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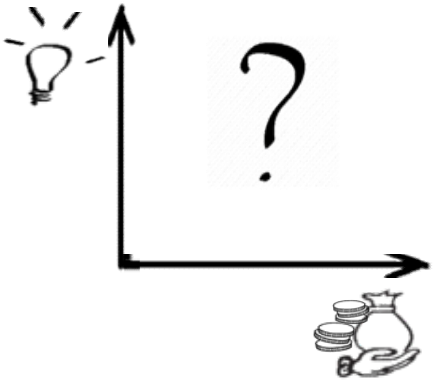
What IQ leads to success?

The relationship between Innovation Quantity (IQ) and success of early-stage start-ups



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Abstract

The present study attempts to extend the current state of knowledge on the relationship between innovation and success of early-stage start-ups in terms of funding security. Innovation cannot be measured ex ante and the prevailing view about its positive role for firms is disputed by recent studies in start-ups. Moreover, innovation seems not to be a distinct investment criterion for start-ups' investors. Therefore, a quantitative study has been carried out using CrunchBase data for the selection of the targeted start-ups and the Innovation Risk Cube framework for their classification. Based on the findings there are indications that there is a sweet spot of innovation quantity which can lead start-ups to investment security, whereas, excessive innovation quantity, accumulated by the use of multiple, simultaneous types of innovation can lead to failure.

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1. Introduction

1.1 Relevance

Research on innovation and its relationship with firms' performance is by no means untouched as of this date. Actually, it is more than a hundred years ago since its significance was implied. In the meantime, many researchers have studied this relationship. The vast majority claims that it is positive. At the same time, a significant amount of start-ups fails and a growing literature questions innovation as a factor which leads to a better performance and competitive advantage. In the midst of such ambiguity around innovation, an explorative investigation based on data of the most successful start-ups[1], which secured the highest values of investments during the last decade is carried out. Through this work the link between innovation, (innovation quantity in particular) and funding security will be explored. A start-up at an early stage consciously or not decides about the quantity of innovation that its solution will include. If a start-up could knew the possible outcomes of these different options, this informed decision would be of great value. The problem is that it is very complex to calculate, or to put it differently, to accurately predict these figures in order to compare and select the one with the highest positive impact. Not only because one has to make predictions about the risk values and eight categories of uncertainty which are inherent in the innovation process: technological, market, regulatory/institutional, social/political, acceptance/legitimacy, managerial, timing and consequence uncertainty (Jalonen H., 2011) but also because it is impossible to think of and include in the equation all potential successful applications, unintended and unforeseen consequences and risks of each combination. Not to mention the required time for each solution which also plays an important role in this comparison of two different innovation-risk weights. And even if one attempts to solve this, the equation will include

[1] When it comes to a company's success there is not a single universal criterion. There are many ways to define and assess success, among which: how impactful a company is in the world, what is its customers' level of satisfaction, or how many customers it has, how high is its growth, or whether it has raised funds. Since the present study focuses on early-stage start-ups, the parameter of measuring success for the scope of this thesis, is whether they have secured investment from investors in order to develop their idea or not. Of course, it is not claimed that all well-funded start-ups will confirm their goodwill and become successful companies. There are hundreds of examples that such start-ups could not make it in the end. Similarly, just because a start-up has not managed to secure investment so far, it does not mean that it cannot be successful. However, the logic of the decision of the present work is the following: if a start-up has managed to secure investment, this means that it has succeeded in attracting the interest and gaining the trust of investors, who judge under elaborated professional criteria about which start-ups are promising and can become successful. Let alone, the start-ups studied for this thesis which are the most funded in their industries and the vast majority of them has the support of more than one investors according to the data.

a lot of predictions/uncertain figures and the more these figures, the higher the deviation between the predicted and the actual total value.

To date, sufficient research to guide us towards a measurement method which can quantify these different innovation-risk combinations in order to render them comparable, does not exist. Considering innovation's nature, probably the achievement of a precise measurement method will remain an unfulfilled wish.

The potential from measuring innovation ex ante is really high though. Not only entrepreneurs could be guided to a more informed selection of innovation type for their idea and consequently increase their chances of success but also the creation of a social benefit through a better exploitation of resources such as huge amounts of capital and labor through more informed investment decisions.

Therefore, the research question of this thesis arises of:

Can a start-up increase its chances of investment security by a conscious selection of its innovation quantity (IQ)?

However, in an analysis of an intangible and abstract idea like innovation many limitations are involved, let alone when it is attempted to measure it ex ante. Limitations are dully described throughout and in the last chapter of this thesis.

1.2 Organisation of the paper

The thesis is organised as follows. The second chapter provides a brief overview of the underpinning theory as well as a presentation of theory relevant to the applied tools and industries. In the third chapter the research context and the research phases of data collection and data analysis are described in detail. In chapter four the findings are presented and discussion of theoretical as well as practical implications for entrepreneurs and investors takes place. In the fifth chapter limitations of this thesis and possibilities for future research are discussed. Chapter six concludes.

2. Literature Review

The purpose of this literature review is to offer an overview of significant academic publications related to the present topic. In the first part, the theoretical background of this thesis is presented followed by a sub-conclusion and justification of the study. In the second part, the theory of the main applied tools for the analysis as well as the selected industries are described.

2.1. Theoretical background

2.1.1. Innovation and entrepreneurship

Innovation is more than an idea or invention and it is important to distinguish it from invention (Fagerberg, 2005). Invention is the conception of a new idea while innovation is the attempt to put this idea into practice. In order for an invention to be transformed into innovation many resources are required, such as knowledge, skills and funding. But this process involves high uncertainty because there is not a handbook with steps to follow and whatever needs to be known is only learned during the innovation process itself (Lazonick, 2005). The key factor for this transformation is the entrepreneur, seen as someone who is willing and able to "enderprendre" (undertake) the transformation of an invention into an innovation as Schumpeter, one of the leading entrepreneurship researchers suggested. As a result, the success of a business is linked to the entrepreneur's proactive behavior and actions, including funding security, management and continuous evaluation of current modes along with continuous search of new methods and ways to operate the business more efficiently and effectively and eventually lead it to outperform its competitors (Schumpeter, 1934). In this sense, innovation cannot only be seen as a critical aspect of the start-up but an important part of entrepreneurship itself.

2.1.2. Types of innovation

Ries (2011) argues that innovation is at the heart of the success of start-ups and that it can be achieved in a number of ways; notably, by using new or reusing existing technology on the market, by planning a business model that unlocks or creates hidden value and by directing the value proposition to customers not yet served by existing solutions. Based on what is the innovative factor on the above ways, three main types of innovation for start-ups exist: a) product/service innovation, b) business model/process innovation and c) market innovation.

The first type is the most common and the most visible. It refers to the creation and introduction of new products which differ from the existing ones (OECD/Eurostat, 2005). Typically they are consumer products and are highly linked to new technology, such as computers and phones. And this is why innovation many times is coupled to the development or use of new technologies and to high-tech industries. On the one hand, this is reasonable and true, since most new ideas involve technological innovation (Rogers, 2003) and a result of this close relationship between them is the often use of innovation and technology as synonyms. However, this is incorrect because technology is just one potential element of innovation and a start-up can be innovative without the use of technology, especially in the following types.

Service innovation is obviously critical for companies which are in the service business and also many times in manufacturing environments, the services which surround the product are of the same or higher importance than the product itself.

The second type of innovation refers to the business model or the business processes. Every company has a business model whether they communicate it or not. It is a plan which shows how a specific business in a specific marketplace is going to operate. In other words, how a company creates and captures value or how it makes a profit. It identifies the amount of products or services the company will sell, the target market it has identified and the expenses it anticipates. An innovation can affect a broad enough range of business dimensions such as the supply chain management, product/service design, production, sales and marketing, distribution or pricing. Innovation in business processes that are not visible to the customer are also a source of important market differentiation and refer to implementation of a new design or development method that changes the way how products are created (OECD/Eurostat, 2005).

The third type is the implementation of new marketing methods and strategies in product design or packaging, placement, promotion or pricing. Its goal is to better address customer needs, open up new markets or newly position a product on the market in order to increase sales. In other words, through market innovation a start-up finds a completely new audience for its same existing skills and products. As a result, its risk is reduced through diversification of its market. Moreover, it avoids the intense and usually unsustainable competition of red ocean and sails through the blue ocean, an unexplored territory in an uncontested market space where it can unlock new demand (Kim C. & Mauborgne R., 2017).

2.1.3. Innovation's nature and definition

Thinking of innovation's significance, one would expect that there must be a universal definition for it. However, after some research, one will find out that it has been a vague idea for many years and it is only ten years ago that a multidisciplinary definition has been formulated. More than a hundred years ago Lorenzi et al. (1912) and Veblen (1899) noticed that processes that are associated with innovation and economic and technological change were perceived as being important and thirty years later Schumpeter (1934) was the first one who defined innovation. Since then, more than sixty other definitions for innovation have been proposed in different disciplines each one of them emphasizing different aspects of innovation, with novelty and technology being the most popular among them. This big number and diversity of definitions stems from innovation's intangible nature and from the fact that technology and business evolve throughout these years, albeit create ambiguity and confusion. In 2009, Baregheh et al. realized that a universal definition of innovation not only would provide a better understanding of it for both researchers and practitioners but would also enable researchers from different disciplines to collaborate and investigate this complex concept more holistically. Through their comprehensive study towards a multidisciplinary definition of innovation they proposed the following definition which summarizes the essence of innovation: "Innovation is the multi-stage process whereby organizations transform ideas into new/improved products, service or processes, in order to advance, compete and differentiate themselves successfully in their marketplace."

2.1.4. Innovation measurement and approaches

Innovation is hard to measure because of its intangible nature and multi-dimensional character as it was described above. Also innovation is context-specific making comparability of data difficult (Neely & Hii, 1998). For example, two different innovations may have a significantly different economic impact, but they both may be recorded as an innovation count. Consequently, no single measure can cover all these constituting aspects of innovation (Shapiro, 2006) but there are multiple approaches to measuring innovation at different levels.

At a national level, innovation measurement is in its infancy (US Department of Commerce, 2008). According to Bowen et al. (2010) and Corrado, Haskel, Jona-Lasinio, & Iommi (2013), main purpose of this attempt is the measurement of the impact of innovation on the economy and

consequently the improvement of financial systems and the increase of economic growth. Four basic broad approaches can be found:

- Innovation outputs based on the use of indicators such as patents, trademarks, copyright, published scientific articles, launch of new products and innovation counts.
- Innovation inputs based on the use of R&D expenditure and R&D intensity.
- Innovation inputs and outputs. Such a case is the EU Scoreboard which consists of a weighted average of 24 indicators from GDP to broadband penetration.
- Outputs net of inputs. Such a case is the multifactor productivity method whose essence is described by Jorgenson (2007). Innovation is that part of growth which comes from the use of more new ideas. The balance of total growth comes from the use of physical capital and machines. Thus, the latter is measured first and innovation growth is measured as a residual.

Another goal of innovation measurement at this level according to the US Department of Commerce (2008) is to develop estimates of the rate of return to investments in innovation activities.

At a company level, the inability to measure a firm's innovation is seen as a barrier to innovation by managers (Kuczmarski, 2000). However, two main approaches to measuring innovation can be found in the literature:

Innovation investment metrics, investment performance metrics and program metrics that measure innovation performance. Both inputs and outputs are used for their calculation and they aim at benchmarking, resources allocation, employees compensation, markets information and future goals setting (Ibid.). Hagedoorn & Cloodt (2003) proved that all of the following metrics are valid and that any of them can be taken as a measure of innovation performance: R&D inputs, trademarks, patent counts, patent citations and new product announcements.

Innovation capacity metrics. Morris (2008) visualized the innovation process as a funnel which consists of nine stages. He proposed qualitative and quantitative metrics for each stage. They can be addressed to companies and organizations with a R&D department and most of the quantitative metrics depend on the outputs of innovation.

A common characteristic of all the above metrics is that they are designed to evaluate innovation "ex post", after it has been implemented. In contrast, not a single metric has been designed in order to assess innovation "ex-ante", before its implementation.

2.1.5. The sign of the relationship between innovation and start-ups' performance

Many years ago, academics pinpointed that innovation becomes an important factor used to characterize entrepreneurship (Covin and Slevin, 1989; Karagozoglu and Brown, 1988; Miller and Friesen, 1982). But does this imply a positive association between innovation and firms' performance too? Taking into consideration theoretical arguments of the literature of that time, which is the dominant stream until today, then, probably yes. In 1934, Schumpeter argued that innovation makes firms able to profitably raise their prices. In 1980, Porter asserted that innovation enhances firms' ability to escape competition. Some years later, Cohen and Klepper (1996) showed that firms' production costs are reduced and Teece et al. (1997) that dynamic capabilities are improved through innovation. Tushman and O'Reilly (1996) and Dess and Picken (2000) regard innovation as a critical source of competitive advantage in dynamic environments. Moreover, innovation is strongly associated with growth (Bessant and Tidd, 2007) and leads to enhanced absorptive capacity (Zahra and George, 2002).

However, during the last years, there is a sparse but growing literature which leads towards an opposite direction. More specifically, that the association between innovation and start-ups' performance is negative or that the positive relationship is not uniform and it does not apply to start-ups, since, as Rosenbusch, Brinckmann & Bausch (2011) explain, most of the literature supporting the positive aspects of innovation focuses on large well-established firms. Part of this literature stream also supports that often times a survival bias is present in empirical studies of the opposite stream (Buddelmeyer et al., 2010). In other words, it states that some companies, unconsciously, have been excluded from the investigated samples that they should not have. For example, this occurs when a sample which comprises companies which have registered a patent or companies that have already successfully traded in the marketplace, although these do not guarantee success, they still indicate a level of successful innovative effort, or when the sample is actually a sub-sample of the companies that entered the market (Hyytinen, Pajarinen, & Rouvinen, 2015). Moreover, examples of theoretical arguments of this opposite new stream are the following: Innovation demands resources of great value (Van de Ven, 1986). Increased uncertainty and risks are associated with innovation (Eisenhardt and Martin, 2000; Knight, 1921). Innovation is linked

to high failure rates (Berggren and Nacher, 2001). DeTienne et al. (2015) claims that some founders may have a desired exit in mind and as a result they may increase the start-up's risk on purpose in order to achieve it earlier.

Contrary to the bifurcation of the theoretical literature, all previous empirical literature like Song's et al. (2008) and Rosenbusch's et al. (2011) are in favor of the positive relationship between innovation and start-ups performance, even after accounting for the afore-mentioned survival biases (Hyytinen et al., 2015).

2.1.6. Innovation financers

Start-ups and innovation are not the only players of the entrepreneurial ecosystem. Another key player is essential for its success, the financers. Typically, an entrepreneurial journey starts with the founders' own capital, including personal savings and financial support from family and friends, but although this might be a big help in the beginning, soon after, more funding is needed. Such sources of capital are the following:

- Business angels (BAs) who are affluent individuals who provide capital, advice and support usually during the difficult very early stages of a venture.
- Venture capitalists (VCs) who are the largest category of investors and the most important and impactful source of funding for new ventures (De Clercq et al. 2006) and
- Corporate venture capitalists who have a strategic primary interest since they invest in start-ups that will add value to their parent company (Ibid.)

VCs except for their main role in financing innovation, they also have a strategic, a networking, an interpersonal, a reputational and a discipline role. For more info about their roles you can see Clercq's et al. (2006) paper. VCs are considered specialists in judging investment opportunities, thus, pools of money from institutions and high net worth individuals are trusted to them to manage. Their main role is that of the financial intermediaries who match this capital with the most promising start-ups seeking funding (Freeman & Engel, 2007). Such investments are highly uncertain and risky but they match the VCs' profile which is more risk-oriented compared to the most traditional sources of finance. Despite this risk-oriented inclination, they of course want to reduce the unsystematic risk, so, according to the financial theory, they invest in many start-ups which compose their portfolio and target for very high returns, (25% to 30%) so that the returns of the few successful selections will compensate both for the loss of the unsuccessful bets and the

expected return of the fund (Zider, 1998). In fact, VC's reputation is frequently built on one or two extraordinary investments. (Ibid.)

There are three stages of investing defined by the development stage of the start-up that receives the investment (Jeng & Wells, 2000).

- Seed stage is the stage after the initial concept stage, during which entrepreneurs approach investors including friends, family and angel investors to find financial support. Funds are typically used in product R&D and to assess the commercial potential of ideas.
- Early stage is the stage where successful seed stage start-ups have progressed to. In this stage more VCs decide to invest cash in exchange for equity or partial ownership of a company. Funds are typically used in product testing and/or pilot production and usually revenue is not being generated yet.
- Late stage is the expansion stage. In this stage a company has already an established product in the market and needs more funding to invest in its growing R&D, manufacturing and distribution needs.

Investing in these stages differs. The earlier the stage, i) the further it is from an exit (IPO or trade sale), ii) the greater the risk of a failure since considerable management, market, and iii) technological uncertainty is generally higher (Elango, Fried, Hisrich, & Polonchek, 1995); consequently the higher the risk of such an investment (Cumming, 2007). Similarly, Ries (2011) confirms that the early stage is a field of high risk and uncertainty. Accordingly, Robinson (1987) showed that investors prefer more and of lower value early-stage investments than fewer and of higher value late-stage investments although the chance of a positive return is higher in late-stage investments. This implies that the potential returns are higher in early-stage start-ups and this is the case until today, since a relatively higher number of deals and less total capital is invested in early-stage compared to late-stage according to CrunchBase. For example, 2.695 early-stage deals of a total capital of 27,63B USD vs. 579 late-stage deals of total capital of 35,41B USD in Q2 of 2019 (Crunchbase, 2019b). Another worth-mentioning point about VCs' investments is that between a specialized portfolio focusing on a single stage or a few close stages of investment and a diversified portfolio with investments across the different stages Norton's & Tenenbaum's (1993) empirical study demonstrated that the first one is more profitable, which implies that the benefit from specialized knowledge outweighs the benefit from diversification.

2.1.7. Innovation financers' criteria

Deciding which start-ups are promising and worth-funding is very crucial not only for the start-ups and the investors but also for the economy and our world. Which are the investment criteria though? Despite the large number of papers on this topic and being a matter of research for more than forty years (Köhn, 2018) there is still no systematic evidence on the decision-making process (Bernstein, Korteweg, & Laws, 2017; Šimić, 2015; Hudson and Evans, 2005; Zacharakis and Meyer, 1998). However, the basic categories of criteria according to Šimić's (2015) work based on previous research are the following: a) the founders' characteristics such as their personality and experience, b) the product's characteristics; e.g. whether it is proprietary/protected and accepted by the market, c) the target market's characteristics like the growth rate and industry attractiveness and d) financial considerations regarding the valuation.

As it was mentioned before, investing in different stages differs. Therefore, it is totally reasonable that some criteria also differ between early and late stage. The team and more specifically: ability, industry experience, passion, entrepreneurial experience and teamwork are relatively more important for early-stage investors due to high uncertainty about the product at this stage (Gompers, Gornall, Kaplan, & Strebulaev, 2019).

Regarding the products' characteristics, uniqueness, ownership and high-growth potential are desired by early-stage investors, whereas market approval is the most desired feature by late-stage investors (Elango et al., 1995). Finally, early-stage VCs consider desired ownership more than late-stage VCs who consider exit matters more (Gompers et al., 2019).

2.1.8. Sub-conclusion of the theoretical background and justification of the present study

The above literature review is of necessity to make one understand the significance of innovation for entrepreneurship and the economy as well as to stress the high ambiguity around it. First of all, the existence of more than sixty formal definitions for it, introduced during the last one hundred years stemming from its intangible and abstract form, denotes a difficulty in defining it. Secondly, although there is a unanimous consideration that innovation is important, there is not an agreement on whether it is positive or negative for a start-up's survival and success. Of course the majority of the literature implies that it has a positive effect and it is an important factor for a competitive advantage leading to greater performance, however there is a growing stream which supports that it leads start-ups to failure. Thirdly, there are many methods that can measure some

aspects of innovation, however there is not a standardized method to measure it globally and adequately yet, nor a method able to measure it before its implementation. Finally, despite the wide acceptance about its significance, one would expect that it should form one of the key investment criteria for start-ups' investors. But again, it is not mentioned as an explicit criterion, or there is only an indirect reference to it in a few cases, usually through the product and market characteristics. As a result, theory is not sufficient in order to find an answer for the research question of the present study. An answer is attempted to be found through a quantitative study in a following chapter of this thesis. Before this, a reference to the main theory and information about the applied tools and industries is made. The electronic database "CrunchBase" was used for the collection of data and the Innovation Risk Cube framework for the categorization of start-ups according to their innovation types.

2.2. Applied tools and industries

2.2.1. CrunchBase and its credibility as a source of data

CrunchBase is the leading platform for over 55 million professionals to discover business information about innovative companies, connect with key people behind them and pursue new opportunities. CrunchBase includes companies from all industries such as finance, biotechnology, automotive, advertising, energy, construction and so on. It was founded in 2007 and during its twelve years of operation, more than 4.000 investment firms globally cooperate with CrunchBase by submitting monthly portfolio updates in exchange for free data access. In addition, an active community of over 600.000 visitors: executives, investors and entrepreneurs contribute by updating and revising over 100.000 company, people and investor profiles each month. Data accuracy is being validated not only by data analysts who provide manual verification but also by artificial intelligence and machine learning algorithms which scan for anomalies and conflicts in the data (Crunchbase, 2019a).

These important innovations of CrunchBase compared to other commercial databases and public data sources commonly used in economic research plus the wider spectrum of included companies from small start-ups with a few employees that might have been founded recently to multi-billion dollar businesses, provide researchers an opportunity to study and analyze phenomena that have been under-investigated so far because of lack of data (Dalle, Den Besten & Menon, 2017). For example, in January 2017 the absolute majority of companies less than 10

years old in the platform was micro-enterprises, something that can be seen as a positive aspect of the database, as coverage of such companies is limited in proprietary databases (Ibid.), especially if one wants to study start-ups. Their review of scholarly use of CrunchBase as main source of data, identifies more than 90 published articles and papers that relied on CrunchBase. In some cases, to source examples of the phenomenon that is described, in other cases to corroborate theories, or else, to illustrate the potential of prediction methods. They cover a wide range of topics, published in management, green innovation, technology and small businesses journals, some of which are among the top journals in their fields, which justifies the reliability and proves the legitimacy of CrunchBase as a source of research.

2.2.2. The Innovation Risk Cube (IRC)

Professor Virginia Cha, Adjunct Professor at NUS & INSEAD Singapore, developed the Innovation Risk Cube framework as a cognitive tool to help entrepreneurs understand the risks from practicing innovations, and the framework also suggests mitigation strategies. This framework is taught in the Entrepreneurship and Innovation modules taught at both the National University of Singapore and INSEAD MBA programs.[2] The framework was derived and adapted from an investment model developed by Terry Opdendyk, Founder and General Partner of ONSET Ventures and Jerry Engle, UC Berkeley. The IRC concept is a scholar contribution to the ever-growing body of knowledge on innovation. It is a theoretical model through which various hypotheses can be tested. To date, the tests have been comprised of numerous qualitative observations which have supported that each sub-cube of it is associated with specific characteristics, risks and possible mitigation strategies to counter the identified risks. A quantitative research study, supported by Singapore's National Research Foundation with use of 152 technology startups in Singapore, was also conducted. At the same time, it also acts as a practical framework and a predictive model that can be applied by the entrepreneurial ecosystem stakeholders such as entrepreneurs, investors and policymakers in their respective area of work.

It has the shape of a cube consisting of two sub-cubes in every dimension. It maps innovation along its three key dimensions for start-ups, as they are described in the beginning of this chapter: a) product innovation, b) business model innovation and c) market demand innovation. Innovations in each dimension are classified under two categories: radical or

[2] The author of the present thesis attended the class of Dr. Cha during an exchange semester in NUS.

incremental under product innovation, untested or existing under market demand innovation and unknown or known under business model innovation. Whereupon, the cube consists of eight (2^3) sub-cubes, one for each specific innovation combination.

At this point, and before explaining the way how the IRC works, it is important to refer to the definitions of the above terms which describe innovations for their use at the IRC, in order to make sure that the limits of each sub-cube are clearly-defined. A product innovation is considered "radical" when profound changes and new approach to the product take place and when such changes and new approach lead to a change in the overall experience and consumer usage behavior and/or outcome[3], without altering the value proposition and the problem it intends to solve. It is "incremental" when slight improvements and/or minor differentiations from existing competitors in the market take place (i.e. one or two additional features) with a little or no change in consumer behavior and habits. A business model innovation can be characterized as "unknown" when the business model is untested and unproven, whereas it is considered "known" when it is known and/or proven but applied to a different solution and/or industry. A market demand innovation falls under "untested" if there is no proof of market demand from customers' target groups same as the competitors', i.e. when there are no competitors offering the similar solution, whereas it falls under "existing" when the market demand is proven from customers' target groups same as the competitors'. An overview of definition of terms, including examples can be found in Appendix I.

Having the above definitions always in mind, the first thing that has to be done is to judge in which sub-cube each case belongs according to its innovation features. Then, each stakeholder can consult the characteristics, risks and mitigation strategies for the relevant sub-cube and act accordingly. The main benefit of the IRC model is that it helps both the entrepreneurs and the investors make smarter and better decisions before taking actions incurring significant implementation costs.

[3] The term "outcome" has been added in order to extend this definition and include cases in Biopharma that a new treatment/medicine may not change the patient's behavior during its use, but it changes the patient's condition after use; so the outcome is different.

2.2.3. The selected industries – Biopharmaceuticals and Food & Beverage

The selected sectors of food and pharmaceuticals correspond to the main needs of daily life, which are nutrition and health. Life and well-being depend greatly on these two vital primary sectors. Both are also economically significant industries. The reasoning of the decision to examine two industries, each one bearing some different critical characteristics, aims to produce comparable results and potentially lead to the detection of patterns, as well as to the better understanding of the underlying dynamics and the potential advantages that innovation brings to these sectors.

2.2.3.1. Biopharmaceuticals industry (Biopharma)

Biopharma is part of and intimately tied to the pharmaceuticals and healthcare industries (Thakor & Lo, 2015). It is a relatively new industry, based on biotechnology technologies like genetics, immunology and molecular, cellular and structural biology (Audretsch, 2003). Moreover, new technologies such as: artificial intelligence, machine learning and big data help in uncovering hidden patterns and inferences connecting causes and effects otherwise not identifiable or comprehensible during the early-stage development. Biopharma's global revenues of $163 billion, about twenty percent of the pharma market making it by far the fastest-growing part of the industry (McKinsey, 2014). It comprises a large number of new, R&D intensive firms with an extended research period corresponding to the many studies, preclinical testing and clinical trials that are conducted for safety purposes, making the industry very innovative. Their motivation to innovate stems from their aim to improve health and enhance quantity of life, through disease prevention and the battle against incurable diseases (e.g. cancer). As a result, innovation is a matter of survival both for these companies and for thousands of people threatened by the diseases.

Another characteristic of this industry that motivated my selection is that it is highly concentrated. This means that the production is dominated by a small amount of large incumbents that can shape the industry and the price levels while at the same time many new tech start-ups emerge (Hoovers, 2019a). Moreover, it is only the incumbents that can commercialize an innovation, meaning that new entrants originate more radical innovations and their ultimate goal is a trade sale (Giniatullina et al., 2013). In other words, to be acquired by one of the incumbents/strategic buyers after they have won the race of a new drug development (Henkel, Rønde, & Wagner, 2015). This complementary relationship between established pharmaceuticals companies and new biopharma start-ups implies that it is more efficient for the big players to

acquire such new innovative products by acquiring innovative companies than to produce them themselves (Audretsch, 2003).

2.2.3.2. Food & Beverage industry (F&B)

F&B is a traditional, albeit growing industry with a pronounced presence in the markets. While the earth's population is growing and more and more people are living a fast-paced life, the industry must adapt to this by supplying the consumers' food and beverages in a faster, cheaper, safer and healthier way. Consequently, innovation significantly contributes to this strong imperative for solutions that meet the above requirements. Every aspect of a food or a beverage's production, from how its ingredients are obtained, to how it is processed, distributed, or consumed, and everything in between is included in this industry.

In contrast to the other selected sector, F&B industry is fragmented, i.e. less concentrated. This means that the production is distributed among more different companies and none of them has a large enough share to be able to shape the industry and affect the price levels (Hoovers, 2019b).

3. Methodology

3.1. Research context

The main purpose of this thesis is the exploration of the relationship between innovation and success. Success as defined for the scope of this thesis, is linked to start-ups' ability to raise investments. For this reason, an exploration of investors' decisions to fund start-ups is carried out, as described in this chapter.

3.2. Data collection

3.2.1. The CrunchBase Dataset

The analysis is based on data obtained from CrunchBase in December 2019. The first step is the definition of the sample of start-ups. All applied filters which represent the selection criteria are accurately presented below followed by a compendious description and justification.

Common filters for both industries:

i. Founded Date: After 10 years ago (within the last 10 years, i.e. between 2009 and 2019)
ii. Funding Status: Seed and Early-Stage Venture
iii. Investor Type: Venture Capital, Individual/Angel, Micro VC, Angel Group

Filters for the Food & Beverage industry:

i. Category Group: Food & Beverage
ii. Categories: n/a

Filters for the Biopharma industry:

i. Category group: Biotechnology
ii. Categories: Biopharma, Pharmaceutical

As noted in the Introduction of this thesis, start-ups comprise seed and early-stage ventures. As mentioned in the "Innovation financers" chapter, the fact that early-stage start-ups attract more investments in terms of number of deals than the late-stage ones implies that the potential of such investments is higher; therefore the early-stage has been considered as more interesting and is selected to be studied in the present paper.

Regarding the selected start-ups' age someone might argue that ten years of age for an early-stage start-up are too many. However, especially after the selection of Biopharma as one of the

two industries to be investigated, it was concluded to this age after taking into consideration the typical characteristic of this industry referring to its long R&D phase as mentioned in the relevant chapter of this thesis. For consistency, this applies to both sub-samples, in Biopharma and F&B.

The types of investors who mainly invest during these early-stages are VCs and business angels. Since they both contribute equally to venture innovation rates (Dutta & Folta, 2016), it was decided to include funding amounts from both of these categories, excluding corporate venture capitalists, who anyway prefer investing in later stages (Clercq et al., 2006).

The decision for the selected industries is justified in the "The selected industries – Biopharmaceuticals and Food & Beverage" sub-chapter.

The above applied filters returned 1.594 start-ups in the F&B industry and 439 start-ups in the Biopharma industry. The next step is to sort the results by Total Equity Funding Amount and select the top 50 from each industry for the sample. The selection of the most funded start- ups is reasonable and the risk of selection bias is excluded since object of the investigation is the profile of successful start-ups. The decision regarding the number of 50 selected start-ups is made in both industries for reasons of comparability of the sub-samples. It also corresponds to the time limitations of the thesis; taking into account the necessary overview of the business particularities for all start-ups of the sample and their products/services as well as the time-consuming task of coding all start-ups of the sample through the IRC. After having clearly defined the sample, the next stage of this work is the coding of the data and the allocation of these start-ups to the IRC sub-cubes according to the innovation choices of the entrepreneurs.

3.2.2. Constraint

At this point, a worth-mentioning constraint about the data collection stage of this work and the way it is treated can be found. The initial intention was to compare total equity funding received only during seed and early-stage no matter which funding stage these companies are currently in. The rationale for this, is the fact that during these early stages, innovation, which is the main subject of this thesis, plays a more important role to the investors' decision since this is their overriding concern compared to management in the next stage (Ruhnka & Young, 1991). Unfortunately, this option of categorization of funds per stage is not available in the platform so a decision had to be made about how to proceed. The options to tackle this implication were the following two: either to include late-stage start-ups with probably higher amounts of funding

because of next-round investments, which by the way they would be relatively higher, or to exclude start-ups currently in a later stage. In the first option, although it was only a 12,7% of the total sample that is currently in a later stage, this percentage was significantly higher at the first 50 companies that the IRC would be applied to. For this reason and because later stage investments are of relatively higher amounts it was finally decided to exclude companies currently in a later stage.

3.3. Data Analysis

3.3.1. Data coding through the IRC

This stage is the hardest, the most time-consuming and the most crucial part of this research method. Not because the methodology is difficult or sophisticated but because it is very important for the results of this study to assort the start-ups at the correct sub-cube, where they exactly fit. It requires a combination of information and skills in order to do this adequately such as: sufficient information about the start-ups, proper understanding of the definitions of the innovation types and judgement.

The first step of this stage is the discovery of all necessary information which will help in forming a true understanding of the product, the business model and the potential targeted customers. Most of the times this information is available at the official website of the companies and rarely more information is required from other sources, such as investors' websites or articles before coming to a safe conclusion.[4]

The next step requires the correct process of this information and the allocation of the start-ups in one of the two sides of each dimension/innovation type. Product/service innovation is usually the easiest to distinguish. A determining factor for some less obvious cases (especially in the Biopharma industry) is whether the new solution changes significantly the consumer behavior and habits. On the business model innovation, the key point is the identification of how the start-up plans to earn revenue and whether this way is typical of the competition in this industry. On the market demand innovation, a way to differentiate the start-ups is whether there exist many

[4] Three startups of the F&B sample are out of business. The intention was not to exclude them from the samples, since the only criterion of success for this thesis is the security of funds. However, since neither their websites are active, nor the essential information to judge where they should be allocated in the IRC can be found from another source, it was opted to substitute them with the next start-ups in the list for numerical balance between the two samples.

close competitors. In such a case the market demand is already existing and there is no innovation, or in case there are only alternative products without competing offers, this means that the market demand is untested and thus there is innovation in this dimension. After having allocated all start-ups in all dimensions, the allocation in sub-cubes[5] is carried out according to Appendix II. and the results generated can be seen in Appendix III. for Biopharma and Appendix IV. for F&B. Their analysis is presented below.

3.3.2. Analysis of the results

At this stage, the analysis of the above-mentioned results is organized in such a way aiming to find an answer to the research question, as posed in the Introduction of this thesis.

First, it is investigated whether these most funded start-ups are innovative or not, i.e. whether they are innovative in at least one dimension of the cube (both in their sectors and in the aggregate). In other words, whether they are allocated in the cube (S1-S8) or not (S0). As already noted in the previous sub-chapter (footnote 5) if a start-up has no innovation in all of the three dimensions it is classified under S0, technically out of the box. Therefore, a comparison between the total number of start-ups allocated in sub-cubes S1-S8 and sub-cube S0 is carried out.

Secondly, it is investigated whether a preference is displayed by the investors to fund specific types of innovation in each industry. A comparison of the sides of each dimension of the IRC according to the investors' preferences (i.e. the following 3 comparisons: D10 vs D1a vs D1b, D2a vs D2b and D3a vs D3b as shown in Appendices III. and IV.) takes place. Additionally, an investigation using both the total amounts of funds raised and the start-ups' ranks based on these total amounts as obtained from CrunchBase, is carried out. What can be tested is whether the two sides of each dimension differ with respect to the ranking of the relevant companies. For example, it is tested whether innovation in business model (unknown) results in a relatively higher ranking compared to start-ups without any business model innovation (known).

Finally, in order to advance to the most determinant investigation of this thesis, aiming directly at the research question and which will help in reaching our longed-for answer, a classification of the start-ups according to their accumulated IQ has to take place. This can be achieved through the introduction of a scoring method which also contributes in detecting

[5] A start-up without a single innovation in any of the dimensions, technically is out of the cube's limits, however it is said that it is allocated in the sub-cube 0 (S0).

patterns. Then, the comparison within each industry, the cross-industrial comparison are carried out and a global presentation of the results is found in the next chapter.

3.3.3. The scoring method and its rationale

The rationale of the scoring method is as follows: Each sub-cube is a sub-group of start-ups of the same selected innovation types described above and therefore of the same quantity of innovation. It is based on the number of selected innovation types and the following simple and evident point system. The scoring for the business model and the market demand dimensions is binary since either there is innovation or there is not; for the product innovation dimension it is ternary on the basis of the existing options: no innovation, incremental innovation and radical innovation. Accordingly, it is zero points for a known business model and existing market demand and one point for a new business model and new market demand. In the product innovation dimension it is zero points for no innovation, half point for incremental innovation and one point for radical innovation, considering that a radical innovation is more difficult to conceive and/or implement compared to an incremental one. Table 1 shows the score for each option and innovation type. The combination of its results with those of Appendix II. produce Table 2, in which the total scores for each sub-cube are presented.

Table 1: Innovation types' score board

PRODUCT INNOVATION (D1)			BUSINESS MODEL INNOVATION (D2)		MARKET DEMAND (D3)	
Zero (0)	Incremental (a)	Radical (b)	Known (a)	Unknown (b)	Existing (a)	Untested (b)
0	0,5	1	0	1	0	1

Table 2: Sub-cubes' IQ score board

Sub-cube	S0	S1	S2	S3	S4	S5	S6	S7	S8
Total IQ Score	0	0,5	1	1,5	2	1,5	2	2,5	3

The scoring method of the innovation types is subjectively decided. On the one hand there is a proportional logic for the scoring in the same dimension, e.g. 0 (zero) for no innovation and 1 (one) for innovation. On the other hand, this scoring is not comparable when it comes to a

comparison of different types of innovations (e.g. a business model innovation vs a radical product innovation; they both have the same score) and of two innovations of the same type (a business model innovation vs another business model innovation; again, they both have the same score). As it has already been mentioned in a previous chapter of this thesis though, due to innovation's nature, this estimation of weights for each innovation is not and probably will never be feasible, and for the same reason the US Department of Commerce (2008) advises that there needs to be tolerance of qualitative and subjective measures. Therefore, this simple and evident way is quite satisfactory for the innovation classification of a first approach to the troubling topic of measuring innovation at the stage before its implementation.

3.3.4. Data classification according to IQ

Next step is the classification of the sub-cubes in two classes according to their total innovation scores as Table 3 shows below. Class A consists of sub-cubes with a total score ranging from 0 (zero) to 1,5 (one point five) and class B consists of the remaining sub-cubes with a higher total score and in turn higher IQ ranging from 2 to 3 points.

Table 3: Classification of sub-cubes according to IQ

IQ Class	IQ Score	IQ	Sub-cubes
A	0-1,5	↑	S0, S1, S2, S3, S5
B	2-3	↑↑	S4, S6, S7, S8

At this point, a practical explanation of the scores of the above classes is of importance and can help in interpreting the results. This is that:

- For class A, a score between 0 and 1,5 practically means that this class comprises start-ups that accumulate between 0 and 1,5 innovation types. In other words, start-ups with no innovation at all, start-ups with only one type of innovation and start-ups with two types at the maximum only in case one of them is the incremental product innovation.

- For class B, a score between 2 and 3 practically means that in order for a start-up to be allocated in this class, it must aggregate at least two types of innovation without incremental product innovation being one of them.

4. Findings and discussion

4.1. Findings and theoretical implications

In this chapter all findings from the above investigations are duly presented and discussed in a way that addresses the research question. Additionally the theoretical background as well as more general theory is taken into consideration. Before this is done, the purpose of this study is worth-reminding. It is the review of the 50 top-funded early-stage start-ups of the last 10 years in two industries and the exploration of the relationship between innovation (innovation types and IQ) and start-ups' success as it is defined for the purpose of this. The results of such an analysis, as it was expected because of the limitations mentioned throughout this thesis, are indicative, without suggesting that they lead to safe and statistically definitive conclusions. However, it is of interest and value to present and discuss these results and how they respond to the research questions posed. Results are presented through tables and bar charts since this is the most suitable form for an accurate representation of categorical and discrete data (Saunders, 2016). The last finding is presented through a multiple bar chart in order to compare results between the two industries (Kosslyn, 2006).

From the first part of this analysis the following findings are reported. As it can be seen in the first two charts below, 49 out of the 50 top-funded start-ups in F&B and all of the 50 top-funded start-ups in Biopharma are innovative, i.e. have at least one type of innovation.

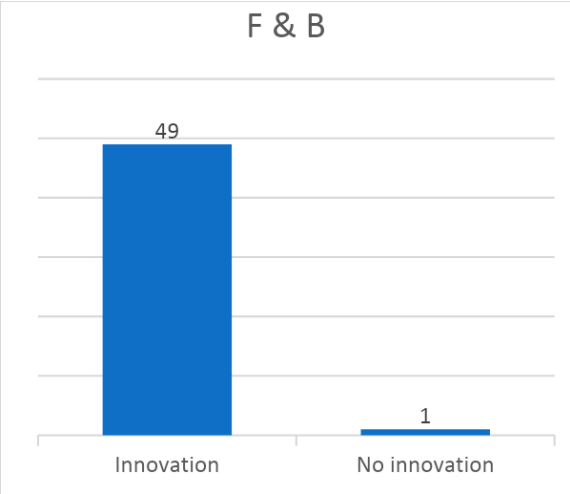

Chart 1: Frequency of innovation in F&B start-ups

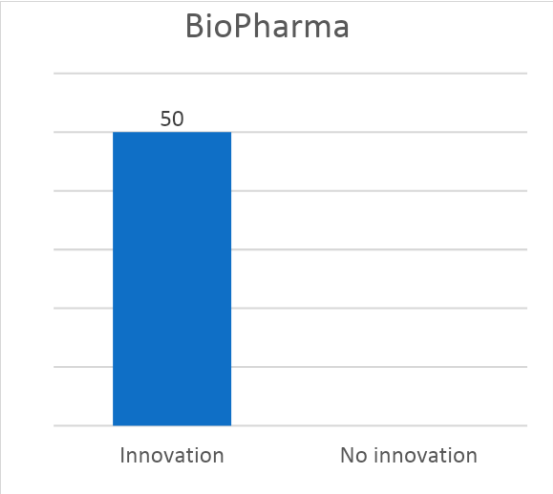

Chart 2: Frequency of innovation in Biopharma start-ups

The fact that only 1 out of the 100 most successful start-ups accumulatively in the two selected categories is not based on innovation for its business shows that although innovation may not be an officially established must-have in order for a start-up to raise investments it practically, significantly influences in a positive way its success. Moreover, this single case of a start-up without innovation proves that "no innovation" is not a reason for investors' rejection by itself and consequently may explain innovation's absence from the investment criteria as mentioned in the theoretical part of this thesis. Therefore, it can be implied that although innovation by itself may not guarantee the success of a start-up, innovation is an essential component of it and confirms Covin and Slevin (1989) among others that innovation has become an important factor used to characterize entrepreneurship and a critical source of competitive advantage in an increasingly changing environment (Dess and Picken, 2000; Tushman and O'Reilly, 1996).

From the second part of this analysis, the numbers of start-ups per innovation type for both industries are reported in table 4.

Table 4: Start-ups per innovation type for both industries

	PRODUCT INNOVATION			BUSINESS MODEL INNOVATION		MARKET DEMAND	
	Zero	Incremental	Radical	Known	Unknown	Existing	Untested
F&B	1	42	7	36	14	39	11
Biopharma	0	6	44	44	6	47	3

It can be seen that there is a diversity on the innovation types for the two business sectors and that inside each sector we see different proportions of the innovation types. However, the only wo figures that stand out are both under product innovation. In F&B most of the companies innovate incrementally and in Biopharma radically. This is something rather expected since Biopharma is a R&D intensive and highly concentrated industry. The existence of a few large well-established incumbents which are also the only ones who can commercialize a new product in the industry, leads to a strong competition of radical innovation between the many young and ambitious start-ups aiming to win this innovation race and finally to be acquired by an incumbent (Henkel, Rønde, & Wagner, 2015). This tendency for a radical product innovation by new entrants in Biopharma is also in compliance with Polidoro Jr. and Toh (2010) and Rivkin (2000). Since Biopharma drugs are inimitable and not easily substitutable, young start-ups' only way to a

competitive advantage promising to secure their survival in such a dynamic environment is to explore another uncharted area in search of a new peak (development of a completely new commercialized drug) which hopefully can be a global peak (if its development will be successful and if it will indeed provide an improved solution compared to the currently existing one) and the incumbent will be "forced" to acquire it in order not only to capture the value itself but also to exclude other competitors from taking advantage of it.

Another noticeable finding comes from the second investigation using both the amounts of funding and the ranks, as described in the previous chapter. More specifically, it comes from the business model dimension in the F&B sector and it seems that companies with unknown business model are positioned to the top of the rank. In other words, that start-ups innovating in the business model dimension in F&B manage to raise higher amounts of investment compared to the start-ups without this type of innovation. A clustered bar chart (Chart 3) emphasizes the higher concentration of red columns to its left side.

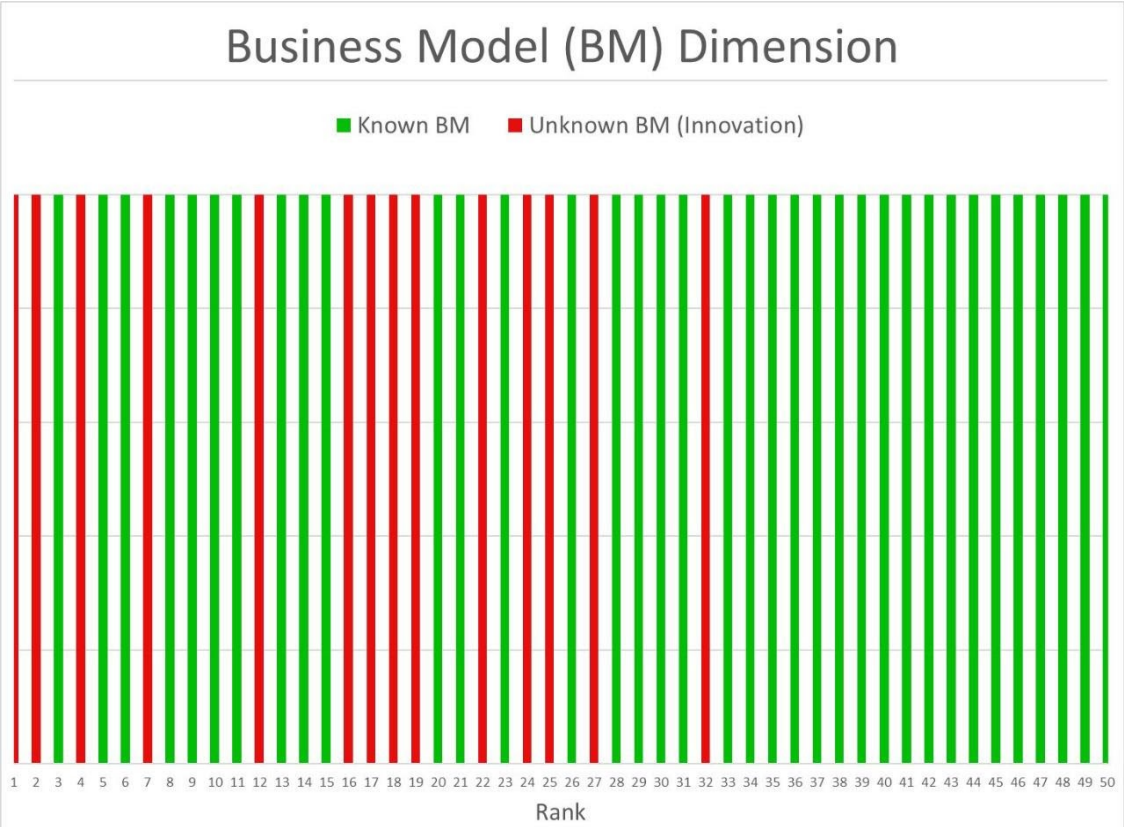

Chart 3: A comparison of the BM innovation type and rank in F&B

It is important here to explain that the raised amounts cannot be a criterion per se without further investigation of these specific companies. In this case it may be that the implementation of such a new business model in this market requires significant amounts of funds and therefore the higher amounts received can be justified by this and it is not a preference that is implied.

In the final part of the analysis the classification of start-ups in the IQ classes A and B takes place and the following results are reported for the two industries.

Table 5: F&B start-ups' distribution in IQ classes

F&B		
IQ Score	IQ Class	# of startups
0-1,5	A	44
2-3	B	6
		50

Table 6: Biopharma start-ups' distribution in IQ classes

Biopharma		
IQ Score	IQ Class	# of startups
0-1,5	A	46
2-3	B	4
		50

The multiple bar chart below presents these findings for both industries in parallel and more comprehensively.

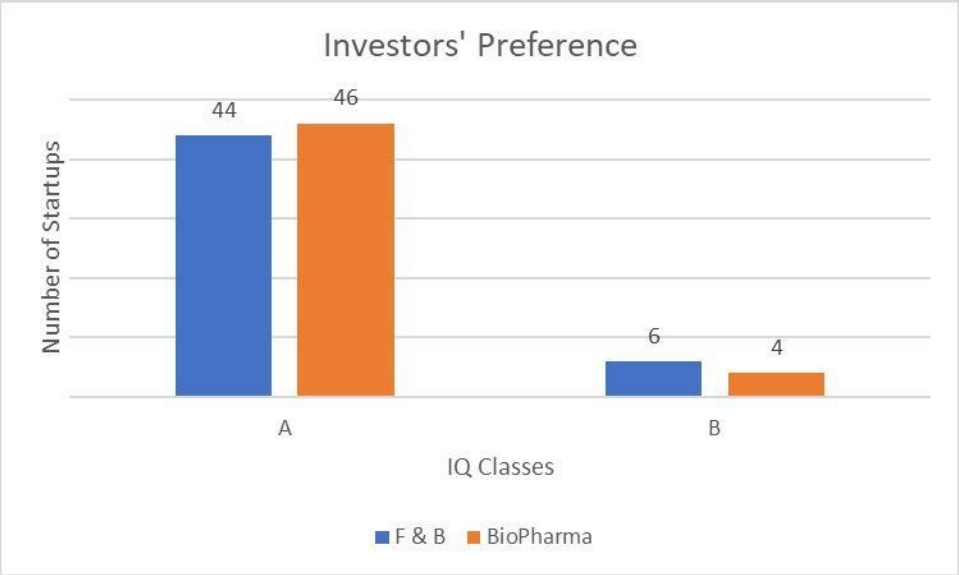

Chart 4: A cross-industrial comparison of investors' preference between IQ classes

It is asserted that the vast majority of start-ups in both industries, 44 and 46 out of the 50 top-funded start-ups in F&B and Biopharma respectively, belongs in IQ class A.

- Although this finding is not statistically significant, it indicates that there may be a pattern/relationship between a specific IQ and start-ups' success deserving further research.
- Another indication, worthy of attention is the significant resemblance of IQ preference between the two quite different in characteristics sectors which may signify a cross-sectoral character of this relationship. One would expect Biopharma to have a relatively stronger presence in IQ Class B than F&B because of the high concentration of the industry which increases start-ups' incentives to innovate. A scenario that could explain this inconsistency of the results with the theory is the following and it derives from the nature of the industry. Since young start-ups thrive to succeed in order to be acquired by an incumbent (Henkel et al., 2015), they ignore almost by default the business model innovation; it is not of concern to them. As a result, this is like Biopharma start-ups' have only two innovation types out of which they can score points and that is why their scores reflect a relatively lower, but in reality not that low, IQ score.

- In addition, the relation between IQ and start-ups' success seems not to be proportional. If it was, then more start-ups would be expected to fall under Class B, the high IQ Class.
- Therefore, it is implied that **there is a sweet spot of IQ which leads to success and that it is not the highest possible.** This sweet spot according to the presence of start-ups in the cube for each sector, seems to be: only incremental (S1) or incremental plus 1 (S3 and S5) or only radical (S2) for F&B and only radical (S2) for Biopharma, all of them within range of Class 1 as it is emphasized in Charts 5 and 6 below and stemming from the second part of the analysis.

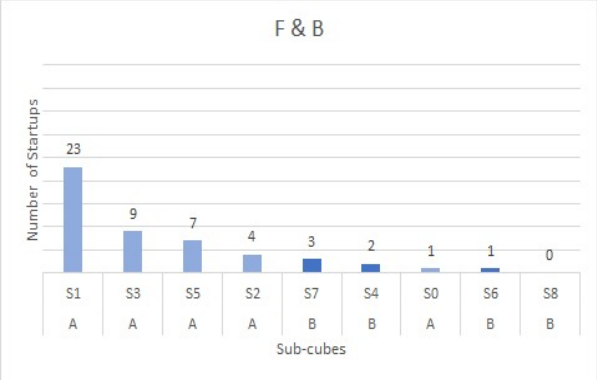

Chart 5: Start-ups distribution in sub-cubes in F&B

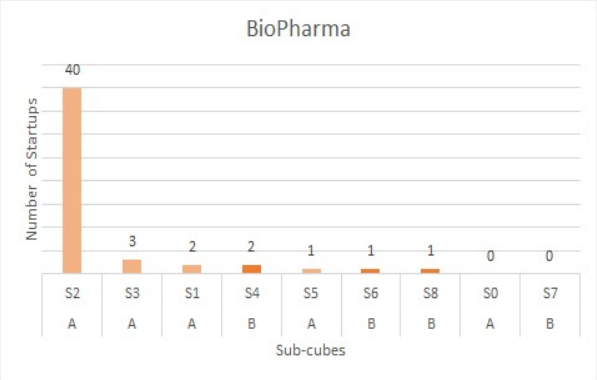

Chart 6: Start-ups distribution in sub-cubes in Biopharma

- One last but not least implication from the poor presence of successful start-ups in Class B seems to appear. The score range in Class B denotes the presence of two to three types of innovation. As a result, it seems that the multiple, simultaneous presence of innovations increases geometrically the uncertainty for the venture, rendering such a start-up significantly riskier, beyond the probably tempting higher returns in case of success, and consequently leads investors to reject it.
- Following on from the two previous bullet points it seems that it is beyond this sweet spot, whichever this is, that the sign of this relationship between IQ and success changes from positive to negative whether it refers to a failure in securing the required funds or to a failure in its literal sense. And if this is valid, it could also explain the ongoing academic debate about the relationship between innovation and start-ups' survival and performance, as mentioned in the theoretical background of this thesis. It seems that both parties, those

favouring innovation and those contesting its potential, are partly right because of innovation's twofold nature which is accompanied by relevant risks and uncertainty.

- And therefore, there is a plethora of different innovation-risk combinations depending on factors like the innovation types of the selected solution/project/start-up, the industry or others. And since every innovation-risk combination has a different portion of these two components, every combination results in a different total value. This total value is the innovation impact and equals the potential benefit/added value from innovation minus the cost and adjusted projections of relevant risk. If this sum is positive, then the innovation is considered positive and vice versa.

4.2. Practical Implications

Apart from the theoretical implications, as discussed above, the findings as well as the use of this method have also practical implications for stakeholders such as entrepreneurs and investors.

Firstly, a piece of advice can be given to all stakeholders in order to make sure that they will reap all the benefits from the use of this method and avoid its pitfalls. That is the precise definition of the sample according to one's exact interests because for example many industries are very wide, including highly differentiated companies although all fall under the same industry and as a result in such a case the conclusions may not be safe.

4.2.1. For the investors:

Some implications originating from the method used throughout the analysis can be found below. This method can be used in various ways according to the user's needs.

Investors who specialize in a specific industry and stage can follow this method. Better yet, they may focus their data collection and analysis on a more targeted sample for more personalized results on companies of interest only.

Others can process and analyze data regarding the innovation type and amounts from previously funded start-ups. In due time and when a sufficient amount of data has been collected, interesting patterns may be spotted. E.g. about the success of a specific innovation type or IQ in a specific industry. Supplementing this dataset with updated information about the start-ups'

progress after funding, data will be leading to safer and more important conclusions which can be of use to their next funding decisions. Not only about which types or IQ should be funded, but also about which categories to avoid.

In the light of the approach presented, investors can reassess their portfolio returns and reconsider portfolio approaches.

4.2.2. For the entrepreneurs:

The same data coming from the method used can also be of use to aspiring entrepreneurs during the concept stage, i.e. before pursuing opportunity.

By having access to such information they will be able to study and understand investors' preferences in the specific sector they are interested in finding a solution for a problem and found a start-up. Consequently, this knowledge can lead them to and/or guide them through the perception of an idea which will be more attractive to investors and customers respectively and increase their chances of survival and future success.

A few more practical implications for the entrepreneurs stem also from the above findings.

The first one can be addressed to entrepreneurs who plan to found a start-up in F&B. Since a preference of investors in investing more capital to start-ups with an innovative business model has been detected it would be advisable for new entrepreneurs to study the current business models in the industry and look for an innovative way to twist these and introduce their idea.

Another implication rather informing about the industry is the knowledge of the most popular innovation types to the investors, especially when there is an obvious preference like in the selected industries, namely a radical product innovation in Biopharma and an incremental product innovation in F&B. The first one may not be new knowledge to affluent entrepreneurs in Biopharma but it can be of help in other industries like in F&B.

5. Limitations and Future research

5.1. Limitations

Setting aside limitations stemming from the afore-mentioned selected definitions of "start-ups" and "success", as well as important limitations of the scoring method which have already been discussed throughout this thesis, another limitation is worth-mentioning. It refers to the size of the samples linked to scope limitations of this thesis which render most of the findings statistically non-verifiable. A more extended sample of start-ups from the same industry, both from successful and unsuccessful start-ups could lead to a second degree of statistically safer comparisons and conclusions.

5.2. Suggestions for Future Research

As shown, measuring innovation at the pre-implementation stage, is an area and a task that remains unexplored and needs to be explored. Apart from the intangible nature of innovation which subjectively makes it a daunting project, another deterrent factor which impedes it, so far, has been the lack of credible information on start-up activity and financing. But with the creation and development of reliable global databases like CrunchBase, this obstacle belongs to the past. Moreover, the democratization of this kind of data along with the introduction of tools such as the artificial intelligence and machine learning increases the potential for more researchers to explore more potential relationships among investors and start-ups.

Furthermore, some suggestions for future research efforts which could lead to additional interesting insights based on the present work are the following. Firstly, an application of the same method to a statistically more significant number of start-ups of these industries could result in a statistically significant comparison of innovation levels and types between start-ups which secured investment and ones that did not. Secondly, it would be interesting for a future study to look at the advancement of the exact same start-ups and check whether: a) they have survived, b) they are still considered successful companies under different criteria that time, like growth or profits or exit. This way, not only one could make conclusions regarding the success of investors' choices, but also safer conclusions regarding the IQ and types which finally survived and prevailed. Thirdly, a comparison between the results presented in this thesis and results from late-stage start-ups in the same industries would be also of interest. Last but no least, more industries could be explored

in order to confirm whether the relationship of the preferred IQ by investors in the two selected industries hinders a pattern applicable in more industries.

6. Conclusion

The aim of this thesis was to contribute vividly to the academic debate about innovation's positive character. An exploration of a possible link between investors' decision to invest in a start-up and the entrepreneurs' decision to innovate was carried out under specific conditions. In accordance with the aforementioned implications, despite their statistical insignificance it is the author's firm belief that innovation is a positive factor for competitive advantage, business performance and economic growth. It is the selection of a wrong innovation for a specific case which leads to failure and can disguise innovation as a negative factor for business growth and survival, not innovation per se. For this reason, the discovery of a way to measure innovation and its relevant risks ex ante, is of crucial importance, so that this sweet spot at which an innovation can be the most productive, in other words where this total sum is maximized, can be calculated.

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8. Appendices

Appendix I.

An overview of definition of terms, as used by the IRC research team.

Types of Innovation		Definitions & Characteristics	Example(s)
Product; Service; Technology	Incremental	Slight Improvements and/or minor differences from existing competitors in the market (i.e. additional 1 or 2 features) with a little or no change in consumer behavior and habits.	Each successive iterations of smart phones.
	Radical	Profound/Breakthrough changes & approach to the product, its overall experience and consumer usage behavior, without altering the value proposition & problem it intends to solve.	3D Printers; LASIK; CRISPR
Business Model	Incremental	Known and/or proven business model but applied to a different solution and/or industry.	Selling solar energy to state-own utilities.
	Radical	Untested & Unproven business model (how customer purchases and/or access the product).	Rolls Royce's 'Power-by-the-Hour'; Power Purchase Agreements as financial products.
Market Demand	Incremental	Proven market demand from same (or more) target group(s) of customers as the competitors.	e-payments platforms; Online games
	Radical	Targeting an untested market demand with no known direct or close proximity competitors with similar value proposition.	Cryptocurrency; Second Life
Process	Incremental	Incremental changes and/or tweaks to existing methodology or process to improve and achieve greater overall efficiency of a process.	Adding Robotics to an automated factory line
	Radical	Implementation of a new or significantly improved methodology or process to improve and achieve greater overall efficiency through a change in user's behaviors and habits.	Toyota Production System (Lean Manufacturing) or Ford's Assembly Line Process

Source: Cha, V., Cai, Y. and Tan, J. (2019). Innovation Risk Cube.

Appendix II.

An overview of sub-cubes' innovations (1 is used as a symbol here, and not as a number)

	PRODUCT INNOVATION			BUSINESS MODEL INNOVATION		MARKET DEMAND	
Sub-cube	No	Incremental	Radical	Known	Unknown	Existing	Untested
S0	1			1		1	
S1		1		1		1	
S2			1	1		1	
S3		1			1	1	
S4			1		1	1	
S5		1		1			1
S6			1	1			1
S7		1			1		1
S8			1		1		1

Appendix III.

The allocation of the Biopharma sample in the IRC

		PRODUCT INNOVATION (D1)			BUSINESS MODEL INNOVATION (D2)		MARKET DEMAND (D3)		
#	Organisation Name	Zero (0)	Incremental (a)	Radical (b)	Known (a)	Unknown (b)	Existing (a)	Untested (b)	Sub-cube
1.	Cytlimic			1	1		1		S2
2.	Juvenescence			1		1	1		S4
3.	Fusion Pharmaceuticals			1	1		1		S2
4.	Repare Therapeutics			1	1		1		S2
5.	Cullinan Oncology		1			1	1		S3
6.	Curon Biopharma			1	1		1		S2
7.	DalCor Pharmaceuticals			1	1		1		S2
8.	Haihe Biopharma			1	1		1		S2
9.	Adicet Bio			1	1		1		S2
10.	Antengene Corporation			1	1		1		S2
11.	EGenesis			1	1		1		S2
12.	Harbour Biomed			1	1		1		S2
13.	Kallyope			1	1		1		S2
14.	BlackThorn Therapeutics			1	1		1		S2
15.	Inozyme			1	1		1		S2
16.	Artios Pharma			1	1		1		S2
17.	Compass Therapeutics			1	1		1		S2
18.	Arrakis Therapeutics			1	1		1		S2
19.	Terns Pharmaceuticals			1	1		1		S2
20.	Insitro			1		1		1	S8
21.	EpimAb Biotherapeutics			1	1		1		S2
22.	Oncologie			1	1		1		S2
23.	Carrick Therapeutics			1	1		1		S2
24.	Turing Pharmaceuticals			1	1		1		S2
25.	Lyndra Therapeutics		1		1		1		S1
26.	Rainier Therapeutics			1	1		1		S2
27.	Faraday Pharmaceuticals			1	1		1		S2
28.	PIQUR Therapeutics			1	1		1		S2
29.	Arcellx			1	1		1		S2
30.	Bolt Biotherapeutics			1	1		1		S2
31.	Pharvaris			1	1		1		S2
32.	ImCheck Therapeutics			1	1		1		S2
33.	Cyteir Therapeutics			1	1		1		S2
34.	Caribou Biosciences			1	1		1		S2
35.	Fog Pharmaceuticals			1	1		1		S2
36.	CMAB BioPharm		1		1			1	S5
37.	ENYO Pharma			1	1		1		S2
38.	Landos Biopharma			1	1			1	S6
39.	XtalPi			1		1	1		S4
40.	Frontier Medicines			1	1		1		S2
41.	Thesan Pharmaceuticals			1	1		1		S2
42.	Genoa Pharmaceuticals			1	1		1		S2
43.	dMed		1		1		1		S1
44.	OncoResponse			1	1		1		S2
45.	Demetrix		1			1	1		S3
46.	Outpost Medicine			1	1		1		S2
47.	Omniome			1	1		1		S2
48.	Rheos Medicines			1	1		1		S2
49.	DTRM Biopharma			1	1		1		S2
50.	Mindstrong		1			1	1		S3
		0	6	44	44	6	47	3	TOTAL

Appendix IV.

The allocation of the F&B sample in the IRC

		PRODUCT INNOVATION (D1)			BUSINESS MODEL INNOVATION (D2)		MARKET DEMAND (D3)		
#	Organisation Name	Zero (0)	Incremental (a)	Radical (b)	Known (a)	Unknown (b)	Existing (a)	Untested (b)	Sub-cube
1.	Bowery Farming		1			1	1		S3
2.	Flow Kana		1			1		1	S7
3.	Bira 91		1		1		1		S1
4.	Infarm		1			1	1		S3
5.	Coffee Box	1			1		1		S0
6.	Xyb2b		1		1		1		S1
7.	Kitopi		1			1	1		S3
8.	Starship Technologies			1	1		1		S2
9.	HeyTea		1		1		1		S1
10.	Letus Legend		1		1		1		S1
11.	Soylent		1		1		1		S1
12.	Cue			1		1	1		S4
13.	Vertical Companies		1		1			1	S5
14.	Bellwether Coffee		1		1			1	S5
15.	DayTwo		1		1			1	S5
16.	Hello Alfred		1			1		1	S7
17.	Kitchen United		1			1	1		S3
18.	The Farmer's Dog		1			1	1		S3
19.	LeafLink		1			1		1	S7
20.	Frichti		1		1		1		S1
21.	Lunchr		1		1		1		S1
22.	Honestbee			1		1	1		S4
23.	Simple Feast		1		1		1		S1
24.	Imperfect Foods		1			1	1		S3
25.	Shixianghui		1			1	1		S3
26.	LELECHA		1		1		1		S1
27.	Xinliangji		1			1	1		S3
28.	Daily Harvest		1		1		1		S1
29.	Spindrift		1		1		1		S1
30.	Citybox		1		1		1		S1
31.	Figure8		1		1			1	S5
32.	Agricool		1			1	1		S3
33.	Hungryroot		1		1		1		S1
34.	MealPal		1		1		1		S1
35.	v2food			1	1			1	S6
36.	Choco		1		1			1	S5
37.	Goldbelly		1		1		1		S1
38.	Wajiu.com		1		1		1		S1
39.	Cheetah		1		1		1		S1
40.	Milkbasket		1		1		1		S1
41.	Freshtohome		1		1		1		S1
42.	Harborside		1		1			1	S5
43.	Ordermark		1		1			1	S5
44.	Kettlebell Kitchen		1		1		1		S1
45.	DouxMatok			1	1		1		S2
46.	Wingreens Farms		1		1		1		S1
47.	The Not Company			1	1		1		S2
48.	Xiachufang		1		1		1		S1
49.	Gobble		1		1		1		S1
50.	June			1	1		1		S2
		1	42	7	36	14	39	11	TOTAL

END OF DOCUMENT