation we found solely observing the resources (Liao & Gartner 2006).

Previous research has suggested that technology-based entrepreneurs might have additional struggles related to the product-market fit, as often the market seemed to be undefined or had to be "created" (Teece 2010). We propose to advance in this line of research by assuming that this type of entrepreneurship has to deal with what would be described as value creation efforts, even before it can start focusing on the value capture or opportunity exploitation mechanisms (Priem 2007). In other words, we propose to change the assumption of a pre-existent homogeneous demand for the products of the startup, and instead we assume that demand might be heterogeneous and not always ready to accept the developments of the technology-based entrepreneur (Adner 2002).

The adoption of a demand-side perspective to the venture emergence opens the theoretical framework to insights from parallel streams such as marketing theory (Srivastava 2001). Thus

the focus of attention with this approximation is not anymore on the ability of the entrepreneur to generate or combine resources and capabilities, but instead in the form and content of its information exchanges with the market (Read et al. 2009).

This approximation from the demand-side, or market perspective, also fits with the previous discussion on the nature of technological contexts for new entrants (Gans & Stern 2003; Godley 2013). The lack of legitimacy and reputation of these new ventures, makes it particularly difficult for these new ventures to convince their potential customers of their capacities and abilities (Godley 2013).

The informational perspective (Stiglitz 1985) provides an explanation for this type of situation, where the differences in information that the producer (the entrepreneur and the new technology-based venture), and the potential buyer (their intended market) become a barrier between producer and buyer (Chen et al. 2014). This informational "barrier" creates an incentive for the technology-based entrepreneur to engage in actions that could provide information to the potential buyer on the "good quality" of the products or services the new venture will offer. In particular, prior research identifies that some of the market approximation actions such as networking and socializing activities (Zhou 2013; Neergaard 2005; Tornikoski & Newbert 2007) could have a positive influence on the venture emergence, in these settings the entrepreneurs can objectively display or provide information on the otherwise internal information of the new venture.

Using as a reference point the observation that one of the key challenges of the entrepreneur is to market their product or service, we review the marketing literature for further clues on what factors and actions could influence on the venture emergence of technology-based firms.

The marketing literature suggests that an active management of the marketing mix would favor a reduction of information asymmetry between the producer and the buyer (Kirmani & Rao 2000). Studies have observed that product, promotion, place and pricing decisions would have an impact on the perception that the buyer or consumer have of the product or service (Kirmani & Rao 2000). Furthermore, investment in brand development or active communication of the expected benefits or uses of the product would reduce the consumer uncertainty and favor the activation of first transactions (Mudambi et al. 1997; Erdem & Swait 1998). In addition, entrepreneurship scholars have been advocating on the potential contributions from using marketing theories to study entrepreneurial action related to opportunity development (Webb et al. 2010).

Thus, we would expect that entrepreneurs that chose to engage in marketing activities would be expected to produce visible signals to the market that could result in lower perceived uncertainty towards their products and services. As previously described, this effect would be more significant for technology-based ventures producing complex consumer goods, which usually suffer from additional concerns from the customer regarding the "quality" of their technology, team or management capabilities (Godley 2013).

Therefore we expect that the development of marketing capacities in the NTBF influences on the venture emergence, in line with the observation that building marketing assets impacts positively on the introduction and commercialization of new products (Ramaswami et al. 2008). One of the assumptions of technology-based entrepreneurship is that dual source of attention (for example, technology and market development) creates misalignments on the priorities of the entrepreneur and its ability to successfully exploit the opportunity at hand (Bhide 2000). Nevertheless, marketing and innovation management theory explain how organizations that have the ability to sustain their innovation capabilities meanwhile staying tuned with market demands, and achieve a better performance (Ramaswami et al. 2008).

Summarizing the different insights, the introduction of the market-oriented factors and capacities describes the ability to commercialize new products and services using a market-pull orientation (Brem & Voigt 2009), or as Gans & Stern (2003) describe, to compete in the "market for products". Thus the marketing theory offers support to expect that NTBFs that activate market factors (for example developing a brand, or investing in a marketing campaign), or that develop a marketing capacity (for example allocating some of their employees to the sales or business development functions), are more likely to advance in their venture emergence.

As a result, we propose that:

H3a: Market factors would positively influence venture emergence.

Additionally, the development of a broad market oriented capacity in the new venture should facilitate to process and learn from the early market feedback (Furr et al. 2012) provided by the initial or potential customers. The market capacity in the new venture should help to transform this feedback and understanding of the market into an activation of the market demand for the NTBF's products. Therefore, we suggest that:

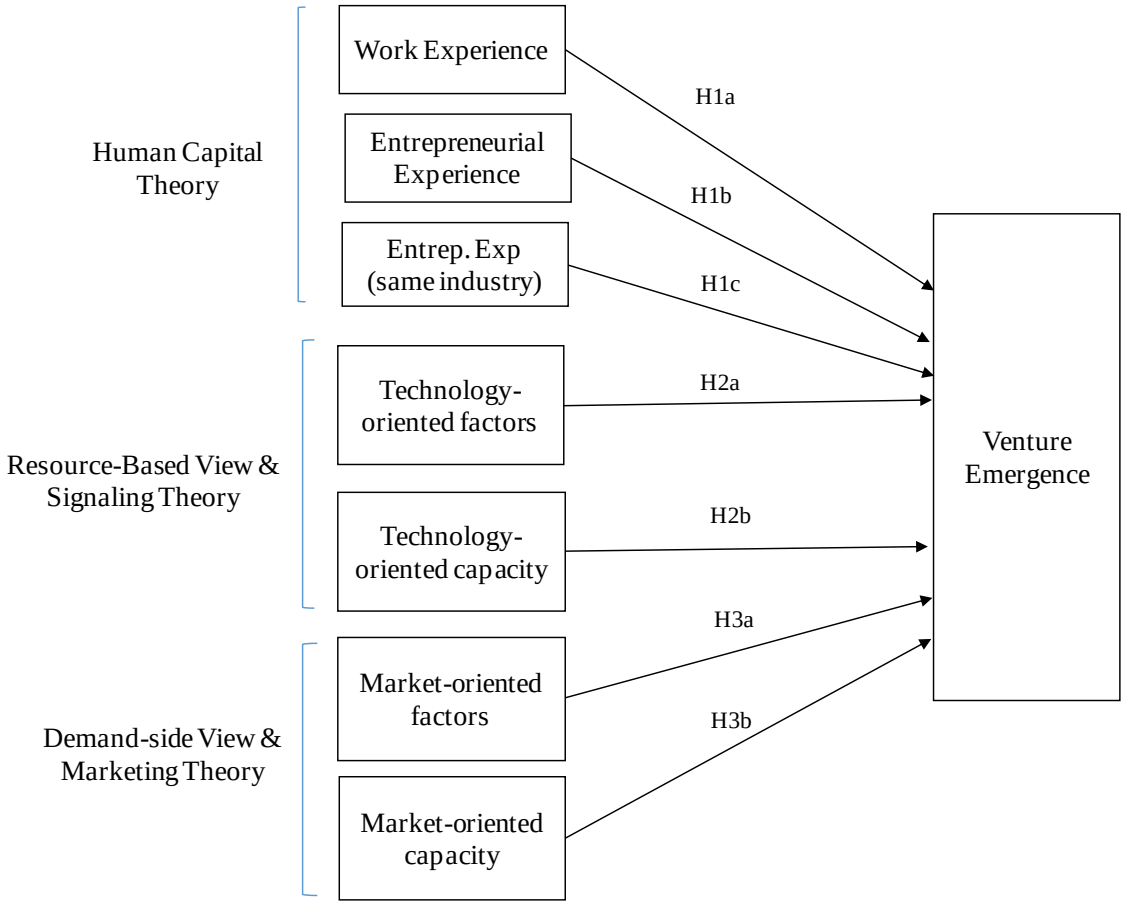
H3b: Market capacities would positively influence venture emergence

6.5. Research model for technology entrepreneurship venture emergence

The theoretical framework development results in a set of hypotheses that derive from the introduction of different theoretical insights that could provide a better understanding of the venture emergence of new technology-based firms. The resulting research model (see figure 7) is the anchor that will guide the development of the research design and the results of the hypothetic -deductive quantitative research section of this document.

Overall the research model provides a visualization of the different constructs and theories being used in this coming section.

Figure 7. Research Model



7. Quantitative section research design: studying venture emergence in Technology Entrepreneurship

Using as reference the research framework and hypotheses (see Figure 7), we advance to the second part of the mixed-method overall research design where we adopt a quantitative approach to explore the validity of the proposed hypotheses. If in the first part of this work the objective was to gain a better understanding on the technology entrepreneurship process, in this second part, we adopt a confirmatory quantitative approach to further assess the initial findings on the influence of resources and actions on technology entrepreneurship outcomes.

In the first part of this section we describe the different quantitative methods available and justify the selection of a longitudinal panel data approach. Then we follow with an introduction to the different measures needed to test the variables of the research model. We end with a description of the different data analysis options, detail on specific statistical techniques that are needed, and a description of the methods employed. This section precedes the presentation of the results.

7.1. Method options and selection

There has been an open call to change the focus in entrepreneurship research, from the focus on the entrepreneur characteristics, studying traits and factors that would make an individual an entrepreneur, to study entrepreneurship as a process (Moroz & Hindle 2012). Such change in study focus has also introduced a change in the methods used for entrepreneurship research, therefore we have seen the start of a shift from static tests to longitudinal studies, experiments and models that would capture additional information on the "process" nature of the phenomenon (Eckhardt & Shane 2003). The nature of the objectives of this research are aligned with the necessity to capture data on the dynamic nature of this process and its outcomes.

This research proposes to follow a hypothetic-deductive approach, building from the literature on marketing and technology innovation we have built a set of hypotheses to be tested with observed data. Therefore, the top-down deductive approximation implies that we are building on existing theories in other fields that can be helpful to explain a new phenomenon (Zahra 2007). The adoption of this approach implies that we aim to explain the phenomenon and its characteristics through the lenses of theoretical developments that have been raised and developed in this and other research fields. Thus, special attention has been given to the

justification of the hypotheses and the description of the theoretical framework, as it is recommended in this type of research approximations (Zahra 2007).

Therefore we combine an interest in studying the process that the entrepreneur follows in the early stages of the NTBF development, with a quantitative approach to respond to the hypothetic-deductive research questions we are proposing to contribute in the theory development of NTBF's venture emergence. As previously described, the entrepreneurship process has a complex nature (Moroz & Hindle 2012); in fact, this complexity is probably part of the essential differences of entrepreneurship when we compare it to other phenomena in the management area. As suggested by Delmar & Johnson (2015), there are five dimensions that influence on the requirements of an adequate research design to study our phenomenon: (1) specific different characteristics and traits of the entrepreneur, (2) individual dynamics of engagement and disengagement in the entrepreneurial project or new venture, (3) influence of the context where the process is happening, (4) nexus between the individual and the opportunity, including the changes in perceptions and co-evolutionary dynamics, (5) the skewness and kurtosis in the distribution of outcomes, making outliers an important part of the study of the process.

As a result, we consider a longitudinal study research design to observe entrepreneurial behavior and closely follow the within-subject changes (for example changes in their technology resources), and the between-subject differences (as individual or firm different characteristics). Overall this research design provides the necessary tools to advance in our research objectives.

7.1.1. Longitudinal data to study entrepreneurship

The development of a longitudinal research design is often associated with lengthy and expensive research projects. The possibility of observing the early activities in the development of a new venture is a rather challenging task for a researcher: it requires to be able to monitor the variables under study and be able to keep track of changes or modifications occurring during the time of observation. In addition, the outcomes of some of the processes and activities might be delayed in time, making it very difficult to extend findings beyond the case or cases being studied. The subtle and often informal nature of many of the early organizing activities leaves them out of the official statistics (Tornikoski 2007), thus some common databases used for socio-economic analyses on established companies do not provide the needed data to track growth and evolution of new venture emergence.

In the field of entrepreneurship research there has been a breakthrough contribution on longitudinal research with the development of major initiatives to build panel data surveys. The Panel Studies of Entrepreneurial Dynamics (PSED) research initiatives (Reynolds 2006) and its international evolutions (for example the Norwegian and Swedish versions), as well as the follow-up - PSED II - in the USA (see Table 13) have offered a new territory to test hypothesis and advance entrepreneurship research (Gartner & Shaver 2012).

Prior to the development of panel data for entrepreneurship research, we would have to rely on data from known entrepreneurs, requesting to remember their initial experiences and activities to build a process view of how their venture emerged. This approach suffered from different bias sources as described by Gartner & Shaver (2012): "survival" bias as more often than not nascent entrepreneurs fail to create an organization that gets in the public records ; "hindsight" bias or the "tendency to distort the initial probability of an event when the outcome becomes known" (Gartner & Shaver 2012, p.2) affecting the estimation of probabilities as the entrepreneur looks back in time; finally the "social desirability" and "social influence" biases mixed with memory decay that produce adjustments to the representation of the actual events to fit with the perceived expectations of the interviewer and social stereotypes (Gartner & Shaver 2012).

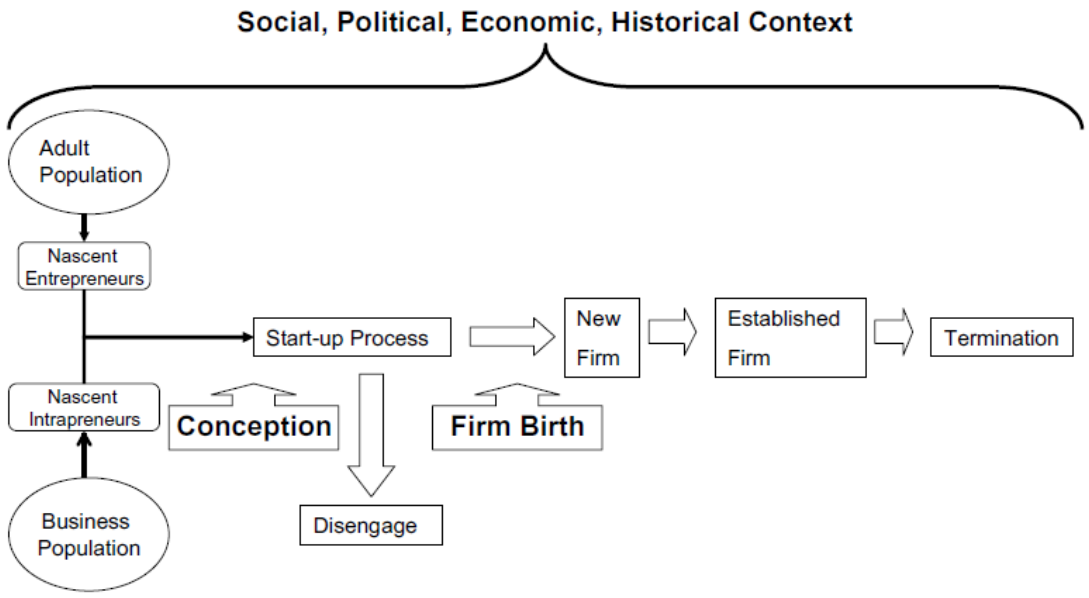
Therefore the selection of panel studies data fits the goals of this research as it offers the possibility to have a research design where we observe both the changes in independent and dependent variables with a time separation; this permits the development and test of causality hypotheses (Davidsson & Gordon 2011). This type of research designs also guarantees a closer view on the dynamics of the NTBF's venture emergence as we have repeated measures of data across time, something that we would not be able to have with a cross-sectional analysis (Delmar & Johnson 2015) where we would be limited to specific data intakes in different moments in time. Unless there is a systematic data collection, we cannot observe the dynamics of the firm in relation to the time dimension.

7.1.2. Panel Data Surveys in Entrepreneurship

The Panel Studies of Entrepreneurial Dynamics (PSED) has long been the reference source for longitudinal data in new business formation (Reynolds & Curtin 2008), and has firm-level data related to theories used in entrepreneurship. The PSED data set had the cases screening in 1999-2000 and the second PSED data set had the cases screening in 2005-2006, this second data set collected data in six waves, closing the file book in 2011.

The interest in further data collection at an international level, but with a similar method and data structure, resulted in the effective internationalization of the PSED across different countries. The different initiatives to build longitudinal datasets, also shared the theoretical understanding of the entrepreneurship process (Reynolds & Curtin 2011; Reynolds & Curtin 2008); consequently, the type of questions and overall design of the surveys is done with this activities and sequences in mind (see Figure 8).

Figure 8. Theoretical perspective of the PSED research design (Reynolds & Curtin (2008))



In addition to the PSED, the Kauffman Firm Survey (KFS) was also launched in 2004 (Robb & Reynolds 2009) to capture additional data on financing and innovation activities, and introduced a different sampling strategy, taking as a reference the new ventures created in 2004 and listed by Dun & Bradstreet (D&B) as reference population. More recently, new entrepreneurship data panels have started to be collected in Australia under the code name CAUSEE project, or the new China PSED dataset currently under development (see Table 13).

Although most of the longitudinal datasets (including PSED, the different PSED in different regions, and the KFS), shared similarities in the research design and also had common motivations and interests in better understanding entrepreneurship. The results were not always in line with the expectations, the difficulties on sustaining the data collection effort, the data revision and response quality assurance, as well as the needed means to make it open to the academic research community, have favored that most of the research work has focused in the data captured by a few of all the datasets available (Davidsson & Gordon 2011).

7.2. Data and sample

In order to test the set of hypotheses, we need to propose a data collection strategy that fits with the research question and hypotheses. In our study, this means capturing data from the new venture resources and activities (will be described as the independent variables), and its performance (will be described as the dependent variable), with the intention to establish whether the expected effects take place. Thus, we are interested in using a method and data that account for the potential time lapse of the activities of the entrepreneur (independent variables) and the outcome, venture emergence (dependent variable). Therefore, a longitudinal approach is needed, where there could be measurement points distributed along the time, keeping fixed the units of analysis, thus capturing the changes and their outcomes.

On the specific sample selection, in line with the exploratory work with mostly industrial or business to business-oriented technology-based entrepreneurs. We introduce control variables on the sample selection to be able to maintain the technology-based firm focus. The review of the previously used datasets, in similar research projects (see Table 13), suggests that the PSED II and the Kauffman Firm Survey (KFS) could be among the best options based on our research design.

Although the PSED II and the KFS are both longitudinal panel datasets, there are important differences in their design and sampling strategy. For example the PSED II has a stronger focus on the activities that occur before the firm registration, while the KFS offers a closer perspective to the initial development steps that a firm does, and follows the firm in its further evolution (see Table 14).

Table 13. Examples of recent longitudinal panels in entrepreneurship

Panel Name	Country	Year started	Screening Sample	Cohort (actual data sample)	Follow-ups (yearly data waves)
China PSED (CN-PSED)	China	2009	10.585	392	2
Kauffman Firm survey (KFS)	USA	2007	32.469	4.928	7
Comprehensive Australian Study of Entrepreneurial Emergence (CAUSEE)	Australia	2007	30.105	625	3
Latvia PSED (LV-PSED)	Latvia	2007	9.000	400	2
Germany PSED (GE-PANE)	Germany	2006	4.049	52	5 (6 months waves)
US - PSED II	USA	2005	31.845	1.214	5
Canadian PSED (CA-PSED)	Canada	2000	49.763	148	5
Netherlands PSED (NL-PSED I / NL-PSED II)	Netherlands	1998 (I) 2001 (II)	21.393 (I) 29.902 (II)	517 (I) 634 (II)	4 (I) 1 (II)
Sweden PSED (SE-PSED)	Sweden	1998	30.427	405	7
US – PSED I	USA	1998	62.612	824	3
Norway PSED (NO-PSED)	Norway	1996	9.533	203	3

Note: Adaptated from Robb & Reynolds (2009), Reynolds & Curtin (2011), Picón et al. (2015).

The KFS offers the possibility to track the new venture performance beyond the formalization of the new venture (registration of the company), making possible to study how the new firm advances or not in the development of their new or potential market. Therefore, it offers a better potential match for our research goals.

Table 14. US-PSED II and Kauffman Firm Survey (KFS) longitudinal panel datasets

Panel	Motivation	Key characteristics
US – PSED II	Provide an alternative to cross-sectional studies. Uncover the nature of the business organizing process (Gartner & Shaver 2012).	• Sample from adults identified as active nascent entrepreneurs from a random sample of households. • Understand the characteristics and gestation activities of nascent entrepreneurs. First in the US, and then provide support for international development of PSED studies with international comparability options.
KFS	Better understand: (1) new firm dynamics, (2) high-tech firms, (3) Firm Innovation, (4) Firm financing, (5) Entrepreneurs' characteristics (Robb 2012)	• Firms registered as new in Dun & Bradstreet (D&B) in 2004, and had for first time performed any registration activity in 2004 (including taxes, get fiscal number, pay for unemployment insurance…). • Oversampled firms in high tech industries. • Included questions on innovation strategy, finances and growth strategy of the new firms.

Therefore, we use the KFS data, its sampling strategy and larger number of variables measured offer a better fit with our research question and hypotheses.

7.2.1. The Kauffman Firm Survey (KFS) data panel

The Kauffman Firm Survey (KFS) is a longitudinal survey of new businesses in the USA sponsored by the Ewing Marion Kauffman Foundation. The KFS panel study of 4.982 business started in 2004 and are surveyed annually from 2004 to 2011 to cover a baseline year (2004) and seven yearly data waves till 2011 (see Coleman & Robb 2009; Robb 2012).

The panel is built using Dun & Bradstreet (D&B) data on new businesses listed in 2004, with an oversampling on technology firms. Additionally to be part of the panel firms needed to meet

the following criteria: (a) they must not have performed any of the following five business organizing activities before 2004, (b) they had performed at least one of them in 2004. The five business organizing activities used for the screening purposes were: (1) business had legal form, (2) business established an Employer Identification Number (EIN) number, (3) the respondent filed a Schedule C (profit or loss on business declaration) on personal income tax, (4) business paid unemployment insurance taxes, (5) business paid Federal Insurance Contribution Act (FICA).

It is also relevant to consider how the data panel evolves during the years, taking into account that the firms being surveyed could change or that some of the firms might disappear. An indicator also of the survey design and execution is its response rate (all but "did not respond" /panel baseline = 4,928) , number of members of the panel that complete the survey (83% in 2007, and 86% in 2011), this information is detailed in Table 15 and is extracted from Farhat & Robb (2014).

Table 15. Evolution of the survey results on the firms sampled in the KFS dataset (Farhat & Robb 2014)

KFS Sample Evolution (2004-2011)

	2004	2007	2011
Responded	4,928	2,915	2,007
Responded: No Data		75	25
Did not respond		825	676
Sold or Merged		45	40
Permanently Stopped		299	209
Temporaly Stopped		98	30
Stopped or sold/merged in previous years		671	1,941
Total	**4,928**	**4,928**	**4,928**
Response rate		*0.83*	*0.86*

7.2.2. Identification of New Technology-based Firms in the KFS

In order to study the technology-based firms from the larger sample of the Kauffman Firm Survey, prior research followed a two-part strategy (Coleman & Robb 2009; Coleman & Robb 2011; Coleman & Robb 2012), identifying as technology-based firms the new ventures in industries that are either “technology employers” or “technology generators” (Coleman & Robb 2009); such classification has shown to provide more accurate data on the identification of technology-based firms than sector based classifications (Chapple et al. 2004). The first filtering for “technology employers” adds as technology-based firms the organizations in industries where employment of science and engineering occupations is three times the national average (Coleman & Robb 2012; Chapple et al. 2004). The second filtering for

"technology generators" adds as technology-based firms those that are in industries above the U.S. average for both research and development expenditures per employee and for the proportion of full-time-equivalent R&D personnel (scientists and engineers) on the total industry workforce (Paytas & Berglund 2004). In conclusion, for this research, we included as technology-based firms those that either were "technology employers" or "technology generators". Detail on the final weight of high-tech firms in the sample of the KFS can be seen in Table 16.

The filtering process is applied through the identification of the North American Industry Classification Systems (NAICS) codes that fulfill one or both of the conditions. The NAICS codes provides a standard classification of over 1.000 industry codes, offering support for a fine grained analysis of statistical data, and in our case the selection tool to determine the relevant sample for the research purpose. Prior work by Chapple et al. (2004) provides an identification of the NAICS codes on "technology employers" industries, and prior studies by Paytas & Berglund (2004) on "technology generators". These have been used to filter the evidences to study from the KFS longitudinal panel.

Table 16. KFS sample description (baseline 2004)

	n	%
High-tech	705	14%
Non-high-tech	4.223	86%
Total	**4.928**	**100%**

7.3. Measures

The description of the measures used to test the hypotheses of the model provides an understanding of the data used and its relationship with the theoretical constructs and concepts. For each of the different needed measurements, a description is given on the type of data collected, the measurement scale, and how this is related to prior research using similar variables and/or data.

First, a description of the measurement of the dependent variable (venture emergence) is made; it follows with a description of the independent and the control variables.

7.3.1. Dependent variable: Venture Emergence

The study of venture emergence has brought the development of specific measurement scales that reflect the theoretical underpinnings to the concept (Tornikoski & Newbert 2007). As scholars have been using the concept of venture emergence for their research projects, further refinement of the scales and discussions on the measuring options has been developed. A common element in all the different paths taken to operationalize the concept is that venture emergence requires a multidimensional measurement approach (see Wiklund & Shepherd 2005).

The theoretical development of the different measurement dimensions of venture emergence benefits from the extensive discussion on how to measure firm performance. In previous research, scholars have used firm revenues, profit, returns, and survival as indicators of firm performance (Short et al. 2009). Each of the measures offers a different perspective; firm revenues are seen to offer comparability and generability of the findings across industries and are the most used measure for performance (Short et al. 2009), in particular when there is an interest in measuring venture growth (Steffens et al. 2009). Other measures such as profits and returns provide more information on the value of the venture besides, for example getting information on the return on assets ratio (ROA) and other common accounting measures for management performance in relation to assets or equity of the venture (He 2008; Morgan et al. 2009). Lastly, survival has been used as a performance measure in new venture studies as it offers an indicator of the first performance objective of an entrepreneurial firm, to stay in the market competing (He 2008). Similarly as it happens with the study of venture emergence, it is common in new venture performance studies to combine more than one of the measures in order to capture part of the multidimensionality of the new venture performance (Stam & Elfring 2008).

Compared to measuring firm performance, the study and measurement of venture emergence requires a specific approach. Venture emergence is described as the progression of changes into a "qualitatively different state" (Lichtenstein et al. 2006), thus it is a construct that is similar to an "event" in the life of a new organization. The list of potential emerging events, and the identification of emergence dimensions was described in Katz & Gartner (1988) and a few years later operationalized by Brush et al. (2008), aiming to provide a reference for further studies in gathering empirical evidence on the properties of emerging organizations (see Table 17).

These initial efforts to operationalize venture emergence inspired further research on the topic, Newbert & Tornikoski (2010) used the definition from Reynolds and Miller (1992) of organizational emergence as a multidimensional construct, built as the entrepreneur goes through key events such as: hiring an employee, making the first sale transaction or receiving funding. Each of those measures individually might not carry enough information on the status of the new venture, but combined they generate a measure of the emergence of the organization. In other words, one entrepreneurial organization might achieve sales without hiring or getting external funding, meanwhile another organization might need to hire some employees and get external funding as a work in progress before achieving their first sales.

The previous studies (see Table 17) can be grouped in two research streams, depending on the final objective of the venture emergence measurement. While in some of the studies there is a final objective to generate a single final measure for the venture emergence "status" of the new organization (Tornikoski & Newbert 2007; Tornikoski 2007; Dimov 2010; Lichtenstein et al. 2007), in other studies the objective is to understand the characteristics of the emerging organizations and the activities that build each of the emerging dimensions (Brush et al. 2008).

A summary of different approaches to measure venture emergence can be seen in Table 17.

Table 17. Measuring Venture Emergence in Entrepreneurship

Authors	Definition	Measurement
Tornikoski & Newbert (2007)	Organizational emergence defined along four dimension, one that is constant (personal commitment) and three that are dynamic: (1) first sale that generated revenues, (2) hired an employee or a non-owner manager, (3) received external financing or debt, from any type of agency.	Objective variable: the total number of measures (zero or one) was summed, resulting in a continuous variables ranging from zero to three. Subjective variable: respondent perception on whether, besides being active, the start-up was an "operating business".
Tornikoski (2007)	Organizations come to exist when they demonstrate intention, establish boundaries, acquire	Using five measures for the three emergence properties: (a) the firm had been registered (boundary property), (b) separate phone line or bank account (boundary property), (c) lead

	resources, and engage in exchanges.	entrepreneur had devoted time or hired someone (resource property), (d) lead entrepreneur had invested his own money or received outside funding (resource property), (e) first sales achieved (exchange property). Thus the markers could generate an indicator that range from zero to five. Perceptual measure, asking the entrepreneur whether he or she perceived that the nascent firm (a) was in business, (b) was working to start business, (c) was in stand-by, (d) had been terminated.
Lichtenstein (2007)	Emergence involves "qualitative novelty", enacts system-wide characteristics that are in some way distinct from the components of the system.	A cognitive measure: entrepreneur's perception that their organizing efforts have resulted in a firm that is operational. A system-wide variable, positive cash-flow, as used in the PSED, the presence of positive cash-flow suggests that the firm has taken on a "life of its own".
Brush, Manolova, & Edelman (2008)	Define emerging organizations as those that display one or more of the properties defined by (Katz & Gartner 1988): intentionality, resources, boundary, and exchange.	Establish a measure for each of the properties of emergence: (1) intentionality: combination of five binary variables, developed business plan?, identified business opportunity?, developed financial statements?, started working full-time? Taken training on new venture creation?, Ç (2) resources: eleven variables, organized start-up team? Applied for patent? Acquired raw materials? Acquired equipment? Saved own money? Invested own money? Asked for funds? Obtained credit from suppliers? Arranged child care? Hired employees?, level of product development? (3) Boundary: four self-reported measures, opened a separate bank account? Applied for a phone listing? Applied for D&B listing? Filed and income tax? (4) Exchange: seven dichotomous variables, started marketing or promotional efforts? Received revenues? Reached a profit? Paid salaries? Paid

		unemployment?, paid insurance taxes? Paid federal social security taxes?.
Dimov (Dimov 2010)	Venture emergence as a process, gradual and iterative, in which nascent entrepreneurs continuously evaluate the prospects of their opportunities.	Generated a status like variable, depending on the self-reported status of the venture: operating business (4), still active (3), inactive (2), no longer worked on (1). The higher the number the more likely to be a fully emerged organization.

In this study, in line with venture emergence research, we use a multidimensional scale to assess the changes in the new firm's emergence. We use an adaptation of the scale used by Tornikoski (2007), and Tornikoski & Newbert (2007), as it allows to develop an aggregated scale to measure the overall venture emergence of the organization, and at the same time it can provide information on the different dimensions of venture emergence.

We measure venture emergence using four different indicator status: does the NTBF have sales? (Yes=1 or No=0), does the NTBF have employees? (Yes=1 or No=0), has the NTBF received external funding? (Yes=1 or No=0), does the NTBF have profits? (Yes=1 or No=0). As a result, for each year measurement the sum of the different indicators generates a status level from 0 to 4. Those that achieve higher values (3 or 4) can be considered firms that have high levels of venture emergence, or even like fully emerged organizations. Those firms that have low levels of venture emergence are the ones with values below 2, meaning that they might have some sales but still not hired employees, or they might have hired employees but not received external funding, neither generated any sales. This measure is updated with every new data wave (yearly) and thus can be used as a dependent variable measurement to track the influence of changes in the independent variables.

7.3.2. Independent variables

The development of the measures for the independent variables related to the human capital, the technology factors and capacities, as well as the marketing factors and capacities has been developed taking as reference the extant literature on human capital and high technology firms, marketing for high technology products and parallel research streams in technology and innovation literature (Colombo & Grilli 2005; Gans & Stern 2003; Dimov 2010; Tornikoski 2007; Sandner & Block 2011).

Human Capital perspective, the individual's experience factors

The three independent variables of the human capital are measured to capture the information on the characteristics of the entrepreneur. Although we have included individual characteristics measures such as age, education and gender, we have done so to have references when analyzing the effects of the human capital variables.

We distinguish between overall *work experience* (years of work experience), *entrepreneurial experience* (number many businesses started), *entrepreneurial experience in the same industry* (business started in the same industry). The measure of work experience in years is similar to the measurement used by Colombo & Grilli (2005), the use of number of businesses that they have started is measured as in Dimov's (2010) study. Lastly, the use of a binary measure to select whether or not there is prior experience in entrepreneurship in the same industry is a more specific measure that just years of work experience in general; it captures specifically whether there is a prior experience in the same market or not. Meanwhile years of work experience, and number of business started could be related to the wealth or volume of experience, the combination of entrepreneurial experience and the industry is an indicator of very specific experience that could generate particular competencies in the entrepreneur (Colombo & Grilli 2005).

Technology development factors and capacities

With the objective to capture valuable information on the technological resources and their changes we follow an inputs and outputs measurement (Hitt et al. 1991) of the technology development efforts being done in the context of the NTBF.

In order to study the capacity of the NTBF to keep generating technological developments, we study the *Technology-oriented capacity* using the well-established measure of R&D Intensity (Lin et al. 2006). Nevertheless, instead of using R&D expenditure, we have to use the alternative measurement of the percentage of employees in the function of R&D (Caloghirou et al. 2004). The panel data set of KFS does not capture the expenditure detail of firms during the first waves, thus we use the indirect measure of the number of employees in this function as a measure of the relative intensity of the firm in this business function. We also study the average level of each firm across the time period of observation (2004-2007), as the relative changes that each firm does in this period of time (the relative difference of each year measurement against the average for that firm). This dual measurement is repeated for all of the technology and market measurements and allows to capture not only the relative positions of each firm but also the intensity and direction of the firm changes.

To measure the *Technology-oriented factors*, we rely on the well accepted use of the number of patents as a proxy for technology knowledge assets measurement (Lin et al. 2006). The number of patents is also used as an indicator of the intentions of the firm to exploit an innovation, and an indication of the potential value of its technological innovations (Hsu & Ziedonis 2013). Thus, when comparing different firms, differences in the number of patents are accepted as measurement of different levels of technological resources and innovation potential (Sandner & Block 2011). In the statistical analysis, both the firm average number of patents and each year deviation from the average are captured.

Market development factors and capacities

We measure the market-related independent variables using a visible factor measure (such as trademarks) and again an input measure that could reflect the market-orientation intensity of the NTBF.

It is with the objective to capture the focus of the firm in building a market orientation and marketing assets that we measure *Market-oriented capacities* as the percentage of sales, marketing and general administration employees. This measure has been used as a good indicator of the commercialization intention of the NTBF (Lin et al. 2006), and it provides a comparison reference to establish differences on market orientation among different firms (Morgan et al. 2009) as it gives an indication of the different intensity of the organization in this market-focused function.

To measure the *Market-oriented factors* in the NTBF we use the number of trademarks (Mendonça et al. 2004). The use of trademarks by new firms captures the decision of the managers (the entrepreneur/s) to establish a position in the market and distinguish themselves from the potential established competitors or new entrants; additionally the use of trademarks also is seen to provide information on the marketing capabilities and complementary information on the innovation capabilities of the firm (Mendonça et al. 2004). Although trademarks can be seen as legal anchors to protect a brand, we are interested in their function as indicators of the marketing assets developed by the company, and of the intention of the organization to pursue a market strategy (Sandner & Block 2011).

We use both the average number of trademarks registered by the NTBF in the period of time under observation in our study (2004-2007); and the deviation of the number of trademarks registered in that year, against the firm's average. These two measures provide information on the influence of trademarks as a differentiating element among different NTBFs, and the influence of the changes in the number of trademarks.

7.3.3. Control variables

We have introduced different control variables in order to be able to discard some possible sources of variety not covered by the independent variables, and also to have references to assess the strength of the coefficients and statistical significance of the proposed relationships between the independent variables and the dependent variable.

The design of the sample used in this research does not require for specific controls on firm age, all firms in the dataset share that their starting point is the baseline (2004). Other research designs using alternative datasets require for very specific controls on firm age to avoid potential endogeneity affecting the variables (Hopp & Sonderegger 2015). Nevertheless, in order to control the influence that surviving every year on the dataset could have on the evolution of the venture, we have controlled for the number of years that the firm manage to survive (see for example Table 26), with detail on the coefficients for each year. This is in line with the recommendation on using panel data sets for entrepreneurship research and controlling for the unexpected time-effects (Delmar & Johnson 2015).

Although all firms start the same year, we have introduced a firm size measure to be able to observe whether firms that start with a larger size would exhibit a significantly different behavior in any of the analyses we perform. To do so, we have added the number of employees (*Employees*); this is a widely accepted measure to control firm size (Deeds 2001).

7.4. Data analysis and method options

The use of panel data to study the venture emergence using a longitudinal approach requires specific analyses method. The novelty of the use of panel data in entrepreneurship research has required adjusting the traditional quantitative analytical tools to those that fit with the characteristics and opportunities that panel data offers. In this sense, we find that most of the techniques for data analysis have been imported from other research fields where they have a long tradition. For example, past research using econometrics (Wooldridge 2002; Baltagi 2005) and survival analysis or event modeling (Singer & Willett 2003; Box-Steffensmeier & Jones 2004) provides key insights to the adoption of these methods in the social sciences (Andreß et al. 2013) and in particular to the entrepreneurship field.

As Davidsson & Gordon (2011, p.18) point out in their review of 86 articles that used the PSED and similar datasets: "much of the research carried out to date has not made use of the full potential of this new approach (panel studies of new venture creation) and not adequately managed the particular methods challenges with which it is associated". Therefore, we start this section with a review of the different methods available for our research, their characteristics and challenges.

7.4.1. Methodological challenges for panel data analysis

The potential benefits from using panel data also involve at least two challenges that need to be addressed or at least taken into account when selecting and using the data analysis method. The first issue affects most of the panels that aim to represent a reference population: how do we represent the population and its changes over time? The answer is related to the reference population that the panel wants to represent. Thus, if the objective is to create a representation of the EU household, we will need to replicate the changes in the countries that are represented in the EU as well as to update the respondents to be sure that we also get a representative sample of the new types of households that appear across time. If the objective is study the population of new firms created in 2004 (as in the Kauffman Firm Survey), a control is needed on the representativity of the sample, taking into account the potential attrition of the sample being surveyed, in order to keep it as representative as possible to the referred population of firms under study.

The second issue that presents methodological challenges is the repeated measurements requirement of a panel design. On one hand we might be concerned on the panel effect, as respondents are answering the same questions year after year, they could get fatigue from

having to fill the same questionnaire and also learn to answer the complicated questions in the survey; overall although the panel effect might introduce some bias, it also helps to reduce the non-response and improves the validity of the data gathered (Andreß et al. 2013). The repeated measurements also require to keep unchanged the questions and their wording, ensuring that they yearly measurement are done in the closest conditions.

In the Kauffman Firm Survey (KFS) dataset, special attention has been given to reduce the attrition rate by doing several efforts to keep the firms engaged with the panel, as well as to complete the measurement in homogeneous conditions across the different measurement waves (Robb & Reynolds 2009).

Dealing with missing data

Another usual challenge when collecting data in panel surveys is how to deal with missing answers in some of the data collection points. In the Kauffman Firm Survey the missing data is described as missing at random (MAR); the available options to deal with this missing data have different implications for the sample characteristics and the variables measurement. As described in Fichman & Cummings (2003) some of the options are: (1) listwise deletion, meaning that only complete case are analyzed, (2) pairwise deletion, where the correlations or analyses are done with the available data for each case analysis, (3) unconditional mean imputation, (4) conditional mean imputation (calculating the mean using an ordinary least squares regression coefficients (OLS)), (5) estimate value using a maximum likelihood (ML) method, (6) multiple imputation (MI) where different values for the data missing are generated as matrix of substitutes. Further details on the types and options to deal with missing data can be found in the appendix IV.

From the above mentioned methods to address missing data, we use the multiple imputation option (Fichman & Cummings 2003; Newman 2003). The application of multiple imputation (MI) has important advantages for data sets that are aimed to be made available to a community of researchers (as is the case of the KFS). Addressing the missing data using multiple imputation means that for each missing observation, an *m* set of possible value are generated; there are two decisions that the curator of the dataset needs to take when applying multiple imputation: first, establish what is the number of imputations that are needed (the number of *m* – usually between 2 and 5), second, estimate the acceptable confidence intervals for the generation of the multiple (*m*) values for the missing value. Further detail on the available alternatives, and the statistical implications can be seen at Fichman & Cummings (2003).

In the case of the KFS, the curators of the dataset used m=5, thus generating 5 possible values for each of the missing data observations. This means that each case is replicated 5 times, one for each possible value for the missing observation; they were created using sequential regression multivariate imputation - SRMI (Farhat & Robb 2014). Examples of uses of multiple imputation (MI) to ensure that the missing data does not condition the data analysis can be seen in other recent entrepreneurship research (Tonoyan et al. 2010).

7.4.2. Longitudinal data analysis, statistical methods

The use of longitudinal data combines two different statistical methods options: regression and time-series analysis (Frees 2004). From the regression, it brings the capacity to study cross-section of subjects, but it needs the capacity to observe subjects (individuals or firms) over time. Time series analysis brings the possibility to study one or more subjects over time as it is needed with longitudinal data. In addition of bringing together regression and time series, we use the longitudinal analysis in a panel data set, meaning that the group of individuals that build the sample are intended to be surveyed repeatedly over time (Frees 2004).

The application of statistical methods on longitudinal panel data benefits from the design advantages of this type of data, as described in Baltagi (2005): (1) allows to control for individual heterogeneity, allowing to introduce it as a control variable in the model, (2) provides informative data, captures more variability and less collinearity among the variables (compared to time-series analysis), benefiting from the cross-sectional element that traditional time-series approaches would not capture, (3) allows to study change as it happens, compared to cross-sectional analysis where the process of change cannot be studied further than the initial and final measurement point, (4) allows for more complex behavioral analyses and more in-depth micro panel data measurements across time. There are also methodological challenges that need to be addressed, as described in Baltagi (2005): (1) measurement errors due to misreporting from the individuals, which happens when there are errors in the design of the questions that could lead the misinterpretations, (2) self-selection issues, attrition or non-response. As previously described, the KFS dataset design and data sample has been prepared to take advantage of the benefits of applying longitudinal analysis methods, while minimizing the possible challenges or risks (Farhat & Robb 2014).

Next, we introduce, briefly, the statistical methods that have been identified as suitable in order to advance in our research inquiry. Starting from the simplest linear methods (regressions), to some more specific models that benefit from the survey design and panel data structure of this research work; alternative methods that would fit with other types of

research questions are described in the appendix V. We aim to avoid entering in the technical elements of each of the statistical methods, but provide references for further information on each of them.

Linear models for longitudinal data analysis

The first and more intuitive approximation to exploring the relationship between two variables is suggesting that there is a dependence between them. Although is important to remember that regression does not imply causation, regardless of how strong is the connection between the two variables, we need a priori theoretical considerations in order to justify the dependence direction and thus the expected causality between them (Gujarati 2004).

Another more subtle preliminary consideration is the difference between correlation and regression. While the correlation coefficient provides information on the linear association of two variables (expected to be statistically random or stochastic), in the regression our aim is to identify coefficients that can help to predict the changes of the dependent variable (Gujarati 2004), assuming unit changes in the explanatory variables.

Regression analysis for longitudinal data

The most simple model (besides the description of one variable changes across time), is to propose a regression analysis between two variables. Also described as two-variable regression analysis. This provides the basic support to then extend the number of explanatory variables and make it a multiple regression. The OLS technique is widely used in longitudinal data research, although it has its limitations and sometimes the assumptions of the method are not fulfilled (Usero & Fernández 2009).

Building from the classic cross-section models we would propose to analyze the regression using an ordinary least squares (OLS). Nevertheless using this approximation would not be the most efficient if we expect the explanatory variables to change across the time of observation. The discussion on the selection of the estimation model is better described in the panel studies research with the introduction of the fixed-effects or random-effects specifications, and the strategies to select the most suitable estimator for each research design.

Fixed-Effects estimation

The fixed-effects (FE) estimation builds upon the assumption that what causes the variability in the dependent variable are the changes in the firm or individual subject of analysis. In other words, we should be using fixed-effects when we are interested in analyzing the influence of variables that change over time (change within the firm). As described in Andreß et al. (2013, p.145) “FE estimation builds on a linear model for panel data that puts all observed an

unobserved time-constant explanatory variables into the error term". This is why it is said that FE estimation assumptions are very similar to the OLS estimation (Andreß et al. 2013) as it assumes the following elements: (1) the units of analysis are part of a random sample of a cross-section, (2) the model is linear in its parameters, (3) each independent variable (IV) changes over time, and is not a linear function of other IV, (4) idiosyncratic error is independent of the variables in the model, assuming strict exogeneity, (5) idiosyncratic errors has constant variance, (6) idiosyncratic error is uncorrelated between any two observations (of the same unit in different moments in time) , (7) idiosyncratic errors is normally distributed. Further details on the impact of not fulfilling the assumptions are seen in Wooldridge (2002).

One of the advantages of the fixed-effects model is that the coefficients are not biased because some time-invariant characteristics are omitted, as it is assumed that the time-invariant characteristics are unique to the firm or individual, and are not correlated with other individual characteristics. Nevertheless, the fixed-effects models are unable to give us information on the time-invariant variables influence on the dependent variable (DV). If in our model we expect that the constant characteristics of the individuals play a role the changes of the DV (and this influence changes across time), then we should instead use a random-effects (RE) model.

Random-Effects estimation

The RE estimation is very similar to FE estimation, except that now the unit level (firm or individual) is assumed to be a random variable with specific characteristics (Andreß et al. 2013): there is a unit-specific unobserved heterogeneity that on average may be different from zero. In this situation, it has been studied that instead of using OLS estimator, Generalized Least Squares (GLS) provides the option to transform the unit-specific source of variability into another variable in the standard least squares (Gujarati 2004). In addition, the GLS estimators are observed to be efficient as either the number of firms (or units of analysis) or periods of time observed are large (Hsiao 2003). RE models assume that the unit's errors term is not correlated with the explanatory variables, thus it allows introducing time-invariant variables that could be needed in the statistical model.

A summary of the different options as well as the implications they have for the statistical analysis can be seen in Table 18.

Table 18. Options for regression analysis and model selection

Estimator	**Random Effects (RE)**	**Fixed Effects (FE)**
Generalized Least Squares (GLS)	Consistent and Efficient	Inconsistent
Ordinary Least Squares (OLS)	Consistent Inefficient	Consistent and Possibly Efficient

A possible situation is that we would be interested in studying the influence of time-invariant and time-variant explanatory variables on the dependent variable. This type of situation can be solved in two different ways, an option is to attempt to use random-effects or fixed-effects models and check which one fits better; an alternative is to introduce a hybrid model that can include both types of explanatory variables after some modifications.

The first option is to assess whether RE or FE works better for the explanatory variables we are using, the Hausman Test (Wooldridge 2002) facilitates this check. The Hausman test has as null hypothesis that the estimators generated by RE and FE are not substantially different (Gujarati 2004). Commonly researchers assume that if the hypothesis is rejected then the Fixed-effects specification is better, this interpretation is subject to some discussion due to the restrictions and assumptions that the FE model imposes (Baltagi 2005). An alternative to having to follow this approach is to adopt the hybrid model option (Schunck 2013; Andreß et al. 2013).

Hybrid models are suggested to provide further understanding on the values of the parameters and the overall relationship of the variables under study (Andreß et al. 2013). A hybrid model allows, with the proper specification of the independent variables, to benefit from the advantages of FE and RE approximations. As described in Andreß et al. (2013), the key idea behind the hybrid model is to be able to separate the effects of time-varying explanatory variables into their in-between and within components of influence on the dependent variable. This allows to also introduce in the model time-constant (or invariant) explanatory variables that are estimated controling for the time-variant explanatory variables (that have been specified in their two different components) (Farhat & Robb 2014; Schunck 2013). As an example of the STATA code used for this tests see appendix VI.

One of the specification options for the explanatory or independent variables of the hybrid model is one that offers the possibility to observe the between and within unit effects. This is done with the following parametrization: use unit (firm) specific means to capture differences between firms or individuals; and use the changes from the firm's mean across time (deviation from the firm's mean) to capture within changes (Andreß et al. 2013).

Non-linear models for longitudinal data analysis

As it happens in our research, there is the possibility that the dependent variable object of study is not a continuous, but categorical. A typical example would be the case that the dependent variable is of a binary-type, to have or not sales, other examples include different possible categories (where order matters or not). Without entering in technical details, we briefly describe the logit and ordinal logit regression models, as well as the multinomial model options.

The logit model uses a cumulative logistic distribution function to establish the relationship between the changes in the explanatory variables and the binary dependent variable. One of the differences that should be taken into account compared to the linear regression is that the interpretation of the coefficients has to be done taking into account that they are log-odds ratios (Baltagi 2005). The interpretation of the coefficients is done related to the likelihood of the event (if a binary dependent variable). If we want, we can also transform the log odds by doing the exponent of it, and then interpret the resulting value as the number of times it is more likely.

Alternatively, the probit model is also used (with very similar coefficient results), the main difference between using probit and logit is on the value of the standard errors, as the two models have different assumptions of how the error is distributed; while the logit model assumes there is a standard logistic distribution of the error, the probit model assumes that the errors has a normal distribution (Baltagi 2005).

We are also interested in briefly describing the option for the case of more than two categorical values for the dependent variable, the ordinal logit model (Wooldridge 2002). This case includes the situations where the order of the categorical values matters, for example it indicates increasing ranges of salary, or evolutionary status of a new venture. The ordered logit model is designed to estimate what observed covariates of the explanatory variables predict one of the dependent variable possible values in relation to the other alternative values (Farhat & Robb 2014). An example of application of this statistical method can be seen in Dimov (2010) study on whether human capital of the entrepreneur would influence on the operating status of the firm after 3 years of operations (doing a cross-sectional analysis).

In the specific case of having categorical values for the dependent variable, but where order does not matter, the multinomial model can be used (Wooldridge 2002). This approximation is also useful to understand whether the coefficients of the explanatory variables that generate one type of response (one of the categorical values) are similar or different from the

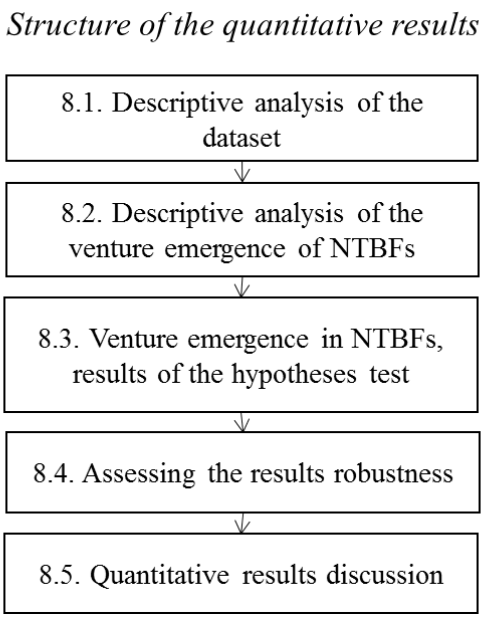
coefficient of another of the possible responses. The interpretation of the coefficients in the multinomial models is done in relation to the likelihood of the alternative events to the most frequent event (that is used as the reference to calculate the coefficients). The ordered logit can be seen as a sub-type of multinomial response where order of the possible responses matters (Wooldridge 2002).

This section has provided with an overview on the expected advantages of using longitudinal data to study our research problem, but also has highlighted the specific analytical tools that are required for this type of analysis. The description of the different possible alternatives for linear models (fixed and random-effects) as well as the non-linear models options provide an insight on the advantages and drawbacks for each of them, as well as the necessity to select the adequate tool that fits the research objectives.

8. Results from the quantitative approach: assessing the determinants of venture emergence in Technology Entrepreneurship

The presentation of the hypotheses tests results provides the insights to assess the proposed research framework. It starts with a description of the different evolution patterns of new technology-based firms, and it follows with an exploration of the venture emergence measure. Then a detailed analysis of each of the independent variables and its relationship with the venture emergence is presented. At this point, an analysis of the different hypotheses is completed, with an overall description of the model fit test. Additionally, robustness tests are introduced to provide further details and evidences on the strength of the results. Figure 9 provides a visual representation of the structure of this section.

Figure 9. Description of the quantitative results structure



8.1. Descriptive characteristics of the new technology-based firms in the dataset

In order to provide a comparative illustration of the differences between new technology-based firms and other types of firms we conducted a descriptive analysis of the firms in the dataset. To conduct the analysis we separated the firms in two groups, depending on their classification as high technology or non-high-technology firms (see Table 19).

As a brief comparison of the main differences between the high tech and non-high-tech firms, we can observe that the average age of the entrepreneur that started the new firm in 2004 is similar (between 45 and 46 years), nevertheless other characteristics of the individual

entrepreneurs and their teams are rather different. For example high-technology firms are seen to have larger teams (2 team members vs an average of 1.6 for non-high-tech), and be mostly started by male entrepreneurs (85% of them). Compared to other types of firms, high tech entrepreneurs are also seen to have reached higher levels of education, and almost half of them say to have had previous work or entrepreneurial experience in the same industry.

An interesting observation is that although the team (entrepreneurial team) of new high-tech firm is larger, the total number of employees is actually not different from other types of startups. Suggesting that in this type of companies most of the employees are also considered as part of the founders that define the entrepreneur's team.

Other statistically significant, but expected differences, come from the intensity of IP assets in the new high-tech firms (35% have some type of IP), and the observation that high-tech firms have on average 0.6 patents.

Additionally, the descriptive statistics of the sample of firms also show how different are the starting points for each type of firm. The average initial assets of high tech firms are more than twice what non-high-tech firms average ($343,467 vs $154,082). Although revenues are observed not to be significantly different, the average (not statistically significant) financial result (profit or losses) of high-tech firms is to be in losses.

Last, the average duration of the firms (number of years that they stay in the panel - from 1 to 7 waves - as the panel tracks them from 2004 to 2011), is slightly (but statistically significant) higher in high-tech firms. These results are all from the firms that are part of the baseline intake in the panel data set.

Table 19. Assessing the differences between technology-based and non-technology-based firms

Baseline values (2004)	*Non-High Tech Firms*	***High-tech Firms***	*T-value (difference)*
Age of the owner	45.72	**45.48**	.41
Number of team members	1.62	**1.99**	-2.68 ***
Gender (male)	.69	**.85**	-6.88***
Experience in same industry	.37	**.48**	-3.38***
Highest education reached (1)	6.24	**7.28**	-10.10***
Number of employees	2.25	**2.11**	0.49
Have any type of IP (2)	.19	**.35**	-7.36***
Number of patents	.11	**.60**	-7.61***
Initial Assets (USD)	154,082	**343,467**	-1.87*
Revenues (USD)	122,997	**106,219**	.40
Profits (USD)	473	**-16,631**	1.38
Duration (in years)	5.77	**6.11**	-2.38**
Number of firms (3)	***2719***	***417***	***3136***

*Notes: *p< 0.1, **p < 0.05, ***p< 0.01*

(1) highest level of education (9th grade, high school, graduate, technical, college, associate, bachelor, grad, Master, professional school or doctorate)

(2) Includes: patents, copyrights, trademarks

(3) some of the variables had slightly lower responses (lower n) without significant differences in the distribution between non-high tech and high-tech.

Besides the sample characteristics of the high-tech or non-high-tech firms, another element that is usually the subject of discussion is whether technology-based firms exhibit different performance in time compared to other types of startups. Using the firms in the sample, and not correcting for changes in the weight distribution or other controls, we can observe that the differences between the two types of firms grows wider in time (see Figure 10 and Figure 11).

This descriptive results are related to the discussion in entrepreneurship literature on the justification for specific policies that promote types of entrepreneurship that have a more substantial impact on employment and economic growth in the long run (Jaffe et al. 2007; Lerner 2010).

Figure 10. Evolution of average number of employees (2004-2011)

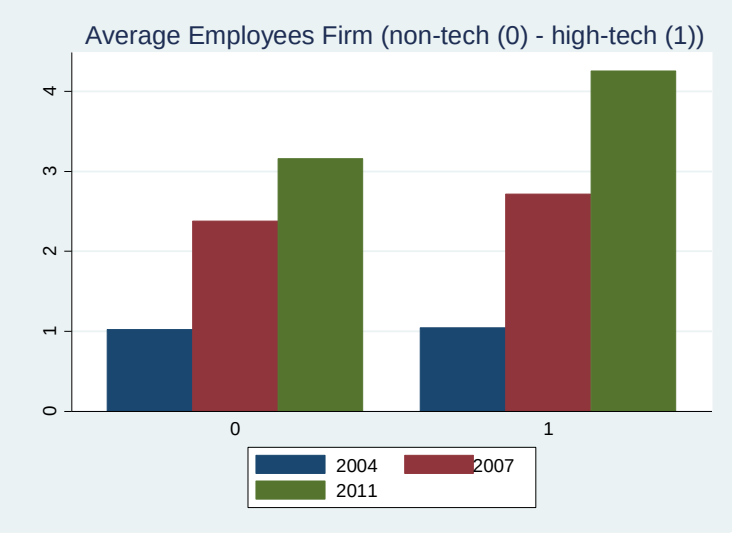
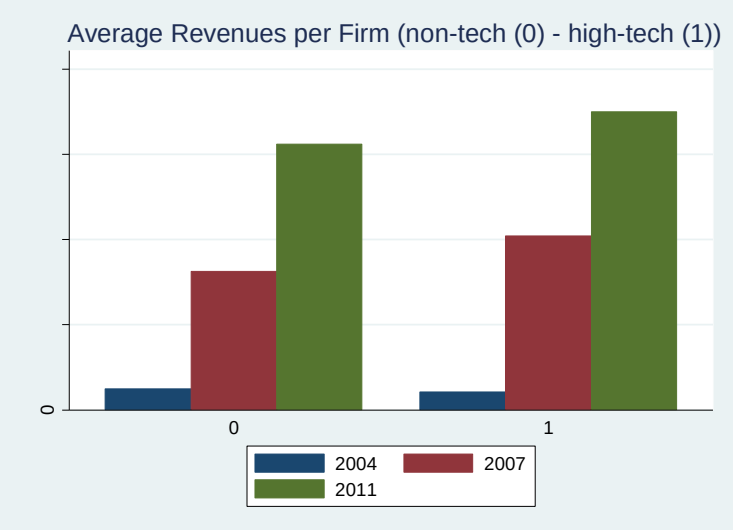


Figure 11. Evolution of average revenues per firm (2004-2011)



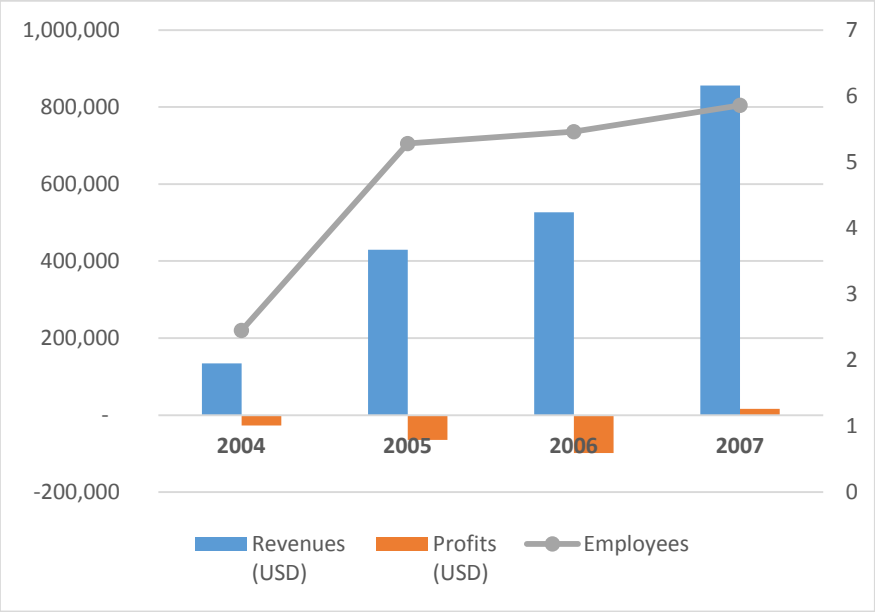
Focusing on the first years of evolution of the new venture, where we expect to see the evolution of the firms towards venture emergence, we observe that there is a change in the average values of the firm that manage to stay in operation. For example, there is a continued growth in the total revenues, and an improvement on the average profits that turns positive in the third year of operations (2007). Similar changes can also be observed in the number of employees and in the evolution of the venture emergence status (further details on the venture emergence are detailed in the next section). In the table we also included as a reference the average number of patents and trademarks of the active firms (see Table 20).

Table 20. Descriptive measures of the active NTBFs in the 2004-2007 period

	Revenues (USD)	Profits (USD)	Employees	Patents	Trademarks	Venture Emergence
2004	134.360	- 27.186	2,45	0,99	0,67	2,34
2005	429.289	- 64.005	5,28	0,52	0,75	2,79
2006	526.710	- 98.710	5,46	0,82	0,87	2,81
2007	856.005	16.661	5,86	0,43	0,76	2,84

Using a graphic representation, it can be observed that there is an important change between the values of the year where firms start operations (2004) and the first wave of data one year after (2005). We only see a similar substantial change in the last year (2007) where there is an important growth of the average revenues, and an improvement on the average profit.

Table 21. Graphical description of the performance measures of active NTBFs (2004-2007)



The observation of the changes in the performance measures of the new firms in the sample opens a question on whether there are or not different profiles of high-technology organizations in the sample. Using the NAICS classification reported by the entrepreneur, we can observe the different sub industries where the firms are operating (see Table 22).

In this table we have used average data of the firms in the sample for the period 2004-2007, in order to get a less biased illustration of the different behavior of the firms in each industry (reducing swift changes in the number of patents, trademarks, or changes in the revenues).

The descriptive results show that firms in different industries, on average, display rather different performance values, and are quite different in size. Without entering in statistical analyses on the significance of those differences, they point out the importance to narrow

properly the types of firms that we include in the model tests. For example, firms that are solely providing services (as it might be the case of some firms in the NAICS 541 or 518) might not fit with the type of research problems that we are exploring, behaving instead like other service firms in other industries. Additional controls are introduced in the research model test to control for this potential bias (controlling that firms in the sample, besides offering services also commercialize a product).

Table 22. Detail on the different high-tech sub industries included in the sample (across 2004-2007)

NAICS	Description	Revenues (USD)	Profits (USD)	Employees	Patents	Trademarks	Venture Emergence	N	%
325	Chemical Manufacturing	503.457	- 343.472	4,3	1,02	0,86	2,62	32	8%
333	Machinery Manufacturing	759.022	42.635	5,8	1,84	0,33	2,39	46	11%
334	Computer and Electronic Product Manufacturing	649.763	- 94.853	6,6	0,56	0,8	2,76	112	27%
511	Publishing Industries	441.984	- 46.997	4,5	0,27	1,18	2,62	22	5%
518	Data processing Hosting and Related Services	6.685	- 705	0,7	0	0,73	2,33	15	3%
541	Professional, Scientific, and Technical Services	232.868	13.804	3,4	0,51	0,73	2,8	190	46%
								417	(*)

Source: NAICS code details from http://siccode.com/en/search/ (accessed 15/03/2015)

** The number of firms for each reported NAICS is an average of the 2004-2007 active firms.*

The distribution of firms across NAICS also shows that some sub-industries have a stronger presence in the sample than others. For example, there is a good representation of electronics and computer products manufacturing, showing a good fit with our qualitative studies sample (see Table 5).

The description of the key measures of the firms in the sample provides the background support to proceed with the description of the dependent variable and then advance to the research model hypotheses test.

8.2. Descriptive analysis of the Venture Emergence of NTBFs

The first step in the description of the results is to provide further information on the dependent variable that is the subject of study: venture emergence. As previously described, we are measuring venture emergence by using a combination of indicators: whether the firm had sales, received external funding, made a profit, or hired any employees. The combination of these different dimensions gives us a status of the new technology-based firm (from 0 to 4) and an indicator of its degree of emergence into a firm that is likely to stay operating in the market.

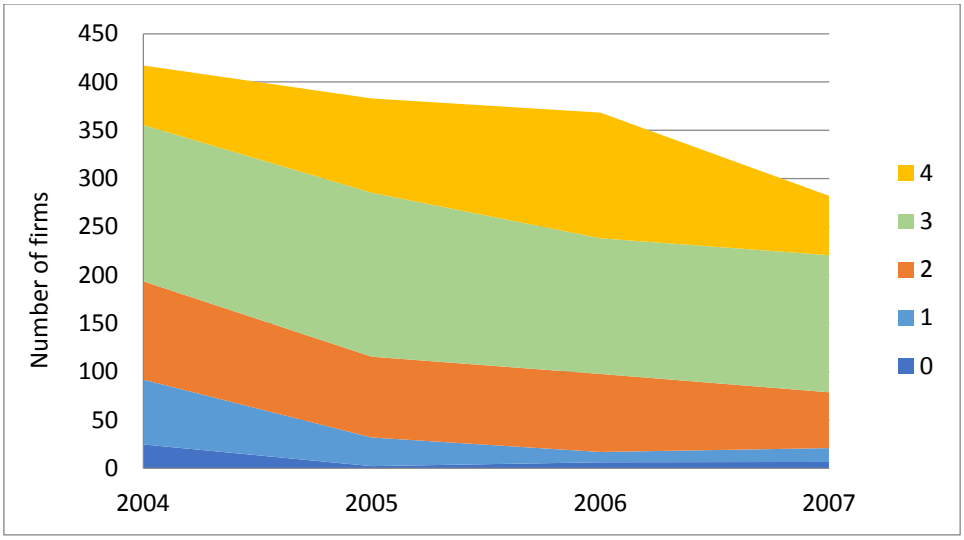
Nevertheless, venture emergence could have different values during the first years of operation of the new firms. A unique advantage of this dataset is that all firms started (are registered) in the same year, so they are the same cohort (Delmar & Johnson 2015); as a result, we are in a unique position to observe the changes in the indicator measurement, and

also the changes in its components. In other words, we have the possibility to understand whether there are differences in the active components that create status 1, 2, 3, or 4, in the year 2004, and also three years later, in 2007 (or any other year included in the dataset).

A graphic representation has been generated to illustrate what are the components that build the different status levels across the different years. This description also helps to better understand the meaning of each of the status levels for this type of firms.

In the first graphic we can observe how the number of firms in each status levels changes across time (see Figure 12). It can be observed that the number of firms in status "1" or "2" of venture emergence diminishes with time. Also the number of firms that do not have any of the four indicators active practically disappear after one year. It is also relevant to point out that the most dominant state across the different years is status "3".

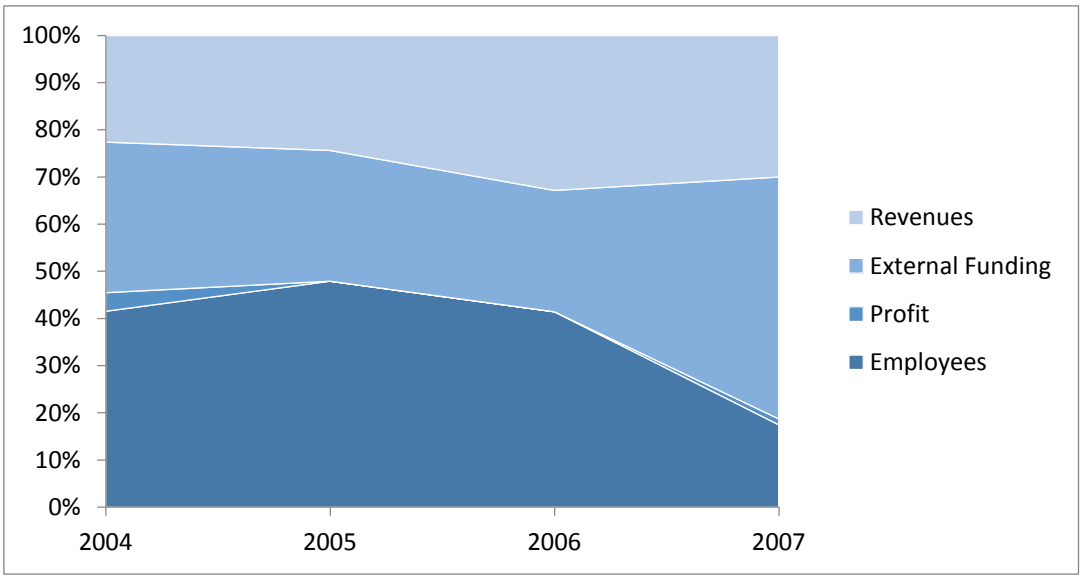
Figure 12. Evolution of the number of firms for each Venture Emergence status (2004-2007)



In order to understand with more detail the components that build each of the status levels in each year, further graphical representations are provided.

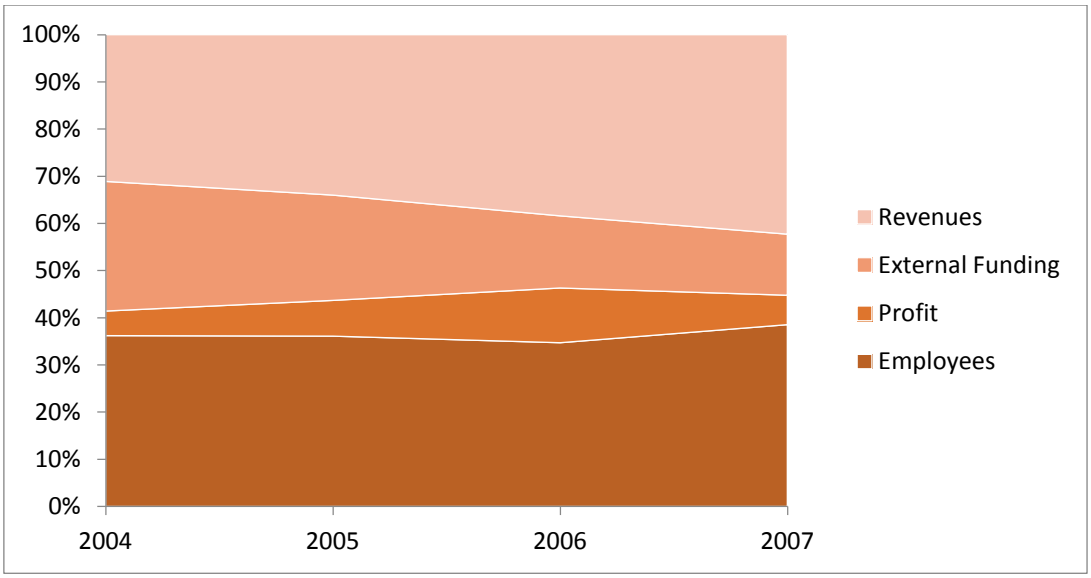
First, we can observe that for firms that are reported in status "1" of venture emergence (only one dimension is active) the dimension that contributes to the status changes across the years (see Figure 13). Meanwhile in the first years status "1" firms are mostly firms that only have employees, in 2007 the majority is firms that have received external funding but have not any other activity dimension (no sales and no employees beyond the entrepreneurial team).

Figure 13. Evolution of the components of Venture Emergence (status "1")



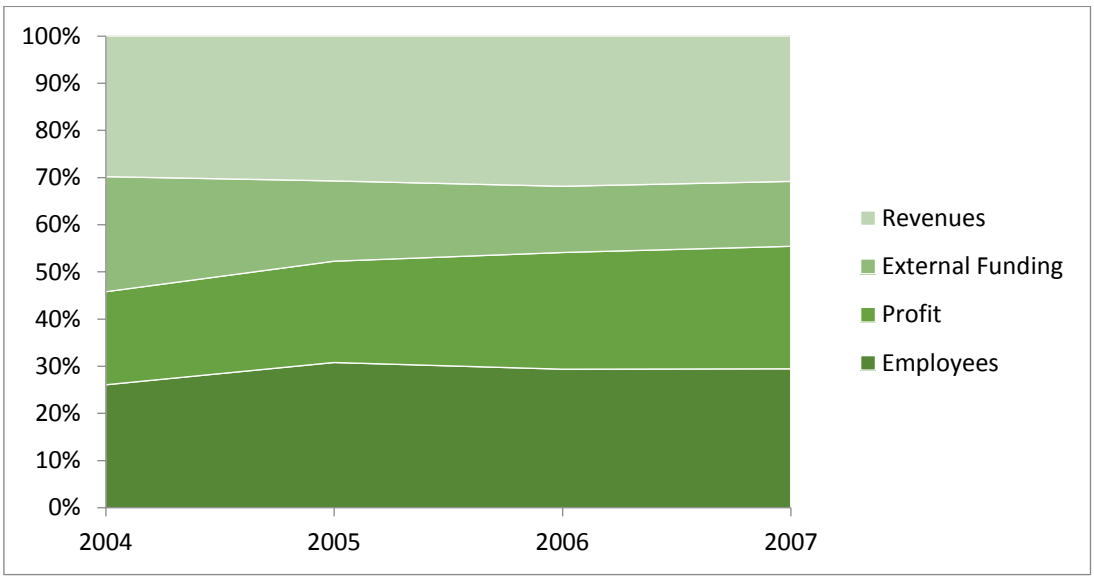
Second, when following up the meaning of venture emergence status "2" across the years, we observe that the source of the two active indicators of emergence, in 2004, could be a combination of revenues and/or external funding, and/or having employees (see Figure 14). But, after three years (in 2007) firms that still only report being active in two dimensions of venture emergence are mostly the firms that have employees and revenues, but have not managed to turn revenues into profits and have not received external funding.

Figure 14. Evolution of the components of Venture Emergence (status "2")



Third, and last, we observe how the components of status "3" across the different yearly waves of data is the most stable (see Figure 15). There is only a small difference on the weight of the component "external funding" that diminished across time, at the same time that the "profit" component increased. This shows that the meaning of venture emergence status "3" in the last waves of data is more related to firms having profits than to having received external funding (besides having employees and some revenues). This also shows that new technology-based firms do not need to achieve status "4" to be fully operating.

Figure 15. Evolution of the components of Venture Emergence (status "3")



Besides understanding the possible different profiles behind the different venture emergence dimensions, we are also interested in assessing whether there is a relationship between the proposed measure of venture emergence and the duration (survival) of the firms. Using a regression tests we aim to establish whether venture emergence is also a good predictor of firm duration. If so, this would mean that firms that show higher venture emergence status would be more likely to have stayed longer in the panel dataset. The maximum value for firm duration is 7, as it counts each year since the baseline (2004) till the end of the data collection (2011).

The results of the analysis (see Table 23) show that there is a positive coefficient (0.23 ; $p<0.01$) between the higher values of venture emergence and duration (as number of years that we can observe the new firm to stay active). Supporting the idea that venture emergence status has a positive influence on the survival (in this case measured through number of years active) of the new firm.

Table 23. Ordinal Logit regression between Venture Emergence and Duration (Venture Emergence status in 2004-2007)

	Ordinal Logit Estimation	
	Duration	
	Coef.	*S.E.*
Venture Emergence	**.23*** **	**.03**
/cut 1	-3.16	.12
/cut 2	-2.01	.10
/cut 3	-1.54	.09
/cut 4	-.82	.08
/cut 5	-.61	.08
/cut 6	-.40	.08
/cut 7	-.14	.08
Log Likelihood (LL)	*-5,758.23*	
LR chi2 =	*58,12*	
Prob > chi2 =	*0.00*	

*Notes: *p < 0.1, **p < 0.05, ***p< 0.01*

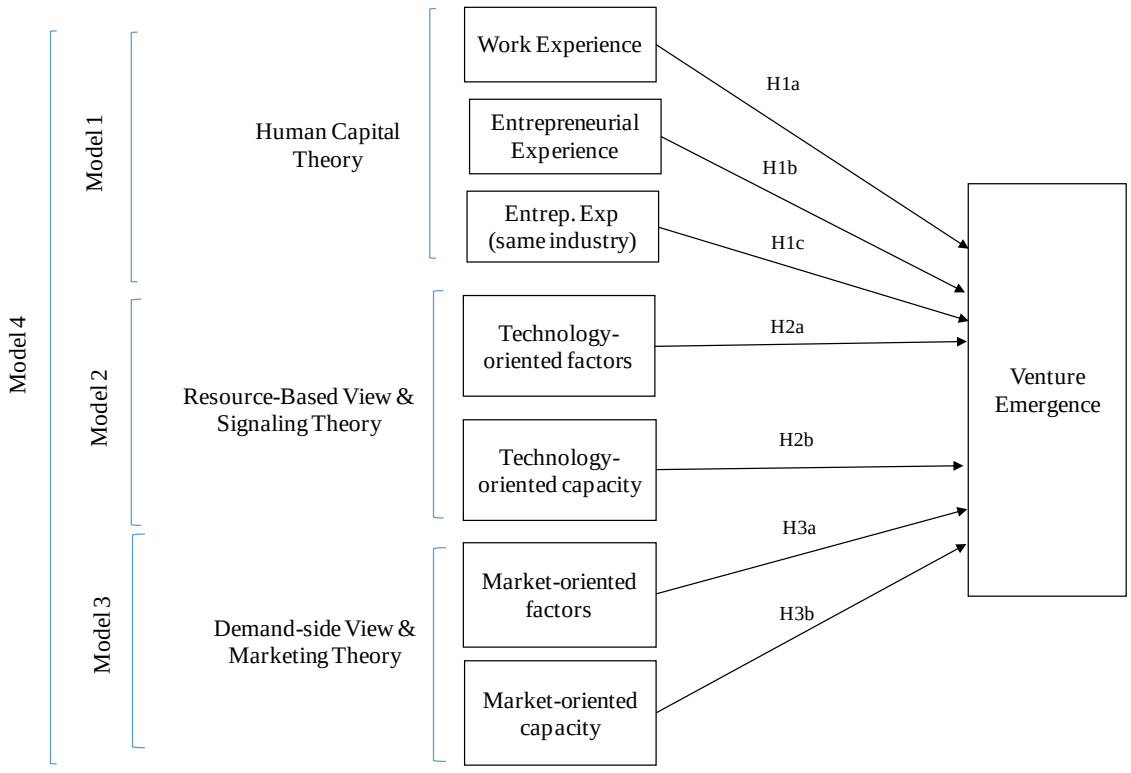
The understanding of the characteristics of the dependent variable, and how it is built, provides the needed background to enter into the description of the research model hypotheses test results.

8.3. Venture Emergence in NTBFs, results of the hypotheses test

This section is structured following the hypotheses described in the research model (see Table 24). First, the descriptive statistics of the variables used in the research model are presented; then the different hypotheses tests are introduced; finally the additional robustness tests performed are also described.

The research model described three main different hypotheses (H1, H2, and H3). We have used the ordered logit estimation of venture emergence (ordinal variable, with an ordered range of value from 0 to 4), to test the effects of the hypotheses. In order to control the effects of each of the independent variables that were introduced, we have built four different models. The utilization of models makes it easier to see the effects of the introduction of the new constructs and control for the changes in measures such as r2 (see Dimov (Dimov 2010) for a similar example). The figure below describes the use of the models and the hypotheses of the research framework (see Figure 16).

Figure 16. Data Analysis Models and linkages with the Research Model Hypotheses



Model 1 introduces the independent variables needed to assess the human capital hypotheses (H1a, H1b, H1c). Model 2 adds the independent variables to test the influence of technology-

oriented actions hypotheses (H2a, H2b). Model 3 introduces the independent variables to measure market-oriented actions (H3a, H3b).

The linkage between the hypotheses framework on the NTBFs emergence is linked to the statistical models developed to test the hypotheses (see Table 24).

Table 24. Hypotheses and research model correspondence

Hypothesis	Model	Reference Theory perspective
H1a: Founder's human capital (in years of work experience) has a positive influence on the new technology-based venture emergence	**Model 1**	Human Capital Theory
H1b: Founder's human capital (as entrepreneurial experience) has a positive influence on the new technology-based venture emergence		
H1c: Founder's experience (as prior startup experience in the same industry) has a positive influence on the new technology-based venture emergence.		
H2a: Technology-oriented factors would positively influence venture emergence	**Model 2**	Resource-based view and & Signaling Theory
H2b: Building a Technology-oriented capacity would positively influence venture emergence		
H3a: Market oriented factors would positively influence venture emergence.	**Model 3**	Demand-side View & Marketing Theory
H3b: Market-oriented capacities would positively influence venture emergence		

An additional model has been introduced in order to compare the different effects of the hypotheses and extract additional results; model 4 includes all the variables (from the different research models) in the same model in order to provide support for a comparative analysis between the different models contributions and also an assessment on whether there is a model fit improvement as we introduce the technology and market-oriented actions variables (see Figure 16).

8.3.1. Descriptive statistics

The descriptive statistics of the variables (see Table 25) includes the mean, standard deviation (SD) and the correlations between the dependent and the independent variables. We have included in the table a group of variables that are only used in the robustness tests: revenues, profits, and employees; the reason to include them in the correlation table is to be able to also identify any a-priori correlations that might be important in the interpretation of the results.

The descriptive statistics helps to get information on the average profile of the new venture in the sample. The average age of the entrepreneurs in the dataset is close to 46 years, their education is above a bachelor's degree, and most of them are men (86%). The entrepreneurs have on average 15.45 years of overall work experience, and have started 1.28 startups in the past. Of those with entrepreneurial experience, 49% had it in the same industry as their current new venture.

At the firm level, the average number of patents is 0.68 and 35% of their employees are in the R&D function. Firms also hold on average 0.79 trademarks, and 47% of their employees are in the marketing and sales function.

The new ventures have on average 432,693 USD in revenues, generating in average 47,438 USD in losses, with 4.63 employees.

Although most of the variables are not correlated, there are a few correlations between variables that require a brief analysis:

- Age and Work experience (0.56), both variables are recorded in number of years, so we could expect that older individuals also have more years of work experience.
- Work experience and Entrepreneurial Experience (0.46), this shows that it is common to see that people with more years of work experience also have had entrepreneurial experience in the past.
- Patents - average number - and Education (0.29) although low, it shows that there is linkage (although weak) between level of education of the founder and the number of patents hold by the new firm.
- % of Employees in R&D (avg) and % Employees in Market functions (avg), contrary to potential expectations that those would be substitute activities, the low correlation (-0.01) suggests that these are cases where they might be substitution effects and other firms where they actually are complementary (for example showing a high % in both functions).

- Revenues and Employees (0.6), as it could be expected firm size influences the relationship between number of employees and revenues of the firm, interestingly enough this measures do not seem to be correlated with other variables (for example no direct relationship between number of patents or trademarks and firm size measures).

The results description continues with an analysis of each of the models used for the hypotheses in the research model.

8.3.2. The Human Capital influence on NTBFs' Venture Emergence (Model 1)

In the analysis of the different models we use the McFadden pseudo-R2 as a measure for the variance explained; it allows us to observe the changes that in variance explained by the model as we add new variables. The analytical method we use (ordinal logit) does not report a regression-like R-square (R2) result, therefore we use an accepted alternative measure (see Hoetker (2007) for further discussion on pseudo-R2 measures). In fact, our analysis focuses on the validity of the reported results (coefficients), using the Likelihood Ratio (LR) of the Chi-Square (Chi2) test. High Chi2 values provide support to rejecting the extreme possibility of having all coefficients equal to zero is very low (reported, for example, in the Table 26 as "Prob>chi2=0.00").

The Model 1 (see Figure 16) explores the influence of the different human capital hypotheses (H1a, H1b, and H1c) from the research model. The results show a low overall McFadden pseudo-R2 suggesting that the human capital factors only explain a limited part of the overall variance; nevertheless, we are more interested in the direction and magnitude of the coefficients (as described in the hypotheses development).

For the first two hypotheses (H1a and H1b), related to the influence of years of Work Experience and the number of Entrepreneurial Experience of the subjects, the results show that we do not have sufficient statistical significance to assess their validity. Nevertheless H1c is confirmed, supporting that Entrepreneurial Experience in the same industry could be a positive influence on venture emergence (.24; $p<0.01$). These results suggest that having entrepreneurial experience, in particular if it is in the same market where the NTBFs are operating, has a rather positive influence on the venture emergence status.

Table 25. Descriptive statistics and correlations

		Mean	SD	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	Venture emergence	2.71	0.99	1.00																	
2	Age	46.02	11.12	-0.08	1.00																
3	Education	7.36	1.89	-0.19	0.07	1.00															
4	Gender	0.86	0.34	0.03	0.04	0.09	1.00														
5	Work Experience	15.45	11.17	0.06	0.56	-0.08	0.22	1.00													
6	Entrep. Experience	1.28	1.56	-0.07	0.25	0.01	0.08	0.10	1.00												
7	Entrep. Experience (in industry)	0.49	0.50	0.11	0.20	-0.05	0.06	0.46	0.05	1.00											
8	Patents (dev)	0.01	3.46	0.09	0.09	0.02	0.00	0.01	-0.01	0.01	1.00										
9	Patents (avg)	0.68	1.83	-0.12	0.24	0.29	0.12	0.23	0.19	0.07	0.09	1.00									
10	% R&D employees (dev)	0.02	0.27	-0.10	0.00	0.09	-0.04	-0.01	0.05	-0.09	0.00	0.03	1.00								
11	% R&D Employees (avg)	0.35	0.28	-0.13	-0.12	0.13	0.12	0.10	0.01	0.07	0.01	0.11	-0.07	1.00							
12	Trademarks (dev)	-0.03	1.14	0.05	0.01	0.00	-0.03	0.00	-0.14	-0.10	0.07	-0.11	-0.06	0.07	1.00						
13	Trademarks (avg)	0.79	1.66	-0.09	-0.01	0.14	0.13	0.00	0.17	0.07	-0.06	0.31	0.02	-0.13	-0.45	1.00					
14	% Market employees (dev)	0.02	1.67	-0.03	-0.01	0.01	-0.02	0.00	-0.01	0.02	0.01	0.00	0.06	0.02	0.00	0.01	1.00				
15	% Market employees (avg)	0.47	1.64	0.15	0.02	-0.03	0.03	0.00	0.05	-0.10	0.01	-0.02	0.00	-0.04	0.01	-0.06	-0.29	1.00			
16	Revenues	432,693	1,405,504	0.08	0.11	0.10	-0.07	0.00	-0.08	0.11	-0.02	0.05	-0.04	-0.20	-0.02	0.11	0.00	-0.04	1.00		
17	Profits	- 47,438	758,955	0.15	0.04	-0.03	-0.08	0.02	-0.15	-0.07	0.01	-0.22	0.02	-0.11	0.01	-0.09	0.00	0.03	0.20	1.00	
18	Employees	4.63	8.84	0.02	0.12	0.07	-0.09	0.05	-0.05	0.22	-0.05	0.09	-0.06	-0.24	-0.06	0.17	-0.01	-0.07	0.60	-0.05	1.00

Note:

avg: firm's mean, measuring between firm component

dev: firm's mean deviation, measuring within firm component

Taking this first models as a baseline (starting point of the analysis); we can briefly comment on the influence of the control variables (age, education, and gender) although they are not part of this first hypotheses. While Age showed no relation with venture emergence (-.02; p<0.01), Education (higher education levels) showed to have a slight negative effect (-.11; p<0.01); meanwhile Gender (.54; p<0.01) suggests a positive relationship between male entrepreneurs and venture emergence, this coefficient needs to be interpreted with caution as the proportion of women entrepreneurs in the NTBFs is rather low, and the actual reference sample might be very reduced.

Table 26. Model 1 - Likelihood of Venture Emergence - H1

	Ordinal Logit Estimation	
	Vent Emerg.	
	Coef.	*S.E.*
Work Experience	.00	.00
Entrep. Experience	-.02	.02
Entrep. Exp. (same industry)	.24***	.08
Age	-.02***	.00
Education	-.11***	.02
Gender	.54***	.12
2005	.77***	.09
2006	1.07***	.10
2007	.97***	,10
_cons	-	
/cut 1	-4.30	.26
/cut 2	-2.59	.24
/cut 3	-1.12	.23
/cut 4	.89	.23
Log Likelihood (LL)	*-3,566.36*	
LR chi2 =	*249.88*	
Prob > chi2 =	*0.00*	
n	*447*	
(Pseudo) R2	.03	

*Notes: *p < 0.1, **p < 0.05, ***p< 0.01*
avg: firm's mean, measuring between firm component
dev: firm's mean deviation, measuring within firm component

To summarize Model 1 analysis, the results do not allow to make an assessment on H1a, or H1b, but offer a strong support for H1c, suggesting the positive influence of entrepreneurial experience on the same market industry for the likelihood of venture emergence of the NTBF.

8.3.3. Technology orientation influence on NTBFs' Venture Emergence (Model 2)

Model 2 introduces the technology-oriented actions in the study of the venture emergence of the NTBFs. We maintain the variables introduced in the first model so that we can use them as a reference control on the effects of the new variables (see Table 27).

The overall fit of the model has improved by 2%, again, this evaluation based on McFadden Pseudo-R2 should be done with caution, but what we can observe is that there is a better model fit that with only the initial set of variables in the Model 1.

Observing the results related to the independent variables used to measure H2a and H2b we can observe the following: (H2a) neither the average number of patents (-.04; $p<0.01$) across 2004-2007 (Patents (avg)), neither the NTBFs changes in patenting activity (Patents (dev) .05; $p<0.01$) showed a substantial influence on the likelihood of venture emergence.

Nevertheless, for the second set of variables (H2b) we observe that those firms that on average had a higher percentage of R&D Employees than their peers, were less likely to show high values on the venture emergence (-1.01; $p<0.01$). We do not have statistical support to assess for the changes (increases or decreases) on the % of R&D employees in across the 2004-2007 time span. The suggestion that the in-between (avg) difference has a negative influence on the venture emergence likelihood requires further analysis in the discussion section.

The other control variables show similar values as in Model 1, suggesting that the model is stable and the introduction of the technology-oriented measures has not changed the orientation of the coefficients, but instead it has contributed to a better understanding of the venture emergence.

Table 27. Model 2 - Likelihood of Venture Emergence - H2

	Ordinal Logit Estimation	
	Vent Emerg.	
	Coef.	*Robust S.E.*
Work Experience	.02***	.01
Entrep. Experience	-.04	.03
Entrep. Exp. (same industry)	.38***	.10
Patents (dev)	.05***	.01
Patents (avg)	-.04**	.02
% R&D employees (dev)	-.16	.17
% R&D Employees (avg)	-1.01***	.17
Age	-.03***	.01
Education	-.14***	.03
Gender	.34**	.16
2005	.43***	.12
2006	.84***	.13
2007	.56***	.14
_cons	-	
/cut 1	-4.83	.34
/cut 2	-2.76	.33
/cut 3	-.30	.32
/cut 4	-	-
Log Likelihood (LL)	*-2,083.00*	
LR chi2 =	*239.15*	
Prob > chi2 =	*0.00*	
n	*303*	
(Pseudo) R2	0.05	

*Notes: *p < 0.1, **p < 0.05, ***p< 0.01*

avg: firm's mean, measuring between firm component

dev: firm's mean deviation, measuring within firm component

8.3.4. Market orientation influence on NTBFs' Venture Emergence (Model 3)

This third model introduces the market-oriented actions and explores its influence in the venture emergence likelihood (see Table 28).

The introduction of the variables used to test for the H3 has also generated a change in the McFadden pseudo-R2, increasing in comparison to Model 1. The degree of changes is slightly above the contribution observed in Model 2 where the variables related to technology oriented-actions had been introduced.

The results show different statistical support for the two hypotheses under study: H3a and H3b. In the case of H3a, there is a very weak statistical support to assess whether the activity on trademark registration is influencing the venture emergence likelihood.

Table 28. Model 3 - Likelihood of Venture Emergence - H3

	Ordinal Logit Estimation	
	Vent Emerg.	
	Coef.	*Robust S.E.*
Work Experience	.01*	.01
Entrep. Experience	-.06**	.03
Entrep. Exp. (same industry)	.52***	.10
Trademarks (dev)	.04	.04
Trademarks (avg)	-.04	.02
% Market employees (dev)	.46***	.11
% Market employees (avg)	.81***	.14
Age	-.02***	.00
Education	-.17***	.03
Gender	.30*	.16
2005	.57***	.12
2006	1.00***	.13
2007	.72***	.13
_cons	-	
/cut 1	-4.18	.33
/cut 2	-2.11	.32
/cut 3	.36	.31
/cut 4	-	-
Log Likelihood (LL)	*-2,056.25*	
LR chi2 =	*276.61*	
Prob > chi2 =	*0.00*	
n	*296*	
(Pseudo) R2	0.06	

*Notes: *p < 0.1, **p < 0.05, ***p< 0.01*
avg: firm's mean, measuring between firm component
dev: firm's mean deviation, measuring within firm component

On the other hand, for H3b, we have statistical support to argue that there is a positive influence on venture emergence when there is a higher average % employees in market-related functions (.81; p<0.01). Also, firms that increase their % across the time span (2004-2007) show a positive coefficient towards a higher likelihood of venture emergence (.46; p<0.01).

As also observed in Model 2, the variables related to Model 1 and the control variables, show similar values (and coefficient sign) and levels of statistical significance.

8.3.5. Complete research framework: influencing factors on NTBFs' Venture Emergence (Model 4)

The results for the complete research framework (see Figure 16 for visual layout of the model 4) offer the possibility to develop a comparative analysis with the contributions and effects of the previous partial models. The results for the complete model (see Table 29) show an increase of the pseudo-R2 explained, suggesting that the introduction of technology and market-oriented hypotheses has enriched our initial understanding (Model 1) based only on the influence of human capital factors.

The complete model also allows for a review of the different hypotheses evaluation and a description of the changes in coefficients and statistical significance. Regarding the first group of hypotheses on the influence of human capital, in the Model 4 there is statistical support to argue that years of work experience are observed to have a weak influence on the venture emergence likelihood (.02; $p<0.01$). Although we still do not have statistical support to test overall entrepreneurial experience (H1b), we see a confirmation that entrepreneurial experience in the same industry (H1c) has a positive and significant coefficient on venture emergence (.59; $p<0.01$).

Regarding the second group of hypotheses (H2a and H2b), we observe almost exact results for H2a in both coefficients and statistical significance. Regarding H2b, there is a confirmation of the negative effects of having a higher % of employees in R&D (in average), and there is also the observation that increasing the % in the time span of observation (2004-2007) has also a negative effect on the venture emergence likelihood (-.47; $p<0.05$). Although for H2a the result would be that no clear effect is observed; for H2b, the effects are actually in the opposite direction than in the proposed hypothesis.

The coefficients and statistical significance for the last group of variables that were introduced in Model 3 (H3a and H3b) see their influence increased in Model 4 (complete model). For example, although we still cannot assess whether increasing the number of trademarks has a positive influence (as part of the market oriented actions in H3a), we now can observe that there are no observed effects, or even slightly negative, of having a higher average number of trademarks compared to other NTBFs in the sample (-.05; $p<0.05$). Alternatively, we see a confirmation on the positive influence of increasing the intensity on the % of employees in

market-related functions (.55; p<0.01) and on having a higher average of % of employees in that function in the different years under observation (1.54; p<0.01).

Compared to the observed coefficient values for the control variables (age, education, gender) we do not observe substantial changes compared to the first model under study (see Table 26).

As part of the results of the complete model, we confirm that the year control (included in all the previous models 1, 2, 3), points that in all the specifications the effect of time is positive. Thus, firms that survive are also more likely to have a higher level of venture emergence.

Table 29. Model 4 - Results from the ordinal estimation of the hypothesized effects on the Venture Emergence of NTBFs

	Ordinal Logit Estimation **Venture Emergence**							
	Model 1		**Model 2**		**Model 3**		**Model 4**	
	Coef.	*S.E.*	*Coef.*	*Robust S.E.*	*Coef.*	*Robust S.E.*	*Coef.*	*Robust S.E.*
Work Experience	.00	.00	.02***	.01	.01*	.01	.02***	.01
Entrep. Experience	-.02	.02	-.04	.03	-.06**	.03	-.03	.03
Entrep. Exp. (same industry)	.24***	.08	.38***	.10	.52***	.10	.59***	.10
Patents (dev)			.05***	.01			.04***	.01
Patents (avg)			-.04**	.02			-.04*	.02
% R&D employees (dev)			-.16	.17			-.47**	.19
% R&D Employees (avg)			-1.01***	.17			-1.82***	.20
Trademarks (dev)					.04	.04	.04	.04
Trademarks (avg)					-.04	.02	-.05**	.02
% Market employees (dev)					.46***	.11	.55***	.14
% Market employees (avg)					.81***	.14	1.54***	.17
Age	-.02***	.00	-.03***	.01	-.02***	.00	-.04***	.00
Education	-.11***	.02	-.14***	.03	-.17***	.03	-.09***	.03
Gender	.54***	.12	.34**	.16	.30*	.16	.42**	.17
2005	.77***	.09	.43***	.12	.57***	.12	.52***	.12
2006	1.07***	.10	.84***	.13	1.00***	.13	.93***	.14
2007	.97***	,10	.56***	.14	.72***	.13	.65***	.14
_cons	-		-		-		-	
/cut 1	-4.30	.26	-4.83	.34	-4.18	.33	-4.65	.35
/cut 2	-2.59	.24	-2.76	.33	-2.11	.32	-2.50	.34
/cut 3	-1.12	.23	-.30	.32	.36	.31	.08	.33
/cut 4	.89	.23	-	-	-	-	-	-
Log Likelihood (LL)	*-3,566.36*		*-2,083.00*		*-2,056.25*		*-1,992.46*	
LR chi2 / Wald Chi2 =	*249.88*		*239.15*		*276.61*		*391.23*	
Prob > chi2 =	*0.00*		*0.00*		*0.00*		*0.00*	
n	*447*		*303*		*296*		*290*	
(Pseudo) R2	.03		0.05		0.06		0.09	

*Notes: *p < 0.1, **p < 0.05, ***p< 0.01*

avg: firm's mean, measuring between firm component

dev: firm's mean deviation, measuring within firm component

8.4. Assessing the results robustness: studying NTBFs' growth.

The introduction of additional robustness tests responds to the interest to assess whether the results that we have obtained are consistent with other possible results that could be generated for similar research designs. They are introduced to provide further depth of understanding on the initial set of results and also to provide ground for a more detailed results discussion.

First, we introduce three variations on the complete Model 4 (where we tested the three groups of hypotheses - H1, H2, and H3) changing the dependent variable (DV). Instead of using venture emergence, we assess the differences on the independent variables coefficients for Revenues, Profits, and Employees. All those three variables have been used to measure growth in other research studies (Colombo & Grilli 2005; McKelvie & Wiklund 2010) on the development of NTBFs, and could provide additional insights on the evolution of this type of firms in their early-stages. This series of tests are done using mixed method regression, also called hybrid method (Schunck 2013); this allows to combine in the same regression analysis time invariant variables (such as the ones related to human capital of the entrepreneur), with other variables that change across time (for example the within change in the number of patents or in the % of employees in R&D functions).

Second, we extend our understanding on the factors influencing the venture emergence of NTBFs by introducing a multinomial analysis with venture emergence as dependent variable (values 0-4). This analysis offers the possibility to better understand the characterization of the firms that are more likely to stay in each of the different levels of venture emergence in the period of observation.

8.4.1. Robustness test with Revenues as dependent variable

An alternative approximation to study the venture emergence of NTBFs could be to focus on studying the growth of ventures in their early stage (2004 to 2007). Although some scholars argue that revenues or sales only capture market performance (Vandenbroucke et al. 2014) it is still one of the most common performance measures in growth studies (McKelvie & Wiklund 2010). Therefore, in this study, we use revenues as a measure to explore the robustness of our findings, and we add additional checks on profits and employees to complete the assessment.

As it can be seen in the following table (see Table 30), for H1, the results point to similar results as in venture emergence (VE). For example a positive and statistically significant effect

(632,422; p<0.01) is observed for H1c (entrepreneurial experience in the same industry). Meanwhile, relatively weak effects are observed for overall work experience (-19,175; p<0.01) and some more negative effects for entrepreneurial experience (-169,299; p<0.01).

For H2, the results only provide statistical support to describe that for H2b there is a significant negative estimation of the effect of having a high average number of employees in the R&D function (-1,390,486; p<0.01). Suggesting that those firms that are significantly different that their peers, and have a high intensity in R&D are less likely to have high revenues in the period of time under study (2004-2007).

Table 30. Robustness test with Revenues as DV

	Mixed Method Regression	
	Revenues	
	Coef.	*S.E.*
Work Experience	-19,175***	5,281
Entrep. Experience	-169,299***	32,199
Entrep. Exp. (same industry)	632,422***	103,105
Patents (dev)	-478	8,593
Patents (avg)	24,599	21,982
% R&D employees (dev)	31,053	166,971
% R&D Employees (avg)	-1,390,486***	173,034
Trademarks (dev)	44,771	35,227
Trademarks (avg)	88,169***	25,152
% Market employees (dev)	-18,331	21,516
% Market employees (avg)	-34,118	22,309
Age	26,924***	5,255
Education	127,890***	27,234
Gender	-401,219**	168,754
2005	578,155***	123,511
2006	503,195***	133,168
2007	1,038,779***	138,667
_cons	-832,593**	329,002
Log Likelihood (LL)	*-29,986.93*	
LR chi2 / Wald Chi2 =	*307.34*	
Prob > chi2 =	-	
n	*286*	
(Pseudo) R2	0.10	

*Notes: *p < 0.1, **p < 0.05, ***p< 0.01*

avg: firm's mean, measuring between firm component

dev: firm's mean deviation, measuring within firm component

Regarding H3, there is only statistical support to observe that for H3a the firms that show a higher average number of trademarks are estimated to have a slightly positive effect on their revenues (88,169; p<0.01).

As it was also observed in Model 4 of the venture emergence results, the control variables (Age, Education and Gender), as well as the year controls, provide some additional information. In this analysis we observe that age and education have a positive effect on revenues, while gender (male) has a significant negative effect (-401,219; p<0.05). Regarding the year controls, we observe that as firms' advance each year there is an overall positive estimated effect on their revenues likelihood.

8.4.2. Robustness test with Profits as dependent variable

The second test introduced aims to extract additional information on whether the emergence of the new firm (measured now as growth) is sustainable (Newbert & Tornikoski 2013). Thus Profits as DV are introduced to explore whether there are any substantial changes in the driving factors.

As it can be observed in the results table for this analysis (see Table 31), for H1 only the overall work experience (H1a) seems to have a positive effect on the profits of the NTBF (11,525; p<0.01). On the other hand, H1b (Entrepreneurial Experience, -100,208; p<0.01) and H1c (Entrepreneurial experience in the same industry, -248,328; p<0.01) show a significant and negative effect on profits.

On the H2, we observe that for H2a we can see that firms with stronger positions in R&D (as in average number of patents) are less likely to have profits (-113,911; p<0.01). Similarly, the firms that compared to their peers have higher % of R&D employees also are estimated to be less likely to produce profits (-315,978; p<0.01).

Regarding H3, there is statistical support to argue that the firms that show a substantial increase in their number of trademarks, thus sustaining an increasing market-oriented action, are subject to a negative effect on their profits (-32,341; p<0.1).

Table 31. Robustness test with Profits as DV

	Mixed Method Regression	
	Profits	
	Coef.	*S.E.*
Work Experience	11,525***	2,907
Entrep. Experience	-100,205***	17,743
Entrep. Exp. (same industry)	-248,328***	56,581
Patents (dev)	1,705	4,703
Patents (avg)	-113,991***	12,111
% R&D employees (dev)	-23,289	91,599
% R&D Employees (avg)	-315,978***	95,114
Trademarks (dev)	-32,341*	19,366
Trademarks (avg)	-1,557	12,807
% Market employees (dev)	-2,170	11,775
% Market employees (avg)	9,085	12,210
Age	6,805**	2,890
Education	31,915**	14,971
Gender	-229,540**	92,436
2005	-65,581	68,058
2006	-211,550***	73,175
2007	-10,634	76,278
_cons	-17,265	180,538
Log Likelihood (LL)	*-28,527.86*	
LR chi2 / Wald Chi2 =	*219.46*	
Prob > chi2 =	-	
n	*263*	
(Pseudo) R2	0.09	

*Notes: *p < 0.1, **p < 0.05, ***p< 0.01*

avg: firm's mean, measuring between firm component

dev: firm's mean deviation, measuring within firm component

The control variables offer information on the positive effects of Age and Education, but highly negative and significant on Gender (male, -229,540; p<0.05). Regarding the influence of the years, we only observe a sustained negative effect in 2006, not having enough statistical support to discuss the other year's controls.

8.4.3. Robustness test with Employees as dependent variable

The last alternative measure we introduce in this series of robustness tests is the number of employees of the new firm. The number of employees is used as a measure of firm size (Park et al. 2002), thus it offers an additional dimension of growth and organizational emergence in the early stages of a venture (Davila et al. 2003)

The results of these test show that for H1 we do not have statistical support to assess H1a, but for H1b there is a negative effect of Entrepreneurial Experience on the number of employees (-.92; p<0.01). On the other hand there is a significant and very high coefficient on Entrepreneurial Experience in the same industry (5.58; p<0.01). These results are also mostly in line with the observations of H1 tests with the venture emergence measure as dependent variable.

Table 32. Robustness test with Employees as DV

	Mixed Method Regression	
	Employees	
	Coef.	*S.E.*
Work Experience	-.05	.03
Entrep. Experience	-.92***	.19
Entrep. Exp. (same industry)	5.58***	.60
Patents (dev)	-.11**	.05
Patents (avg)	.32**	.13
% R&D employees (dev)	-1.62*	.97
% R&D Employees (avg)	-10.27***	.100
Trademarks (dev)	.12	.20
Trademarks (avg)	.69***	.15
% Market employees (dev)	-.07	.12
% Market employees (avg)	-.29**	.13
Age	.11***	.03
Education	.59***	.16
Gender	-3.66***	.98
2005	3.66***	.71
2006	3.25***	.77
2007	3.05***	.80
_cons	1.43	1.91
Log Likelihood (LL)	*-7,248.82*	
LR chi2 / Wald Chi2 =	*421.42*	
Prob > chi2 =	-	
n	*290*	
(Pseudo) R2	0.16	

*Notes: *p < 0.1, **p < 0.05, ***p< 0.01*

avg: firm's mean, measuring between firm component

dev: firm's mean deviation, measuring within firm component

On H2, we can observe differences from other previous tests. For H2a, we observe that there is a negative coefficient for firms that increase their number of patents (-.11; p<0.05), but a positive effect for firms that have, on average, a higher number of patents (.32; p<0.05). On

the other hand we see negative effects of having a high intensity of R&D employees (-10.27; p<0.01). Thus firms with high % of R&D employees are also expected to be smaller firms in the 2004-2007 interval.

Regarding H3, we observe that on H3a there is statistical support to argue that firms with high average number of trademarks are estimated to have more employees (.69; p<0.01). On the other hand, high proportion of market related employees has a slight negative effect on the number of employees (-.29; p<0.05).

The control variables show a positive small effect on the Age and Education variables. For gender there is a negative effect (-3.66; p<0.01) that is compensated with the coefficient values for the control years variables (all of them with coefficients above 3 and with p<0.01).

From the three robustness tests, this last one using Profits as DV is the one that shows a better overall fit (attention, R2 is obtained running a normal regression on the variables, thus only for comparison purposes). This provides further confidence on the coefficients and effects described in the hypotheses analyses results.

8.4.4. Multinomial test on Venture Emergence

The introduction of the multinomial test responds to the interest in understanding the different profiles of new technology-based firms behind the different status of venture emergence (VE), we will use the VE acronym for venture emergence in this and the following sections to simplify the presentation of the results.

The multinomial model offers the possibility to establish the likelihood of each of the different values of the variable under study (in this case VE), in relation to the most frequent status (in our case the most common status is VE=3). Thus when the different independent variables are shown to have positive coefficient, this is interpreted as that the factor positively influences the likelihood of that firm to be in the status level under observation, instead of being at the dominant status of VE (in this case: 3).

Therefore the description of the results will be done following the different venture emergence status values (see Table 33).

In order to describe the firms that are more likely to have VE value of "1" instead of "3", we see that there is a negative coefficient on Entrepreneurial Experience in the same industry (-1.11; p<0.01). But rather strongly positive coefficients for H2 variables (focus in Technology-Oriented actions and resources).

Table 33. Multinomial test on Venture Emergence

	Multinomial logit (base is VE = 3)					
	Status = 1 (VE)		**Status = 2 (VE)**		**Status = 4 (VE)**	
	Coef.	*S.E.*	*Coef.*	*S.E.*	*Coef.*	*S.E.*
Work Experience	.01	.02	-.02**	.01	.03***	.01
Entrep. Experience	.10	.10	.08*	.04	.05	.04
Entrep. Exp. (same industry)	-1.11***	.32	-.75***	.15	.08	.14
Patents (dev)	-.02	.08	.00	.03	.06**	.02
Patents (avg)	.20***	.06	.06*	.03	.02	.03
% R&D employees (dev)	1.58***	.47	-0.7	.26	-.45*	.27
% R&D Employees (avg)	4.09***	.63	2.4***	.28	.15	.26
Trademarks (dev)	-.21***	.08	-.09	.06	-.23***	.07
Trademarks (avg)	.17***	.06	-0.3	.04	-.08*	.04
% Market employees (dev)	-.92	.62	-.48**	.21	.12	.14
% Market employees (avg)	-8.62***	1.06	-1.51***	.26	.34**	.14
Age	.03*	.02	.03***	.00	-.04***	.01
Education	.00	.10	-.04	.04	-.14***	.04
Gender	13.54	639.90	-.73***	.21	.03	.24
2005	-.19	.31	-.34**	.17	.41**	.18
2006	-.50	.37	-.87***	.20	.60***	.19
2007	-3.20***	1.04	-.17*	.18	.37*	.20
_cons	-17.42	639.90	-.87*	.47	.97**	.45
Log Likelihood (LL)	*-1,859.77*					
LR chi2 / Wald Chi2 =	*656.62*					
Prob > chi2 =	*0.00*					
n	*290*					
(Pseudo) R2 / R2	0.15					

*Notes: *p < 0.1, **p < 0.05, ***p< 0.01*

avg: firm's mean, measuring between firm component

dev: firm's mean deviation, measuring within firm component

On the other hand, market-related factors (such the % of employees in market-related functions) are seen to have a negative coefficient, thus these variables are less likely to have high values for firms with status "1" of the venture emergence.

For the status "2" of venture emergence, we observe again that variables related to technology development are positively associated with firms on this status instead of status "3", repeating the contrary effects for market-related factors.

Firms that are more likely to be in status "4" than "3", show to have higher values of average % of employees in market-related activities (.34;$p<0.05$), and do not have the negative coefficient on entrepreneurial experience in the same industry (observed for status "1" and "2").

Overall, the multinomial analysis offers complementary insights on the ventures that are more likely to stay in the low levels of venture emergence during the period of observation (2004-2007), suggesting that firms with high values and high intensity on technological development are also more likely to have lower values of venture emergence.

The insights from the multinomial analysis provide further light to the observation that technological resources or orientation might actually show a negative influence on the new technology-based performance. While the venture emergence, or other performance dependent variables, show more or less similar results on the positive or negative influence of the different independent variables, the multinomial analysis provide some light on how different resource and action combinations could be more related to certain types of venture emergence. The combination of the different tests offers a more comprehensive understanding of the venture emergence in the new technology-based firms (NTBFs).

8.5. Quantitative results discussion

Prior research has suggested that not all organizations follow the same emergence patterns, and identified different factors that could be influencing their evolution. Nevertheless, limited research has been done to study the venture emergence of New Technology-based Firms (NTBFs). The results of this study suggest that venture emergence for this type of new firms requires a combination of resources and actions that go beyond an intensive focus on pure technology-development.

8.5.1. Human Capital and Venture Emergence

Based on human capital theory our first group of hypotheses have explored the influence of entrepreneurs experience on the venture emergence of NTBFs. Prior studies provided support to expect that human capital would have an overall positive influence on the development of new firms (Rauch & Rijsdijk 2013; Colombo & Grilli 2005). Our results show that not all types of human capital (Work Experience, Entrepreneurial Experience, and Entrepreneurial Experience in the same industry) have the same effect on venture emergence (VE).

The evidence of the weak influence of years of work experience (H1a) on VE (as seen in Model 4), confirms the findings of Dimov (Dimov 2010) that were missing statistical significance, and the prior findings of Colombo & Grilli (2005). These results suggest that it is not enough to have many years of work experience to actually have developed knowledge and skills related to the tasks and activities that the technology entrepreneurship process requires. Prior research on work experience and entrepreneurship has also displayed the difficulties to establish a linkage between the "volume" of experience and future behaviors, unless there is more information about the specific types of experience and whether there has been a transformation (Politis 2005) of the experience into entrepreneurial knowledge (Miralles et al. 2015; Garcia 2016).

Thus we would expect that the entrepreneur would need more specific types of human capital, for example a measure of entrepreneurial experience (as we have in H1b). Contrary to our expectations, we have not observed a positive influence on venture emergence from the number of startups that the entrepreneur has launched in the past (see Model 3, and also the robustness tests). An explanation for this unobserved relationship (even negative in our tests with revenues as dependent variable) can be related to how and whether entrepreneurs learn from their previous entrepreneurial experiences (Westhead et al. 2005), it could be that having had prior experiences launching a startup could not be enough to reduce the probabilities of

having another failure in the next startup. Additionally, the number of startups launched is a rather quantitative figure, thus we are missing how this previous experience (positive or negative) has shaped the behavior and decision- making of the entrepreneur (Politis 2008).

The combination of entrepreneurial experience and industry knowledge (as the experience is in the same industry as the current venture) shows a very positive influence on venture emergence (see H1c in Models 1-4 and also Revenues and Employees). This finding confirms the results obtained by Dimov (2010) using a sample that included both tech and non-tech new firms; therefore the combination of market (industry) and entrepreneurial experience is confirmed as the most influential aspect of the different factors studied in the human capital perspective. The strength of the coefficients in our sample of high technology firms can be argued as clear evidence that this type of very specific knowledge in a highly competitive and dynamic industry has a substantial impact on the evolution of the new venture. Therefore, understanding the problems of the market, as well as understanding the possibilities of the technology and the challenges of the entrepreneurial process appears as an influential "resource".

8.5.2. Technological resources and actions in the Venture Emergence

Our second line of inquiry has been on the value of the technology-based resources as well as technology-oriented actions. Using the resource-based view perspective on technology entrepreneurship we built our hypotheses expecting that holding valuable and unique assets such as patents would confer an advantage to the NTBFs. Contrary to our expectations holding and developing specific technological resources did not directly impact on the venture emergence likelihood; these findings challenge prior research insights on the expected value of technology assets such as patents (Hsu & Ziedonis 2013). Nevertheless, prior research by Hsu & Ziedonis (2013) explored the influence of patents as "quality" signals for new ventures to access financing, thus instead of focusing on the influence of patents in the new venture performance, it focused on their influence on accessing resources in competitive contexts. A possible explanation is that for some of these new ventures technological performance is their priority (and this implies sustaining a high intensity in R&D), even if this means to sacrifice short-term market performance.

From the multinomial analysis we can also observe that this type of technology intense and technology oriented firms, are more likely to fall into low status levels of venture emergence, thus confirming this idea that some of those firms might be taking higher survival risks while looking for the next technological development.

8.5.3. Market resources and actions in the Venture Emergence

The third element we introduced, answered the call to further bridge the marketing and entrepreneurship theories (Webb et al. 2010), aiming to provide evidences on the suggestions that new firms would benefit from adopting a market orientation in their early development stages. The results showed that although we could only find limited effects of engaging into innovative market-oriented activities (as indirectly measured through the registration of trademarks (Mendonça et al. 2004)), we could observe that firms that build a sales and market capacity early, would be more likely to show high levels of venture emergence.

Meanwhile having trademarks was only seen to have an effect on the likelihood of revenue generation (see the Revenue as DV regression), the development of marketing capabilities was seen to be a strong driver of venture emergence, these findings fit with recent research on the impact on performance from the adoption of a market orientation and capabilities in profitability (measuring the Return on Assets - ROA) of a sample for firms in the US (Morgan et al. 2009).

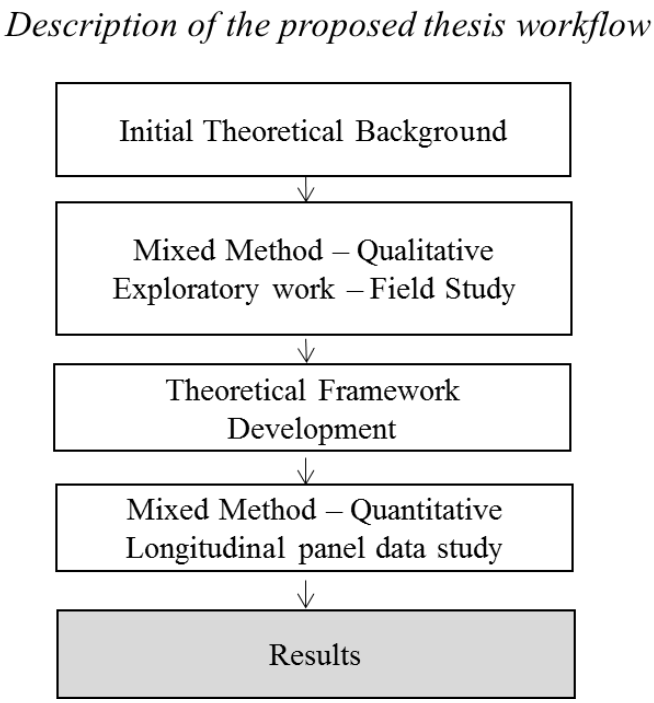
The identification of the positive effects of building early a market capacity, together with the observation that entrepreneurs experience has particularly positive effects when it comes from the same industry, suggests that this combination of elements in the NTBF could be a strong driver of venture emergence likelihood.

This section has covered the different results obtained with the hypotheses test, the findings on human capital influence, the value of technological resources, or the influence of a technology or market orientation in the development of the new technology-based firm. In order to get a better understanding of the findings, in the next section, we compare and illustrate the quantitative and qualitative findings, aiming to gain a further understanding of the new technology-based firm and their behavior towards venture emergence.

9. Integrating the qualitative insights with the quantitative evidences: meta-inferences discussion and contributions

As described in the research design section, this study aimed to follow a developmental mixed method approach (Venkatesh et al. 2013); this means that we address the propositions that emerged from the qualitative work, after being evolved into hypotheses, with a quantitative test. Following the thesis workflow we are able to reflect on the overall research results (see Figure 17).

Figure 17. Meta-inferences as mixed method final results



Therefore, instead of closing the research work with the discussion of the quantitative results, the use of mixed methods encourages the researchers to further contrast the findings from each of the sections and build their work contributions from there (Venkatesh et al. 2013). Thus, in this section we describe the meta-inferences that are a result of bridging the findings from the qualitative and quantitative section, as well as the final contributions.

9.1. Reflecting on the results and proposing meta-inferences

In order to organize the meta-inferences as described by Venkatesh et al. (2013), we follow the general structure of the main research questions that guided this work. Thus, we start with the process of venture emergence, introducing the influence of individual characteristics such as

the entrepreneur's experience. Then, we move to firm level actions such as the impact of managing technology resources, and the influence of developing a market orientation in the venture emergence of the new technology-based firms (NTBFs).

9.1.1. The Venture Emergence in NTBFs

The identification and exploitation of entrepreneurial opportunities are the central activities of the entrepreneurship process, they provide a reference framework to study entrepreneurship phenomena in different contexts (Shane 2004). In the particular phenomenon of technology entrepreneurship, we have observed that, in line with other prior research, the development of technology-based opportunities often follows a lengthy and complex development project (Clarysse, Wright, et al. 2011).

In order to measure and compare the development of the entrepreneurship process we have adopted the venture emergence (VE) perspective. This organizational evolution perspective has offered the possibility to compare how different firm's characteristics, and actions could influence the technology entrepreneurship process.

The measurement of venture emergence in the quantitative analysis of the study confirms two insights that we captured in the qualitative work: (1) VE is a lengthy process, as described by the entrepreneurs in the case studies and as observed in the measurement of VE; (2) there can be different paths towards VE, as there is not a clear sequence of activities that explains how successful ventures emerge, supporting the idea that it is a complex and uncertain process (Lichtenstein et al. 2007).

Additionally, the quantitative analysis offered further insight on the linkage between emergence and firm duration (survival). It also added further understanding to the meaning of different VE levels as firms' age, describing that the characteristics of an emerging firm in their first year of operations would be different from a firm that is still in the same level of emergence after three years of operation. These findings open future research opportunities on venture emergence conceptual development and measurement for technology-based firms.

9.1.2. The entrepreneurs experience as a positive influence for the Venture Emergence of NTBFs:

As part of the research on the entrepreneur-opportunity nexus, attention has been given to the characteristics of the entrepreneur, in particular to their previous experience in entrepreneurship (Hopp & Sonderegger 2015; Miralles et al. 2015). In our qualitative work we

identified that prior experience in entrepreneurship was perceived as an advantage for the entrepreneurs. In addition, it was observed that entrepreneurial experience would have an influence on the type of decision-making mechanisms being used, as well as on the capacity to understand how to deal with stakeholders in the opportunity development.

Moving beyond the generic resource-based view, and adopting a human capital perspective on entrepreneurship, the quantitative analysis has provided further information on the qualitative insights: (1) It has confirmed that not all types of work experience generate the skills and abilities needed for the technology entrepreneurship process, as years of work experience was seen to have no impact on the new firm development; (2) prior entrepreneurial experience is particularly valuable if it is in the same industry; suggesting that for venture emergence it is not enough to have prior entrepreneurial experience, the entrepreneur also needs to understand the dynamics of a high-technology market. This finding contradicts the observation from West & Noel on the limited value of knowledge resources for new firms (2009), suggesting that at least in NTBFs, entrepreneurial experience and market knowledge are a positive contribution to the new startup success likelihood.

Additionally, the quantitative findings suggest that the combination of entrepreneurial experience and knowledge of the industry where the firm operates can generate a significant positive influence on the venture emergence. This finding provides evidence on the influence of the combination of the two sources of human capital. Prior research work had suggested the potential positive effects of this specific knowledge combination (Zahra et al. 2006), now we can offer empirical evidence on its impact on the venture development.

9.1.3. The value of resources as quality signals and the impact of technology orientation in NTBF's Venture Emergence

The study of the influence of resources on the entrepreneurship process has traditionally relied on the resource-based view (Foss et al. 2008); nevertheless, scholars have suggested that there are limitations in the use of this theoretical perspective to explain the technology entrepreneurship phenomenon (Priem et al. 2011).

The qualitative studies we completed showed that the initial resources of the entrepreneur (for example technology related assets) did not always impact directly in the market performance of the venture in the short term. Nevertheless, we identified that resources were used to signal the firm capabilities and their quality. These findings extended the current understanding of resources as quality signals for investors (Hsu & Ziedonis 2013), as we

identified that signaling strategies were also used to gain legitimacy and reduce uncertainty with customers, following a more market-oriented perspective (Im & Workman 2004).

These findings were then contrasted with the results from the quantitative study. The results showed that technological resources, such as patents, where not reliable predictors of future market performance of the startup. Instead, we observed that firms with higher number of patents showed lower levels of venture emergence. The results also showed that there are firms that manage to stay active (survive) despite having low levels of venture emergence; this might be the case of firms that stay focused on developing their technological resources or that struggle to generate revenues.

These findings suggest that further research could explore whether or not the initial positions of resources condition the decision to focus on technological or market performance, and how this decision could be influenced by the ongoing interactions with the market.

9.1.4. The orientation towards market in technology-based firms as a construction strategy for technology entrepreneurship

Technology entrepreneurship has been identified as a difficult to understand phenomenon (Brown & Mason 2014), scholars have suggested to explore how insights from technology innovation management could help to improve our understanding (Brem & Borchardt 2014). This perspective provides clues on the elaborated and lengthy process that technological developments often go through before reaching market acceptance.

In our qualitative work we built upon theoretical perspectives such as socio-constructivism to explain how entrepreneurs perceived to benefit from early interactions with partners and stakeholders, regardless of the early stage of their product development, to successfully bring their product to the market. From these insights, we extract propositions to suggest that the adoption of a market orientation and building of marketing capabilities should have a positive influence on venture emergence. These findings motivated the revision of marketing theory frameworks, justifying how marketing or market-orientation capabilities should help to understand how entrepreneurs with these resources and capabilities are more successful, for example being able to mitigate the uncertainty of their first-time buyers in a dynamic and uncertain technological market.

The quantitative findings showed that our hypotheses that market-oriented factors such as registering trademarks (as a proxy for marketing development in the new venture) were not impacting on venture emergence; on the other hand, the results confirmed the significant

impact of increasing the market capacity of the new venture, showing how venture emergence was positively influenced by the increases in marketing capacity. These findings strengthen our contribution on the unexpected important impact of building a market orientation in the early stages of a new technology-based firm development, suggesting that despite competing in high technology markets, to achieve market performance, it is not enough to rely on the technological resources alone. These findings also contribute to the calls for further research on the marketing and entrepreneurship literature linkages (Webb et al. 2010), in particular in the high technology context and new firms' venture emergence.

9.1.5. Towards a broader understanding of Technology Entrepreneurship by combining resources and actions to study Venture Emergence in NTBFs

The qualitative and quantitative findings from this research highlight the limitations of a short-term static perspective on the value of resources, suggesting the need to instead introduce a longitudinal perspective. This perspective should capture the changes in the individual's and firm's characteristics. In other words, a common contribution in both parts of the study is the identification that technology entrepreneurship is a lengthy process. In this process initial resource configurations explain only a limited part of the future and evolution of the new venture.

The qualitative cases studied described new ventures with very different resource configurations, some with patents and strong research teams, and others with limited technological resources although they were competing in a high tech environment. Overall, the cases helped to identify and describe the finding that, regardless of their resource configurations, they perceived that the evolution of the new venture was actually related to their ability to act and use those resources not only internally but also externally as signals for market creation. This changed the focus of attention to the influence of market oriented actions on the venture emergence. In the quantitative analysis, the combination of initial resources and actions that introduced changes in the new technology-based firm, allowed for further empirical evidences on these dynamic elements that otherwise would have been unnoticed.

This research has benefited from using a mixed method design, sharing a common focus on exploring the technology entrepreneurship process using a longitudinal perspective, thus capturing the initial stages of opportunity identification, and the evolution towards its exploitation. The developmental and sequential approach of the use of the two methods has, on one hand, offered a greater contrast and validation of the initial qualitative findings, and on

the other hand, enriched the quantitative findings and contextualized our overall results discussion.

The contributions of this thesis are two-fold, theoretical and practical. In the following section a more detailed reflection of the contributions is presented.

9.2. Theoretical contributions

The aim of this thesis is to contribute to the technology entrepreneurship research stream. To do so, we have advanced in the understanding of the technology entrepreneurship as a process and extended the theoretical framework to better explain the venture emergence of new technology-based firms. The findings of this research have implications for entrepreneurship theory in general, but in particular they add to the following research streams: study of venture emergence, human capital theory in entrepreneurship, technology innovation and entrepreneurship, and the stream of entrepreneurial marketing that combines marketing and entrepreneurship perspectives.

9.2.1. Contribution to research on Venture Emergence

This research contributes to extend the current research stream on the venture emergence of firms (Tornikoski & Newbert 2007; Dimov 2010); in particular, it offers a better understanding of the venture emergence in new technology-based firms (NTBF). The longitudinal panel data approach also offers a better understanding not only of the initial founding resource configurations, but also of the characteristics and evolution of the new firms in the sample (Davidsson & Gordon 2011). Overall, the results point towards an extension of the resource-based view on venture emergence to include additional perspectives to explain changes and evolution of these ventures in dynamic contexts as high-technology industries.

One of the contributions of this work is to further define the concept of venture emergence for new technology-based firms; instead of following a sequential development (sales, external funding, employees and profit), we have observed that the meaning of each of the venture emergence status changes across the years. This opens the door to further conceptualization of the concept of venture emergence for this type of firms, in line with recent suggestions from Lichtenstein (2014) proposing to further embrace complexity science to study the emergence dynamics of organizations.

9.2.2. Contribution to resource-based view and human capital theory

We have been able to complete a fine-grained application of the human capital theory in the high-tech context, generating insights that can be brought back to this theory. The findings suggest that experience, even entrepreneurial experience, is more significant and relevant if it is in the same industry. The possibility to further contextualize where the human capital is built has offered additional clues on the influence of human capital in technology entrepreneurship (Rauch & Rijsdijk 2013; Unger et al. 2011). Previous research in high-tech contexts was not able to explore the longitudinal effects of the initial human capital endowments of the new firm, therefore the results complement prior research in this area and confirm findings on the positive influence of entrepreneurial experience (Unger et al. 2011).

9.2.3. Contribution to technology innovation and commercialization

We also contribute to the extension of the resource-based view when studying the influence of technological resources in the early commercialization of new technology products (Gans & Stern 2003). Prior research has used signaling theory to suggest that some resources in these type of contexts are used as "quality signals" to access resources and build legitimacy.

Our findings contribute to this signaling theory extension of the resource based view, but with the condition that there is a marketing capacity in the firm. Otherwise, having a large number of patents or a high intensity in R&D employees is not seen to have a positive effect on the venture emergence of the new firm. Therefore, it could be argued that the activation of a market orientation could be a potential mediator between the technological resources and the market performance of the new firm.

In this sense, this thesis findings are in line with some recent conceptual contributions that aim to bridge the theoretical concepts of entrepreneurship and technological innovation (Becker et al. 2015). Insights from technology innovation are useful for entrepreneurship theory as the new venture is often built around a singular technology and product offering, thus a successful management of the technology innovation can have a rather positive impact on the NTBF's venture emergence.

9.2.4. Contribution to marketing theory and entrepreneurial marketing

We also contribute to the open call to establish bridges between entrepreneurship and marketing theory (Webb et al. 2010). In particular the qualitative and quantitative findings support the marketing theory insights on the positive influence on venture performance of

building market-oriented resources (Mendonça et al. 2004; Im & Workman 2004); the results suggest that these type of actions have a positive effect on the venture emergence of new technology-based firms, therefore they extend the areas of application of these theories to the technology entrepreneurship context.

From a broader perspective, the findings also contribute to the emerging research stream of entrepreneurial marketing (Miles et al. 2015) suggesting that the development of market-oriented capacities might play a role in the successful transformation of technological developments into valuable market innovations. Furthermore, we have been able to gather evidence to describe how technology entrepreneurs might have to go through a process of market creation (building legitimacy and trust with their potential customers), in particular if they are holding high potential but still incipient technological resources (Godley 2013).

9.3. Practical contributions

The findings of this research suggest that the market creation efforts play a key role in the development of high-tech firms; positively influencing their options to consolidate their organizing efforts and become consolidated firms. As observed in the data collected, this process of market creation requires building up capacity to commercialize technological products. The entrepreneur's skillset that has supported the technological development is not enough to ensure a successful commercialization. The entrepreneur's capacity to acknowledge that the initial technological idea requires for a market-oriented transformation is by itself a valuable capacity.

An additional practical implication is related to the evidences of different NTBFs profiles depending on their market or technology orientation. As suggested in Gans & Stern (2003) different profiles could be identified depending on their market or technology orientation. Based on our findings, the new ventures that have a market orientation or "market for products" as defined by Gans & Stern (2003), would benefit from accelerating their market capacities, and completing their venture emergence status. On the other hand, the findings suggest that new ventures with a stronger technology orientation, focused in the "market for ideas" as described by Gans & Stern (2003), would instead have to be ready to sustain low levels of venture emergence, and probably lower short-term revenues or other measures of market performance. The entrepreneurial choice of market or technology orientation has consequences on the types of value creation actions of the new firm, supporting the idea that

the resource and the demand perspective would have complementary value when it comes to build a sustainable organization regardless of the strategic orientation (Priem et al. 2011).

This research also holds implications for investors and other stakeholders in technology entrepreneurship. The results suggest that although overall entrepreneurial experience (as number of startups launched in the past) does not seem to be a strong indicator of future success, when this entrepreneurial experience is in the same industry, it has a much stronger effect on the new venture development.

Therefore, these results add further information and data evidences to the mechanisms used by investors or institutions to screen for new ventures with potential. Paying more attention to the context where prior experience has been gained can provide some clues on the future possibilities of the new venture to be successful and sustain growth. On the other hand, the results suggest that the assumption that NTBFs with a strong patent portfolio might be more likely to be sustainable and successful has not been supported by the data. Suggesting, that unless there is support (p.e. from the investors or stakeholders) on the development of marketing capacities in the new firm, some of those IP assets might not hold direct influence on the market performance.

10. Limitations and Further Research

This research is not absent of several limitations, which also constitute opportunities for further research that could contribute to the understanding of technology entrepreneurship.

First, this study on technology entrepreneurship has been built upon qualitative work that captured information on cases of entrepreneurs that at that moment were operating their business. Although some of them had experienced failures in their past entrepreneurial endeavors, we have not been able to get specific details and cases of failed technology entrepreneurs. We aimed to mitigate this potential bias by selecting entrepreneurs in different stages of development, thus capturing profiles and activities of entrepreneurs that could also potentially fail. Nevertheless, we did not select specific failure cases to further extend our understanding on the technology entrepreneurship process.

Further research on technology entrepreneurship could benefit from extending work on prior entrepreneurial experience by including cases of failed new ventures, to further elaborate on how this impacts the entrepreneur when it engages in the development of new technology-based firms, as well as how it influences the stakeholders involved in providing a supportive context for the technological opportunity development.

Second, our case studies were mostly built using the interviews with the entrepreneurs and secondary data on the venture (including news, presentations, and other public documents). As a result, in order to further enrich the findings on the venture emergence additional stakeholders should be included, including for example the first customers, or investors. This could provide a more in-depth picture of the evolution of the venture. This way, further research could describe with more detail the role of the different actors in the opportunity construction and the initial steps of venture emergence, probably identifying activities or processes that have gone so far unnoticed for existent research in this area.

Third, the adoption of the mixed method approach has also required an effort to establish a bridge between the qualitative work sample and the quantitative sample. We have controlled potential differences by ensuring that the size, industries and profiles of the ventures were similar, we also have made sure that the behavior of the firms was similar as the majority of them compete in the international high tech markets, thus sharing challenges and difficulties. Nevertheless, this research could benefit from actually increasing the contextualization of the quantitative analysis, for example running similar tests on high tech firms in Spain or other European countries, to observe whether the findings in the US high-tech markets also hold in

other national contexts, although the firms in the panels might be playing at a similar international market.

Fourth, we have focused our work on studying the venture emergence on the three factors that were prominent in the qualitative work that guided the hypotheses development. Thus, the model we are developing focuses on the specific elements that are seen to impact on technology entrepreneurship, future research work on venture emergence could rely on recent suggestions to embrace complexity science to capture further sources of variance and adopt new perspectives (Lichtenstein 2014). In more detail, further research could focus on extending this specific model, introducing further controls, factors and exploring the interactions between them. For example, in our hypotheses development, we have not researched whether there are specific combinations of actions, or whether the sequence and pace of those actions could have an impact on the outcomes; complexity theory provides a theoretical framework to explore this ideas (McKelvey 2004; Lichtenstein et al. 2007; Lichtenstein 2014).

Fifth, in order to assess our hypotheses we have had to use and in some cases adapt measurement scales and specific measures that could be improved in the future. For example, in order to study technological resources positions, instead of using the number of patents, we could use the market valuation of the patent or the technology potential that it has. Similarly, indicators like technology or market capacity could have been measured with direct questions to the entrepreneur, instead of using indirect measures. In this sense, the future designs of panel data sets could be improved if they included theory-based questions (Delmar & Johnson 2015), this would allow for a more direct and conclusive testing of theory.

Sixth, the study of the evolution of new ventures using longitudinal panel data is limited by the type of data collected from the venture. Although we used the best option available for our research objectives (the Kauffman Firm Survey), this research could be improved if the data from the ventures in the panel could be enriched with secondary information, for example news reports, changes in the structure of the firms and other information that could be captured with precise time stamps (not limited to the yearly data wave intake). Future research could also benefit from cross-checking on the data reported by entrepreneurs, for example being able to complete missing data on financial aspects with tax reported data.

Seventh, the focus of this research has been on the venture emergence in the technology entrepreneurship process, this means that we have left unattended the implications that different paths towards venture emergence have for the new firm future growth or overall

development. We have limited our analysis to the first years of operation (2004-2007), future research could explore the evolution of this ventures in the following waves of data (till 2011) using a strategic entrepreneurship (Kuratko & Audretsch 2009) or new venture growth theoretical perspective, and aim to reflect on the findings from this venture emergence study. A growth study should also include competitive context elements that have not been taken into account in this research, for example exploring the different rivalry and competitive responses in the different sub industries that are part of the sample.

Last, our study has not explored in detail the alternative survival routes of new firms when they do not fully emerge in the market. Further research could focus on the different patterns and characteristics of firms that close (fail), but also those that end up being bought or merged with another firm. Those firms, as suggested by our findings, might have actually been focusing on technology performance, either intentionally or as a response to the difficulties to activate market performance. Future research could help to better understand this type of goal setting choices and their impact on the technology entrepreneurship process.

11. Conclusions

Despite the extant interest in promoting fast growth organizations that benefit from the latest technological advances, technology-based entrepreneurship remains as a phenomenon complex to understand. This research explores the venture emergence in technology-based firms.

In the initial theoretical background (chapter 2. Background) we have established that technology entrepreneurship is not a well understood process, suggesting the need for further research on the interplay between the entrepreneur and the technological opportunity. Prior research findings point that static perspectives on the firm's resources only provide a partial explanation on the development of technology-based firms. From the initial theoretical background we establish the need to look beyond the resources, and propose to use venture emergence as the construct that helps to understand the changing outcome of technology entrepreneurship.

Therefore, instead of starting by answering the research question on "do initial resource configurations impact on technology entrepreneurship outcomes?" we proposed to first gain a better understanding of the phenomenon by exploring "are there specific factors in technology entrepreneurship? And how do entrepreneur's actions influence the process?

Using a mixed-method approach, we first use a qualitative exploratory approach and then a quantitative confirmatory approach to advance in the research. The exploratory work provided clues on the constructivist nature of technology entrepreneurship, where the actions of the entrepreneurs and their orientation have a significant impact on venture emergence; we observed how the transformation of the initial business idea into the entrepreneurial opportunity could be influenced by the different decision-making mechanisms and the entrepreneurs' interactions with the context. These observations uncovered the potential influence of prior experience and of the type of entrepreneurial opportunity they were dealing with. We also shed light on the use of different types of resources by entrepreneurs besides their expected direct function, finding that market, social capital and technological resources were used to issue signals to potential customers, investors and stakeholders. Thus, in this early stage of evolution the face value of resources might be as important as the capacity to use them as quality signals. Overall, these results suggested to further study entrepreneurial action combined with resource configurations, as this could help to better understand technology entrepreneurship.

The propositions that derived from this qualitative work guided the theoretical framework development that was completed with the hypotheses development. We used a longitudinal panel data study test the hypothesis and provide answers to the initial research question on "do initial resource configurations impact on technology entrepreneurship outcomes". The findings from the data analysis suggest that human capital, in particular entrepreneurial experience, is a valuable resource, even in the dynamic context of technology entrepreneurship. The hypothesis results showed that despite general work experience did not have an influence on venture emergence; previous entrepreneurial experience in the same industry would have a significant positive influence.

Contrary to our expectations, the standalone value of technological resources was not observed; the data analysis reports that having a large number of patents would not have a direct positive impact on venture emergence. In fact, the results suggest that unless there is an active development of market resources or capacities, technological resources by themselves have a limited direct impact on the new technology-based firm venture emergence. This was observed firms that allocated employees in that business function would report a higher likelihood of venture emergence. Finally, the results of the additional statistical tests provided support to argue that the factors that explain why some ventures stay in low levels of emergence are different from the ones that would predict complete venture emergence, suggesting that there could be different profiles of firms and evolutionary paths among new technology-based firms.

The main contribution of this work on entrepreneurship research is to provide a better understanding of technology entrepreneurship as a specific phenomenon. More specifically, we contribute on refining the resource-based view by suggesting the potential boundaries of this theory on a dynamic phenomenon as technology entrepreneurship; nevertheless sustaining that it still provides valuable insights, for example through the identification of the positive influence of specific human capital resources such as entrepreneurial experience. We also contribute to the extension of technology innovation and commercialization theories by providing evidence on their valuable insights in the context of entrepreneurship. Similarly we also enrich the entrepreneurship theoretical framework bringing insights from marketing theory, providing evidence on the substantial influence that early development of market capacities have for new technology-based firms in the high-technology context. Finally, we also contribute on the research stream of venture emergence in entrepreneurship by describing how this construct provides a prism to study the evolutionary nature of new technology-based firms, and proposing influencing factors in the technology entrepreneurship setting.

Overall, this research shows that technology entrepreneurship is actually not only about new firms built around promising technological resources, but about how entrepreneurial action is a key influence in the value creation process, connecting the technological product and the market needs for a particular application or function. Furthermore, we have been able to gather empirical support for the suggested relationship between building market capacities in new technology-based firms and their venture emergence; thus confirming open calls to relate marketing with entrepreneurship theory. Last, we have also contributed on the resource vs. demand-based view on entrepreneurship, showing that human capital and demand-side views facilitate answers to further understand the actions, changes and their consequences.

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Appendix I: Questionnaire used for the interviews in the qualitative field work:

The business – first steps: ideas and opportunities, creating something new, innovating

- (0) Talk to us about your business. How did you begin?
- (1) What was the first seed idea? Where does it come from?
- Which have been the most important steps /changes in your firm history?

Evolution – History: from the opportunity identification to the company configuration

- (2) What about your prior business experiences?
- Have you used planning methods, to organize your future steps, How? When? Motivation?
    - Did they reflect your actual – real development? How did they influence?
- (3) Did you have an explicit plan on how to create the company?, exploit an opportunity, how to get the resources (people, financial, others?). Were there changes, adjustments to initial idea?
    - (4) How do you approach the market, innovative solutions? Compared to competitors, where do you stand? Has this approach changed/evolved?
- (5) What is an opportunity? How did you identify yours?
- (6) What about your specific business sector/industry knowledge?
    - Does this influence your ability to identify opportunities to innovate?
- Did you get formal training on entrepreneurship or innovation methods?, were you involved in direct personal experiences or you participated in developing new products or services in the past?
    - (7) What did you specifically do?
    - (8) Why you think that your previous entrepreneurial experiences influence on the opportunities you identify?;
        - How? Is it a question of volume (number), quality, and accuracy?
- (9) Tell me how you work when you identify new opportunities with a high degree of uncertainty?
    - Do you always pre-plan? When do you plan after the practice of the activity or initial exploitation of the opportunity?

Current situation: how would you describe your current business?

- How are you making money? What is your value proposition/selling proposal?
- Are you familiar with the idea of business model?
    - How would you describe yours – transaction/activity based? What are your vision, aims?

Appendix II: Examples of the coding process

The coding process starts with the identification of key points related to the research question. This is done by highlighting sentences in the interview transcript.

Introduction to the company	The company is Securiforest, it's a company in....securing valuable assets, information through technology. There are two sides to the business a hardware side and a software side, to put it in a very basic way, because there are a lot of companies that focus in software, firewalls, antivirus...and that's good and we are trying to do some of this too. But very often security for Banks, military or people, comes from hardware, loosing a pc, usb stick, everything... so what we are doing in the part of hardware is trying to develop customer designed gps kind of tracking,for better tracking laptops, usb sticks, people, bags. And then on the software side we are developing a piece of software that is our first product. That basically sits on a pc an allows people to operate different operating systems on one pc...**so that's our first solution we are gonna come... and this can also work for the home user...securing either assets valuable p19-001**, it can be people, assets, information. Because **I believe very strongly that there needs to be a theme in a company ...the theme should focus in providing a solution p19-002,** so we provide a solution to security concern, wether its is corporate or for somebody at home, whether its software or hardware. There is a very popular trend today in IT of Virtualization...our solution is a virtualization solution, it pretends to be PC
Where does the idea come from?	I think a variety of things, the tracking of information comes from a kid getting lost, a phone getting lost...so **that's one side of where the idea comes from, you see the problem in life p19-003**. Also I worked in the PC industry for years so I can see **some of the problems customers have, they are worried about security, another big benefit I saw for it is migration,companies always struggle to migrate from an operating system p19-004**. Because big companies have a lot of special applications, written for Windows XP and they can not go to let's say Windows 7... In our case they can go quicker...no that they can go quicker, that they can go in a more effective way. So the ideas around kind of confirm the problems within the industry, knowing the people are worried about security, worried about migrating from operating systems. the idea comes from that. Also the Technology, as 3 years ago this wouldn't have been possible...
How does your previous experience affect, the way you conceptualize the idea, how the market is evolving?	**If I didn't have the experience in that industry, I wouldn't have this company. Because this gave me an insight into the big accounts p19-005**, to find the right type of people, the network of people that you get to know is critical. You learn about the technology, you learn about the customer, you learn about the product, you learn about the people you need. That definetly comes from years of experience in the industry. If I never had worked in the industry I (would) never had the idea.

The following step is to codify the key points into codes that will be combined into concepts, following an abstraction process:

ID	Key Point	Code
P19-001	so that's our first solution we are gonna come... and this can also work for the home user...securing either assets valuable	idea identification
P19-002	I believe very strongly that there needs to be a theme in a company, the theme should focus in providing a solution	business vision
P19-003	that's one side of where the idea comes from, you see the problem in life	idea identification
P19-004	some of the problems customers have, they are worried about security, another big benefit I saw for it is migration,companies always struggle to migrate from an operating system	idea identification
P19-005	If I didn't have the experience in that industry, I wouldn't have this company. Because this gave me an insight into the big accounts	prior experience
P19-006	By being outside of the industry now, I am more free to see solutions for customers, when you are in the industry you are not going to look for solutions that are going to damage the industry	business vision
P19-007	what we try to do with people is to stay, here is where we are today, and for the company to survive, it is important, it is vital that in the next month we deliver this, that...and we keep people very focused	focus
P19-008	you need to stay flexible to move. Because, when I describe what we do, it is a very simple diagram...but what we are doing is cutting edge, you can not get accurate feedback from developers,... they just don't know	market fit
P19-009	you can't be precise.... When you develop a new product that nobody has done	product development

Code	Emergent Concepts		
idea identification	Business idea is clearly defined in an existing pı	P19-001	P19-003
business vision	The company provides a solution to customers	P19-002	P19-006
idea identification	Prior experience gives me insight in the industry	P19-005	
idea identification	Focus on clear objectives to survive in the marke	P19-007	
prior experience	Uncertain technological development forces earl	P19-008	P19-010
business vision	Customers requirements drive developments an	P19-009	P19-011
focus	Self financing to support business start	P19-013	
market fit	No detailed plan but clear statement of the busi	P19-014	P19-015
product development	Team motivated to create culture and build a dre	P19-017	P19-018

The emerging concepts where further abstracted into categories that would describe a specific factor influence or complexity in the technology entrepreneurship process. This analysis stage was done case by case, but also cross-case, aiming to identify whether there were new case categories that would not fit with the preexistent findings in the other cases:

Cross-Case Analysis		Case by Case analysis		
Main Categories	Sub-Categories	Case Categories		
Financial Resources	External funding	Opportunity	Business idea is clearly defined in an existing problem	P19-001
	Founder seed funding	Business strategy	The company provides a solution to customers	P19-002
	Investor knowledge	Entrepreneur	Prior experience gives me insight in the industry and skills to start a plan	P19-005
Business Strategy	Market orientation / vision	Business strategy	Focus on clear objectives to survive in the market	P19-007
	Set Priorities	Management	Uncertain technological development forces early customer involvement	P19-008
	Revenue Model	Management	Customers requirements drive developments and become development milestones	P19-009
Management	Uncertainty	Financial resources	Self financing to support business start	P19-013
	Control Risk/Loss	Management	No detailed plan but clear statement of the business and its goals	P19-014
	Product/Technology Market Fit	Entrepreneur	Team motivated to create culture and build a dream	P19-017
	Decision making mechanism	Management	Business success relies on first product to be sold to first customers	P19-019
	Instruments	Environment	Environment and social network as a source of opportunities for cooperation	P19-020
Entrepreneur	Prior Experience / Knowledge	Business strategy	Visualization of a business model that combines services and products	P19-021
	Attitude /Motivation / Confidence	Management	Business development dependent on finding right people	P19-022
	Social Network/Team			
	Family business links			
	Situation			
	Control focus			
Opportunity	Previous Employer / existing clients			
	Idea identification			
	Search Information			

Appendix III: Example of the types of questions and variables recorded by the Kauffman Firm Survey:

1. **Introduction**
   - 1.1. Out of business reason (sold/merged/…) A10_Out_Of_Business_4
   - 1.2. Impacted by financial crisis – A11b_economy_effect_4
2. **Screening**
   - 2.1. Business start origin (new branch, inherited, new independent biz, purchase, franchise, NGO, other) b1_bus_start_0
   - 2.2. Legal status (sole prop, limited liability, subchapter s-corp, c-cop, GP, LP) b2a_legal_status_0
3. **Business Characteristics**
   - 3.1. Legal status (Sole Proprietorship, Limited liability…) C1z2_Legal_Status_4
   - 3.2. NAICS Code
   - 3.3. Number of Owners C2_Owners_4 // c2_owners_0
   - 3.4. Number of employers (with detail on FT and PT) C5_Num_Employees_4
   - 3.5. Type of Location (residence, leased space, client site.. C8_Primary_Loc_4 // c8_primary_loc_0
   - 3.6. Reason for location change (expensive, space, customer…) c9_loc_change_reason_4
     - 3.6.1. Number and place of operating locations…
   - 3.7. Training and Assistance source (SBA, Fed Agency, state, non profit, chamber…) c12a_sba_4
4. **Strategy and Innovation**
   - 4.1. Product and/or Service d1a_provide_service_4 d1b_provide_product_4
   - 4.2. Have a competitive advantage d2_comp_advantage_4
     - 4.2.1. Reason for competititve advantage (team up with college /another company, / government /patents) d2a_compadv_comp_reason_4 d2a_compadv_govlab_reason_4
       - 4.2.1.1. Major and minor reason d2b_compadv_comp_strength_4
   - 4.3. Have or not, and number, patent, copyright or trademark. d3_a_have_patent_4 d3_a_num_patent_4
   - 4.4. Have you license out? (patent, copyright or trademark) d4_a_lic_out_patent_4
   - 4.5. Have you licensed-in? (patent copyright or trademark) d5_a_lic_in_patent_4
   - 4.6. Customer or sales in this year? d6_have_sales_4
   - 4.7. Sales breakdown in % (business, government, individuals) d7_perc_sales_bus_4
   - 4.8. Where are most of customers? (neighborhoods/city/region/nation/international) d8_customer_locations_4
   - 4.9. Sell overseas? And % of total d8a_international_sales_4, d8b_perc_international_sales_4
   - 4.10. Sell through internet? And % of total d9_internet_sales_4
5. **Business Organization and HR Benefits**
   - 5.1. Breakdown of employees in number (HHRR, sales, exec, R&D, Production,admin, fin, other..): e1_a_num_human_res_4, e1_b_num_sales_4, e1_c_num_exec_admin_4, e1_d_num_resdev_4
   - 5.2. Benefits to employees to FT and PT (health, retire plan, stock, bonus, tuition, flex…)
6. **Business Finances**
   - 6.1. Did owner invest in business during the year? f2_owner_eq_invest_01_4
     - 6.1.1. Amount or range: f2_owner_amt_eq_invest_01_4 f2_ownr_amt_eqinvest_range_01_4
   - 6.2. Counting all years amount and % owner ows. f2_ownr_amt_eqinvest_allyrs_01_4, f2_owner_perc_own_01_4
   - 6.3. During the year, did you get equity investment for some ownership (spouse, parents, indvidiuals, others, government, VC, others) f3a_eq_invest_spouse_4, f3b_eq_invest_parents_4
     - 6.3.1. For each, amount or ranges f4_eq_amt_angels_4
   - 6.4. The same for all years f4_eq_amt_angels_allyrs_4
     - 6.4.1. And percentage owned f5_perc_owned_angels_4, f5_perc_owned_companies_4
   - 6.5. Money withdrawn by owners and amount
   - 6.6. Debt financing (credit card, loans, corporate card, others) f7_pers_other_specify_4, f7a_bus_credcard_4
     - 6.6.1. And number used and credit line/balance and other to check if they owe money.
   - 6.7. Trade financing and amount: f13_trade_fin_4, f14a_trade_fin_amt_4
   - 6.8. New Loans, approved? And reason: f14d_new_loans_4, f14e_approved_denied_4, f14f_bus_credit_hist_4, f14f_inadeq_doc_4
   - 6.9. Needed credit but not apply? Loan from SBA? f14h_loan_guarantees_4
   - 6.10. Influence from crisis? f14i_economy_effect_4

6.11. Most challenging problem (credit, lost sales, real state value, cost of credit, biz condition unpredictable…) f14j_most_challenging_4
6.12. SALES in the year? f15_revenue_2008_4 // This change depending on year number
6.12.1. Amount f16a_rev_2008_amt_4 or range
6.13. EXPENSES in the year f17a_total_exp_2008_amt_4 or ranges
6.14. PAYROLL – in the year f18a_wage_exp_2008_amt_4 or ranges
6.15. R&D Expenses in the year - f19a_res_dev_amt_2008_4 or ranges
6.16. INTANGIBLE assets (design new prod, new software or DB, Brand adv, Company formation or consulting, worker training: f19b_a_design_4, f19b_b_investments_4, f19b_c_brand_dev_4, f19b_d_org_dev_4, f19b_e_worker_training_4, f19b_f_other_4, f19b_f_other_specify_4
6.16.1.Total amount expenses f19c_intangassets_amt_4, or ranges.
6.17. Purchase NEW MACHINERY OR EQUIPMENT f20_mach_4
6.18. Rental or lease for BUILDINGS – STRUCTURES f21_land_rent_4
6.19. Rent MACHINERY or EQUIPMENT f22_mach_rent_4
6.20. PROFIT OR LOSS f23_profit_or_loss_4
6.20.1.Profit amount or ranges f24_profit_amt_4
6.20.2.Loss amount or ranges f26_loss_amt_4
6.21. Assets for the company (Cash, Accounts receivable, inventory, equipment, land, vehicles others) f28a_asset_cash_4, f28b_asset_acct_rec_4
6.21.1.Asset valuation or range f29_assetval_acctrec_4
6.22. Liabilities (accounts payable, pension, other liabilities) f30a_liab_acctpay_4
6.22.1.Amount or range
6.23. File for CHAPTER 11 – during the year f32_chap11_bankruptcy_4
6.24. How much do you think biz growth met your expectations? (exceeded, met, did not) f33_expected_growth_4
6.25. Expected revenues in 2011 growth? With % f34_future_revenue_4

7. Work Behaviors and Demographics

7.1. Owner is also paid employee? g1a_emp_owner_01_4
7.2. Hours worked in average g1b1_hours_owner_01_4
7.3. Marital Status g10b_marital_status_4
7.4. Total net worth – in ranges - g10c_net_worth_4
7.5. Agreement with sentence: In uncertain times I usually expect the best: g10d_personal_outlook_4
7.6. Year of work experience, for each owner g2_work_exp_owner_01_4
7.7. How many business started, for each owner g3a_oth_bus_owner_01_0
7.7.1. Was it in the same industry? g3b_bus_same_ind_owner_01_4
7.8. Age of owner or range - g4_age_owner_01_4
7.9. Hispanic or latino origin g5_hisp_origin_owner_01_4
7.9.1. Other Races (American indian, Alaska, ahwaiian, Asian, black, white, other) g6_race_amind_owner_01_4
7.10. Born in the US? g7_native_born_owner_01_4
7.11. US Citizen? g8_us_cit_owner_01_4
7.12. Highest level of education (9^{th} grade, high school, graduate, technical, college, associate, bachelor, grad, Master, professional school or doctorate) g9_education_owner_01_4
7.13. Gender, male or female g10_gender_owner_01_4

8. Computed Group Variables

8.1. Age of owner age_owner_01_r_4
8.2. Active Owner owner_active_01_4
8.3. Total owners in year totalowners_4

Appendix IV: Dealing with missing data

A usual challenge when collecting data in panel surveys, is how to deal with missing answers in some of the data collection points. This missing data for a question or case is often temporal, for example one of the yearly observations, but it can be collected again in the following year. Temporal missing data is different from panel dropouts, or firms that cannot be reached or reject to fill the follow-up waves of the survey; dropouts are accounted as so in the panel structure, they effect on the representativity of the sample unless weights are introduced.

Before entering in the discussion on the different option to deal with missing data, it is important to understand the assumption we make on why the data went missing. There are two options: missing at random, and not missing at random. Missing at random (MAR) assumes that the missing answers to a variable are not linked to other observed variables in the dataset; there is the stronger assumption of missing completely at random (MCAR), often used when the data is missing by design (when for example only part of the sample is covered with a measurement (Allison 2009)). In order to assume that the missing data is MAR, the condition is that "the parameters governing the missing-data mechanism must be distinct from the parameters in the model to be estimated" (Allison 2009, p.74), condition that is unlikely to be violated in real world situations. The alternative of not missing at random (NMAR), where a specific set of assumptions need to be developed to justify that the assumption of ignorability (no relationship with the coefficients that we are estimating) does not hold. This type of approaches require specific developments, for more information and suggestions on how to deal with this type of non-random missing data see Allison (2009).

In our case, the missing data is described as missing at random (MAR), the available options to deal with this missing data have different implications for the sample characteristics and the variables measurement. As described in Fichman & Cummings (2003) some of the options are: (1) listwise deletion, meaning that only complete case are analyzed, (2) pairwise deletion, where the correlations or analyses are done with the available data for each case analysis, (3) unconditional mean imputation, (4) conditional mean imputation (calculating the mean using an ordinary least squares regression coefficients (OLS)), (5) estimate value using a maximum likelihood (ML) method, (6) multiple imputation (MI) were different values for the data missing are generated as matrix of substitutes.

From the above mentioned methods to address missing data, the KFS is available in both the original raw data set, but also with the most reliable method for treating missing data, the multiple imputation (Fichman & Cummings 2003; Newman 2003). The application of multiple

imputation (MI) has important advantages for data sets that are aimed to be made available to a community of researchers (as is the case of the KFS). Addressing the missing data using multiple imputation, means that for each missing observation, an *m* set of possible value are generated; there are two decision that the curator of the dataset needs to take when applying multiple imputation: first, establish what is the number of imputations are needed (the number of *m* – usually between 2 and 5), second to estimate the acceptable confidence intervals for the generation of the multiple (*m*) values for the missing value. Further detail on the available alternatives, and the statistical implications can be seen at Fichman & Cummings (2003).

In the case of the KFS the curators of the dataset used m=5, thus generating 5 possible values for each of the missing data observations. This means that each case is replicated 5 times, one for each possible value for the missing observation, they were created using sequential regression multivariate imputation - SRMI (Farhat & Robb 2014). Examples of uses of multiple imputation (MI) to ensure that the missing data does not condition the data analysis can be seen in other recent entrepreneurship research (see Tonoyan et al. (2010)).

Appendix V: Survival Analysis and other event history analysis (EHA) options

One of the benefits of working with longitudinal panel data is to be able to study the effects of time, event history analysis (EHA) offers a group of methods that offer the tools to advance in this direction. This analysis perspective includes survival, duration, failure time and hazard time analysis, the methods are focused on exploring the time-to-event data from the observations in the panel (Farhat & Robb 2014).

The study and use of survival analysis has been widely used in fields like biomedical sciences, the statistical development and methods used in this field are more and more used in social sciences (Singer & Willett 2003). This analysis method offers the possibility to study situations where an individual (or firm) with determined set of characteristics is exposed to various changes (or treatments in the biomedical field) and is either observed to exit (failure) or manages to remain active, thus it survives (Wooldridge 2002). One of the conditions is to control for when the individuals start the treatment, in our case, when they become active (the business is created); otherwise the duration data would not be comparable across the different firms. The objective of this analysis method is to estimate the effects of the covariates (from the explanatory variables) on the expected duration (survival) of the firm (Wooldridge 2002).

When the study is focused on survival or duration of the firm, the reference event is the failure of the firm, if this event occurs then the firm exits the panel. From a hazard analysis perspective, all the time that the firm has stayed in the panel is the risk period (Andreß et al. 2013). Additionally, it could also be that instead of being interested in a single event (failure), we are interested in studying multiple events than can actually be repeated in time (for example getting external funding).

For the scope of this research, we are interested in the survival or duration function, and the hazard function. Survival or duration function offers the possibility to analyze the probability of the firm to stay active (or that the event of failure has not occurred) during the defined time of observation (for example the first four years after creating the firm), this approximation requires a careful treatment of right censoring, as the event might just happen in the next wave of data not captured in the dataset, and remain unobserved to the researcher (Box-Steffensmeier & Jones 2004) . Alternatively we can also study the hazard function, or the rate of occurrence of the event in the unit of time we use (in our case the year, as data is gather in yearly waves). The hazard models offer the possibility to study the probabilities of the event occurrence without having to introduce assumptions on the duration distribution functions

(Box-Steffensmeier & Jones 2004), there are different options to study hazards models for example the Cox proportional hazards model, where we can study what are the effects of the changes in the covariates (explanatory variables) in the occurrence rate of the event (or hazard risk). Examples of the use of this methods are seen in studies of factors influencing the venture emergence, aiming to understand whether some initial characteristics of the firms or time-variant factors influence on the failure risk (Brush et al. 2008). Survival and hazard analysis provide alternative but similar characterizations of the influence of time on the event object of study.

Appendix VI: Details of the STATA code and results used to assess whether the two measures for each factors are different (comparing in-between and within measures of the same variable):

```
Detail on the test:

. test ( dsalestoemployees= msalestoemployees) ( dresdevtoemployees= mresdevtoemployees) (
dmarketexp= m
> marketexp) ( dresdevexp= mresdevexp) ( dd3_c_num_trademark= md3_c_num_trademark) (
dd3_a_num_patent= m
> d3_a_num_patent )

 ( 1)  [Ventemerg]dsalestoemployees - [Ventemerg]msalestoemployees = 0
 ( 2)  [Ventemerg]dresdevtoemployees - [Ventemerg]mresdevtoemployees = 0
 ( 3)  [Ventemerg]dmarketexp - [Ventemerg]mmarketexp = 0
 ( 4)  [Ventemerg]dresdevexp - [Ventemerg]mresdevexp = 0
 ( 5)  [Ventemerg]dd3_c_num_trademark - [Ventemerg]md3_c_num_trademark = 0
 ( 6)  [Ventemerg]dd3_a_num_patent - [Ventemerg]md3_a_num_patent = 0

           chi2(  6) =   42.00
         Prob > chi2 =    0.0000

(for xtreg - on sales amount)
. test ( dsalestoemployees= msalestoemployees) ( dresdevtoemployees= mresdevtoemployees) (
dmarketexp= m
> marketexp) ( dresdevexp= mresdevexp) ( dd3_c_num_trademark= md3_c_num_trademark) (
dd3_a_num_patent= m
> d3_a_num_patent )

 ( 1)  dsalestoemployees - msalestoemployees = 0
 ( 2)  dresdevtoemployees - mresdevtoemployees = 0
 ( 3)  dmarketexp - mmarketexp = 0
 ( 4)  dresdevexp - mresdevexp = 0
 ( 5)  dd3_c_num_trademark - md3_c_num_trademark = 0
 ( 6)  dd3_a_num_patent - md3_a_num_patent = 0

           chi2(  6) =   57.19
         Prob > chi2 =    0.0000
```

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