University of South-Eastern Norway
Faculty of Business School
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Industries' influence on companies' innovation activities

A quantitative analysis of how companies' innovation activities are affected by the industry in which they operate.

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This thesis is worth 30 study points

Summary

Due to the increasingly competitive market today's society is experiencing, companies must invest large amounts of resources in innovation activities (Pring- Mill, 2019; Damanpour & Wischenvsky, 2006). However, there are significant differences between companies' innovation activities across different industries. When looking into this issue, two conflicting theories were discovered regarding how companies' innovation activities are affected by the industry in which they operate. These two theories are the recent evolutionary theory and technological regimes theory.

The recent evolutionary theory essentially revolves around the argument that innovation patterns are not linked to industries, but to companies (Hollenstein, 2019). The innovation patterns are shaped by the company's unique resources, dynamic capabilities and routines which results in different learning activities and approaches to innovation, creating firm heterogeneity (Prahalad, 1993). On the other hand, according to technological regimes theory, innovation patterns are viewed as applicable to the industry and not to companies. Therefore, companies within the same industry follow a homogenous innovation pattern due to the industry's technological regime (Leiponen & Drejer, 2007).

Therefore, this master's thesis aimed to answer the research question: *"How are a company's innovation activities affected by the industry in which it operates?".* Together with the research question, two hypotheses were also created: "Companies´ innovation activities are only influenced by the industry's technological regime" and "*Evolutionary theory and technological regime theory are not complementary."* These were examined through analyses of a quantitative survey conducted by 71 firms from four different industries.

It was concluded that the two contradictory theories, technological regime and evolutionary theory, both are valid. The implication this entails is that the degree industries affect firms' innovation activities, will vary across industries. The result of this is that no industry's innovation activities are completely heterogeneous, but neither are they exactly homogeneous. The two theories are therefore complementary, since they both explain different aspects of companies' innovation activities and thus fulfilling each other.

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Foreword

This master's thesis constitutes the last 30 study points of our master’s degree within Industrial Economics by the University of South-Eastern Norway. The thesis was written during the spring semester of 2022 and is a continuation of our preliminary project from 2021 within the same subject.

The research conducted during the thesis has been comprehensive, but also very instructive. Through the work, we have gained a better and deeper understanding within the topic of how firms' innovation activities are affected by the industry in which they operate.

In connection to the work on this thesis, we would like to thank our supervisor Jon Mikel Zabala for his commitment. His contribution has led to a good collaboration consisting of constructive feedback and has been an important factor in our professional development. We would also like to thank every firm that has taken part in the survey and the participants of the pilot-survey.

Hønefoss - 15.05.2022

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1 Introduction

For companies in today's competitive market, the ability to be innovative and adapt to the ever-changing business environment plays an essential role in their survival. As the market's competitiveness increases locally, nationally, and internationally, the battle for resources and market shares intensifies (Pring-Mill, 2019). Let alone; if companies want to surpass their competitors in growth and revenue, innovation is a competitive necessity.

Research conducted by PricewaterhouseCoopers (PwC) shows that leading innovative companies outperforms less innovative companies in terms of growth, with 16% higher over three years. The same companies also predict that their future growth will surpass the average global growth rate by double and the least innovative companies with an even higher rate (PwC, 2013, p. 1).

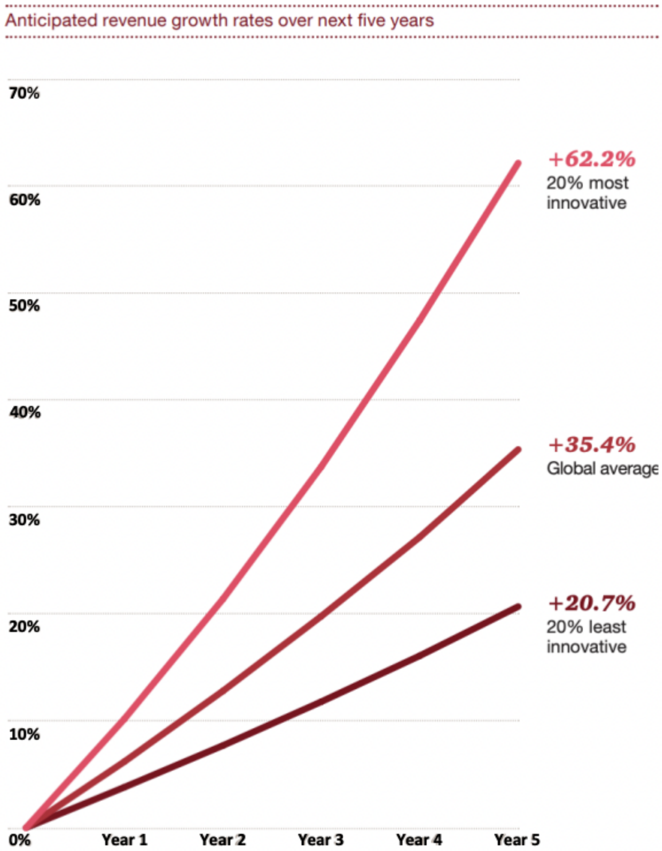

Figure 1: Anticipated revenue growth rates (PwC, 2013)

The recognition of innovations as a prime driver for company's growth and success has led to an increased focus on the benefits of innovation activities. Innovation activities lay the foundation for future innovations and involve all activities that result in, or intend to result in, technologically new or improved products/services (Hashi & Stojčić, 2013). As a result of increased innovation activities, the last decade has experienced rapid technological development as significant resources are being assigned to such activities. Therefore, losing market shares and being outperformed is an increasing risk for companies that do not engage in innovation activities (Damanpour & Wischenvsky, 2006).

1.1 Background for study

Despite an increased focus on innovation and recognition of the importance of innovation activities over the last decades, there are significant differences between industries regarding the priority of innovation activities. A survey performed by Statistics Norway (SSB) "Innovasjon i næringslivet" in 2018 - 2020 (Appendix 1) revealed considerable differences in how companies within different industries related to innovation activities (Statistisk sentralbyrå, 2021). Within industries such as information services and data and electronics, over 90% of all the companies practice innovation activities. Whereas in industries such as catering and building and construction, only about 40% of the companies did the same (Statistisk sentralbyrå, 2021).

The apparent differences presented by SSB on how companies in different industries seem to emphasize innovation activities, can suggest that the possibilities to conduct such activities will vary across industries. In that case, each industry will to a certain degree affect both if and how companies will relate to innovation activities. This assumption highly correlates with the theory of technological regimes introduced by Nelson & Winter (1982). The notion of technological regimes argues for a joint foundation of prerequisites that all companies within the same industry share because of technological incentives and industry limitations (Nelson & Winter, 1982; Winter, 1984; Leiponen & Drejer, 2007). This shared foundation explains the differences between the level of innovation activities across industries.

Even though the theory of technological regimes is acknowledged in the research community, another recognized conflicting theory exists. On the opposite side, evolutionary theory does not view the industry within which a company operates as an affecting variable. Conversely, they see the company's ability to acquire and process knowledge as the affecting variable (Leiponen & Drejer, 2007). From the perspective of evolutionary economics, companies within the same industry will therefore develop specific strategies and activities, separating companies within the same industry apart from each other.

Even though both theories are recognized in the research community, they are conflicting. Whereas the technological regimes theory argues for companies' homogeneity in innovation activities, evolutionary theory argues for heterogenous behavior. Research addressing both theories in relation to companies' innovation activities, is found to be lacking within these two conflicting theories. The existing literature on the subjects primarily focuses on either technological regimes or evolutionary theory, limiting the research to just one side of the bigger picture. It is also problematic that significant parts of the existing literature are primarily based on theories from the early 2000s and older, which is outdated regarding technological development and innovation activities.

1.2 Research question

Based on the growing role of innovation, especially the activities that lead to innovation in companies, we see it as necessary to address the phenomenon around companies' innovation activities. Innovation activities are a phenomenon that should be investigated further because of their importance for innovations and development. Furthermore, investigation is also deemed necessary because of the inadequate literature on the topic, not addressing the conflicting theories. The research question for this study is thus:

"How are a company's innovation activities affected by the industry in which it operates?"

By answering this research question, we strive to understand to what degree, or even if companies' innovation activities are affected by their industry. As there are significant differences between industries regarding the level of innovation activities, it is essential to understand why these differences occur. The relationship between the various characteristics of industries and the firms within them could explain these differences, indicating to what degree firms themself are in control of their strategic positioning in relation to innovation activities. This would provide essential information on how firms could more efficiently tailor their strategic plans regarding innovation activities based on the influencing factors.

1.3 Positioning

For this thesis, a clear positioning was taken regarding which objects should be included in the research. One of the early events that sparked our interest for this topic was a survey conducted in Norway by SSB (Appendix 1) on how the innovation activity level differs across industries. We felt it was natural to take a similar positioning. Therefore, this thesis undertakes a positioning toward Norwegian-based firms. It was also advantageous to emphasize Norwegian-based firms as they would most likely be more open to participating in our research than firms outside of Norway. In addition to the emphasis on Norwegian-based firms, we saw it necessary to position ourselves towards some specific industries. Therefore, the thesis emphasizes the following four industries; forestry and fishing (F/F), building and construction (B&C), accommodation and catering (A&C), and research and development (R&D).

The reasoning behind our position towards the four industries consist of two parts. Firstly, the chosen industries have significant differences in the level of innovation activities. By choosing these industries, the thesis will obtain a broader dataset representing industries with low, average, and high levels of innovation activities. The second reason behind the positioning was the capacity we had to gather and analyse data. As it was limited how much data we could analyse during this thesis, it was necessary to take a position towards a few relevant industries.

1.4 The structure of the thesis

The structure of the thesis begins with a literature review under chapter 2A, which is the basis for the theoretical framework presented in chapter 2B. The main focus in chapter 2B is the theoretical framework on evolutionary theory and technological regime. However, theoretical input about innovations is also presented. Following the theoretical framework is the methodological approach, presented in chapter 3. Here the choices of research design and method, selection process, data collection and quality assurance will be introduced and justified. The analyses of the gathered data is presented in chapter 4, followed by a discussion of the analyses and theoretical framework in chapter 5. The thesis ends with Chapter 6, where the conclusion, limitations, and further research are presented.

2 Literature review and the theoretical framework

A. Literature review

The introduction established that the purpose of this master's thesis is to examine how companies´ innovation activities are affected by the industry in which it operates. To do so, one has to form a theoretical framework on the subject through a literature review of previous studies. The literature review procedure will be presented in this chapter, in addition to how the different research studies will be used.

As a precursor to this master’s thesis, a preliminary project was written, where a simplified literature review were conducted, which helped form a theoretical foundation for this thesis. Since this thesis was more comprehensive than the preliminary project, it was considered necessary to conduct a new and more extensive literature review. Furthermore, it was also a goal to form a broader overview of existing literature within the chosen, and other relevant topics, so that the foundation created through the preliminary project could be expanded. With help from the theoretical foundation created through the literature review, we could answer the research question satisfactorily.

Since a preliminary project had been conducted, it was already known that the topic consisted of several articles on how industries affect innovation activities. Therefore, a good and systematic literature review was essential to ensure that all relevant literature was discovered. The methodology of Kitchenham and Charters' (2007) systematic literature review was chosen as a template for this literature review to ensure high quality.

2.1 Exclusion and inclusion of literature

The creation of exclusion and inclusion criteria is one of the most critical tasks to ensure the quality of the review. To answer the research question satisfactorily, it is essential to ensure that all relevant literature is uncovered while all irrelevant literature is excluded. Inclusion and exclusion criteria make the process faster and easier if the correct criteria are set. Therefore, the fixed criteria must be closely related to the thesis topic.

Exclusion criteria:

1. Articles published before 2000.
    - Since the last decades have been characterized by fast-growing technological development and large amounts of innovations, it was considered relevant to emphasize recent research articles. In the world of technology and innovation, what was relevant in the early 2000s is not necessarily as relevant today. However, as pointed out earlier, there is a lack of relevant literature. It was therefore necessary to include some articles from the early 2000s since they provided relevant theoretical literature. Without them, the theoretical framework would be thin.
2. Articles written in languages other than English.
    - As this thesis is written in English, referring to literature in other languages was considered problematic due to future readers potentially not being able to understand some of the used literature. Although it is known that exclusion based on language should be avoided (Kitchenham & Charters, 2007), any inconveniences this would cause were seen as acceptable.
3. Studies published in other formats than an article.
    - To ensure quality, studies published in other formats than an article, such as PowerPoint, book, or abstract, were excluded.

Inclusion criteria:

1. Articles on companies' innovation activities.
2. Articles on firm heterogeneity.
3. Articles on firm homogeneity.
4. Articles on differences among industries' innovation activities.
5. Articles on innovation.

2.2 Keywords formulation

With exclusion and inclusion criteria set, the search for literature could begin. However, a search strategy should be implemented to prevent spontaneity and ensure a systematic search (Kitchenham & Charters, 2007). The exclusion and inclusion criteria are a part of the search strategy, but keywords must also be formulated as it is essential to secure a systematic search. Keyword formulation is crucial as the keywords are the "guides" used to find relevant literature in databases. The keywords used should ideally reflect the entire scope of the chosen topic and the research question (Kitchenham and Charters, 2007; Wolfswinkel, Furtmueller & Wilderom, 2013). It must be mentioned that although a search strategy must be followed, it can also change throughout the review if it becomes necessary.

KEYWORDS					
ENGLISH	*Innovation*	*Industry*	*Firm heterogeneity*	*Firm homogeneity*	*Technological regime*
	Innovation activity	*Organization*	*Heterogeneity*	*Homogeneity*	

Table 1: Keywords

2.3 Forwarding and backward citation

The most important part of the literature review is to ensure that all relevant literature is included. Therefore, any good search strategy should emphasize forwarding and backward citation (Wolfswinkel et al., 2013). During forwarding and backward citation, several relevant articles were discovered, reinforcing the theoretical foundation. However, some of these uncovered articles were published earlier than the 2000s. Despite exclusion criteria 1, a choice was made to include those articles since many of the other articles from the literature review referred to them. An exclusion of those articles would lead to relevant literature being lost, damaging the theoretical framework. Although articles were included through forwarding and backward citation, the main elements in the theoretical framework originate from the articles discovered in the literature search. The articles uncovered by forwarding and backward citation were used to supplement the articles from the literature search. Forwarding and backward citations were continuously performed throughout this literature review.

2.4 Search result

Great emphasis was placed on which databases were to be used in the literature review to uncover all relevant articles. The most crucial element was that the chosen database had to cover significant parts of all available articles on the topic. Web of Science became the database of choice as it covers large parts of all available articles, provides opportunities to specify the search, and is a recognized search engine.

Search history					
Date of search	Database	Keywords with combination words	Delimitations	Number of hits	Relevance
02.02.2022	Web of Science	(((((TS=(Innovation)) AND TS=(Industry)) AND TI=(Firm heterogeneity)) AND PY=(2000-2022)) AND DT=(Article)) AND LA=(English)	Year: 2000-2022, Language: English, Document type: Article	29	3
02.02.2022	Web of Science	((((ALL=(Firm homogeneity)) AND ALL=(Innovation)) AND PY=(2000-2022)) AND DT=(Article)) AND LA=(English)	Year: 2000-2022, Language: English, Document type: Article	54	6
02.02.2022	Web of Science	(((((TS=(Innovation)) AND TS=(Industry)) AND TI=(Technological regimes)) AND PY=(2000-2022)) AND DT=(Article)) AND LA=(English)	Year: 2000-2022, Language: English, Document type: Article	28	9
02.02.2022	Web of Science	(((((TI=(Innovation)) AND TS=(Innovation)) AND TS=(homogeneity)) AND PY=(2000-2022)) AND DT=(Article)) AND LA=(English)	Year: 2000-2022, Language: English, Document type: Article	44	0
02.02.2022	Web of Science	(((((((TS=(Innovation)) AND TS=(Innovation activity)) AND TS=(Firm heterogeneity)) AND TS=(Industry)) AND TI=(Innovation)) AND PY=(2000-2022)) AND DT=(Article)) AND LA=(English)	Year: 2000-2022, Language: English, Document type: Article	42	2
02.02.2022	Web of Science	((((((TS=(Innovation)) AND TS=(Innovation activity)) AND TS=(Technological regime)) AND TI=(Innovation)) AND PY=(2000-2022)) AND DT=(Article)) AND LA=(English)	Year: 2000-2022, Language: English, Document type: Article	47	1
02.02.2022	Web of Science	(((((TS=(Innovation)) AND TS=(Organization)) AND TI=(Innovation)) AND DT=(Review)) AND LA=(English)) AND PY=(2018-2022)	Year: 2018-2022, Language: English, Document type: Article (Review)	147	6

Table 2: Search history

After seven searches with different keyword-combinations on Web of Science, 391 studies were uncovered. These articles met the criteria set, as the search engine allowed to specify the search to English articles published after 2000. All three exclusion criteria were therefore implemented. The sample of 391 articles was a coarse collection of some relevant and less relevant articles, thus the inclusion criteria were used to filter out the less relevant articles. The filtering process was conducted by reading the title of all the articles and thereby deciding if they were relevant or not by comparing them to the inclusion criteria

(Wolfswinkel et al., 2013). More extensive parts of the articles were reviewed if a decision could not be made by reading the title alone. The selection process resulted in 27 articles that were seen as relevant out of the original 391. Of the 364 excluded articles, 314 were excluded by reading the title, 31 by reading the abstract, and 19 by reading the full text. In addition, 75 articles were included by forwarding and backward citation, bringing the number of relevant articles to 102.

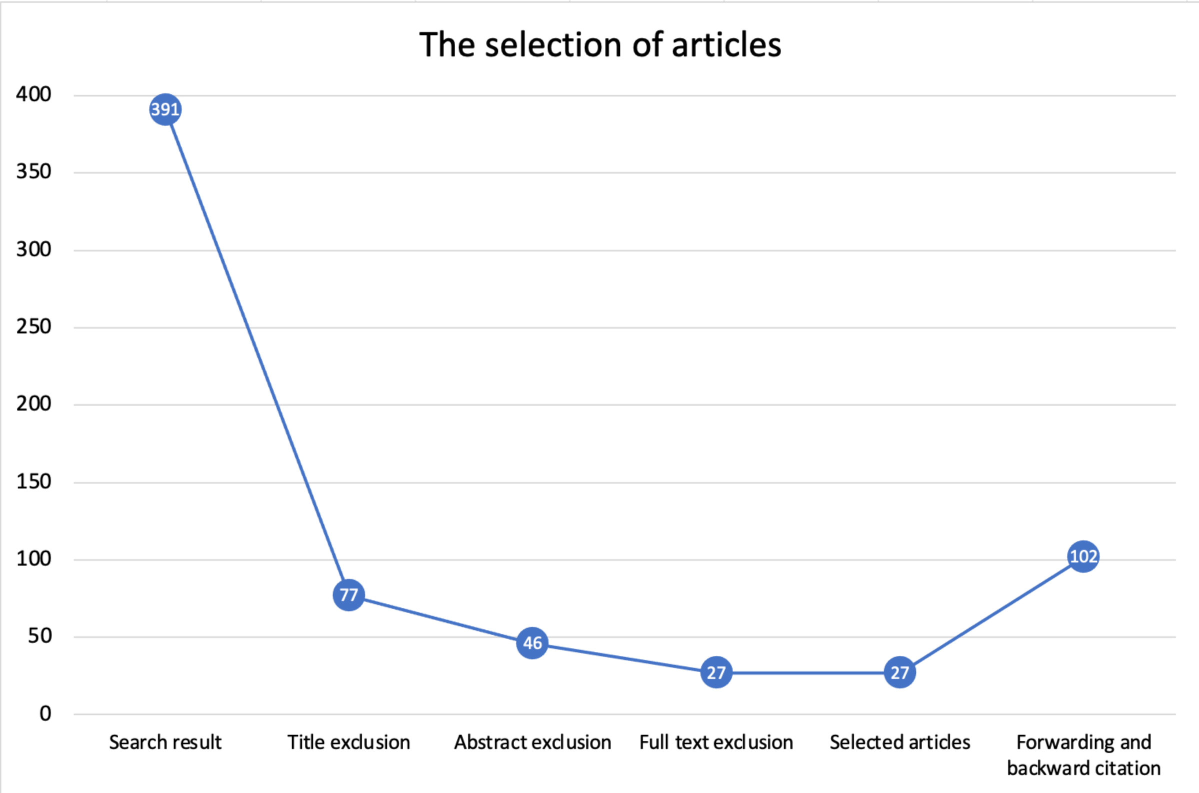

Figure 2: Selection of articles

Figure 2 illustrates the original number of articles from the literature search, and the remaining amount after each exclusion method. The total number of articles included through forwarding and backward citation is also illustrated.

2.4.1 Literature matrix

The literature matrix presented in Appendix (2 – 8) illustrates all the articles discovered through the literature search. Those are the articles that constitutes the theoretical framework together with the articles uncovered from forwarding and backward citation. The tables present the authors, key words used in the articles and a brief overview over the main content and findings.

2.4.2 Potential weaknesses in the literature review

In the process of conducting a literature review, it is important to be aware of publication bias. Publication bias is a potential weakness referring to the probability that positive research results being published are higher than for negative results. If one does not address this potential problem it can lead to systematic bias and hurt the research result (Kitchenham & Charters, 2007).

As a result of the topics this thesis examines, publication bias could be a potential problem. Since two conflicting theories are examined, the possibility of publication bias having occurred, cannot be ignored. As a countermeasure, search strategies have been implemented, such as forwarding and backward citations.

It was known when creating the exclusion criteria that excluding literature on the basis of language could have a potential damaging effect. However, because of language barriers, this was deemed as necessary.

B. Theoretical Framework

In this chapter, relevant theory on the subject of innovation activities and how industries affect them will be reviewed, creating the theoretical framework for this thesis. The presented framework is built upon literature obtained from the literature review in the previous chapter. Creating a theoretical framework is essential to establish an overview of research within the subject area and clearly define important terms. Thus, a comprehensive survey can be completed later with a good overview of the subject, resulting in more valid results and a sounder discussion and conclusion.

Firstly, fundamental theory about innovation and innovation activities will be presented to ensure an understanding of the terms and the expected results from innovation activities. Then the framework will move toward more specific theories regarding how firms´ innovation activities are influenced and formed by the industries in which they operate. Two different perspectives, "evolutionary theory" and "technological regime," will be introduced, creating an overview of their conflicting perceptions on how industries affect companies' innovation activities.

Firms' prerequisites for conducting innovation activities are a highly debated topic with two conflicting perspectives. On the one hand, the evolutionary theory argues for firms' heterogeneity regarding innovation activities (Hollenstein, 2019). On the other hand, the theory about technological regimes argues for firms' homogeneity regarding innovation activities that follow from the industrial operating environment (Leiponen & Drejer, 2007).

2.5 Innovation and innovation activities

The main focus of this thesis is, as mentioned, the two conflicting theories, however it was necessary to present fundamental theories about innovation and innovation activities. This was done to achieve a better understanding of evolutionary theory and technological regime theory. Thus, fundamental theories about innovation will be accounted for first, then theory specific to innovation activities will be presented.

2.5.1 Innovation

2.5.1.1 Definition of the term innovation

According to prior research, innovativeness and the ability to innovate are considered to be more critical and essential contributors to organizational performance than other more traditional business orientation approaches (Hamel, 2007; Baregheh, Rowley & Sambrook, 2009; Ryan & Tipu, 2013; Norris & Ciesielska, 2018; Morente, Ferràs & Žižlavský, 2018). It has been argued that a positive way to enhance organizational performance is to integrate innovation into organizational behavior (Merx-Chermin & Nijhof, 2005; Norris & Ciesielska, 2018).

Despite the term innovation becoming more and more widespread, there is no definitive definition of the term (Baregheh et al., 2009; Morente et al., 2018). However, two definitions of innovation are recurrent in literature. One of the two definitions comes from Schumpeter (1934) - cited in Morente et al. (2018) - who defines innovation as *"the commercial or industrial application of something new - a new product, process or method of production, a new market or source of supply, a new form of commercial, business or financial organization."* Schumpeter (1934) argues that innovation is a creatively destructive force that destroys current market conditions while simultaneously creating new ones through new combinations (Iwai, 1984; Gaglio, 2011; Morente et al., 2018). The definition provided by Schumpeter (1934) covers five dimensions:

- *The introduction of a new good, or a new quality of a good*
- *The opening of a new market segment*
- *The introduction of a new production method*
- *The conquest of a new source of supply of half-manufactured goods or raw materials*
- *The implementation of a new organization in any industry*

The Organization for Economic Co-Operation and Development (OECD) manual provides the other recurring definition. In the manual, the term innovation is defined as "*the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organisational method in business practices, workplace organisation or external relations"* (OECD, 2005, p. 46; Morente et al., 2018; Resende Junior

& Fujihara, 2018). The concept of innovation involves the following steps: The search, the discovery, the experimentation, the development, the imitation, and the adoption of new goods, services, processes, and new organizational methods. Innovation, which is observed in the products or processes' finalized characteristics, is a result of the skills of suppliers, the mobilization of technical capacity, and the clients during services (Resende Junior & Fujihara, 2018).

It has been argued that it is more relevant to take notice of whether or not the company has a culture-oriented for innovation, rather than seeing innovation as a new or improved product or process. When companies are focused on innovation, the organizational environment tends to be more open to new ideas and changes through new resources, abilities, technologies, and administrative systems (Zhou, Yim & Tse, 2005; Resende Junior & Fujihara, 2018).

2.5.1.2 Innovation climate

As mentioned in Chapter 1, companies must innovate to maintain or gain a competitive advantage by differentiating products and services from competitors. The need to be innovative is due to the ever-increasingly competitive global business environment (Newman, Round, Wang & Mount, 2020). In order to foster innovation, companies can develop internal work climates that support and incentivize innovation (Mumford, 2000; Newman et al., 2020). Climates as such are referred to as "*innovation climates*" by prior studies (Anderson & West, 1998; Mathisen, Torsheim, & Einarsen, 2006; Newman et al., 2020).

Anderson & West (1996, 1998), Sarros, Cooper & Santora (2008), Khalili (2016), and Newman et al. (2020) define innovation climate as the shared perceptions at the corporate (or team) level in regards to the extent to which corporate (or team) processes enable and encourage innovation. It is easy to confuse the construct of innovation climate with innovation culture due to some of their overlapping concepts (Khazanchi, Lewis & Boyer, 2007; Newman et al., 2020). Even though both innovation climate and culture explain similar organizational phenomena, such as innovation in the workplace, some factors separate the two constructs (Newman et al., 2020).

Firstly, innovation culture is defined as the orientation a company has towards experimenting with new approaches or alternatives by breaking through existing norms, exploring new resources, and creating new products or services to enhance its performance (Ireland, Kuratko, & Morris, 2006; Newman et al., 2020). It is argued in prior studies that one generally distinguishes climates from cultures because climates provide the behavioral evidence for a company's culture (Schneider, Salvaggio, & Subirats, 2002; Schein, 2010; Newman et al., 2020). It is also argued that climates are more visible and observable in the organization's practices and policies than cultures are (Ahmed, 1998; Newman et al., 2020).

The notion of innovation climate goes beyond focusing on intellectual activity and individual thought processes to generate new ideas, insights, and solutions to problems. It focuses on the exploitation, adoption, and implementation success of said ideas, insights, and solutions (Amabile, Conti, Coon, Lazenby & Herron, 1996; Newman et al., 2020). According to research, innovation rates differ significantly between societal contexts. Therefore, it is surprising that there is a lack of research examining the influence cultural and institutional contexts have on innovation climate (Shane, 1995; Jones & Davis, 2000; Taylor & Wilson, 2012; Newman et al., 2020). Newman et al. (2020) encourages researchers to fill this hole by examining how institutional development (e.g., levels of corruption, ease of starting a business, and intellectual property protection levels) and societal culture (e.g., power distance and collectivism) influence the commonness of innovation climates in companies.

By looking at Hofstede's (2001) - cited in Newman et al. (2020) - framework of cultural dimensions, one may expect innovation-oriented organizational climates to be less common in high power distance cultures. This is because cultures as such are dependent on the need to maintain control through organizational hierarchies and rules. Thus, it is less likely that climates contributing to innovation activity are created. Similarly, other empirical research has found that cultures high in individualism and low in uncertainty avoidance have higher innovation rates (Shane, 1995; Jones & Davis, 2000; Taylor & Wilson, 2012; Newman et al., 2020).

Newman et al. (2020) encourage examining the influence companies’ respective industrial sectors have on the innovation climate within organizations. According to them, innovation climates might be more common in “creative industries” such as architecture and advertising. In those industries, success depends on developing and implementing creative ideas. On the other hand, a lower prevalence of innovation climates could be expected in industries (e.g., call center) in which employees are required to perform repetitive structured tasks and are given little discretion (Taylor & Bain, 1999; Fleming & Sturdy, 2010; Newman et al., 2020).

2.5.2 Innovation Activities

Innovation activities include all technological, financial, organizational, scientific, and commercial activities that result in or intend to result in technologically new or improved products or services being implemented (Hashi & Stojčić, 2013). According to research, there are three conceptually distinct reasons to expect that innovation activities are persistent; the “success-breeds-success” assumption, the accumulation of knowledge, and the properties of the knowledge base (Flaig & Stadler, 1994; Geroski, Reenen & Walters, 1997; Breschi, Malerba & Orsenigo, 2000; Triguero & Córcoles, 2013).

The “*success-breeds-success*” assumption refers to innovative success having a positive effect on further innovations in the following years. A company's innovation probabilities are dependent on demand and cost expectations, unobserved heterogeneity, and market structure. However, the positive influence of prior innovations shows a strong state dependence in the innovation process. A company's choice probabilities concerning innovation are thus directly influenced by prior innovations, confirming the choice´s structural state dependence (Flaig & Stadler, 1994; Geroski et al., 1997; Triguero & Córcoles, 2013).

How companies accumulate technological capabilities to enhance their innovation outcomes, also known as knowledge accumulation, is the second reason why it is expected that innovation activities are persistent. Knowledge accumulation ensures that the company's knowledge and innovation activities today support tomorrow's innovations (Breschi et al., 2000; Triguero & Córcoles, 2013). Companies are dependent on their respective technological trajectories when developing organizational competencies and innovating (Malerba & Orsenigo, 1999; Triguero & Córcoles, 2013). The assumption that "failure breeds success" in innovation activities could thus be explained by the accumulation of technological capabilities (Triguero & Córcoles, 2013).

Lastly, for companies to strive to be continuous in their innovation activities, the properties of the knowledge base are critical. It is a common understanding that research and development (R&D) involves, at least partially, sunk costs (Cohen & Klepper, 1996; Triguero & Córcoles, 2013). Within R&D, there are costs related to organizational changes, collecting information on new technology, engaging in training or contracting a qualified workforce, and learning costs concerning technological adoption. If the company did not innovate, these costs would be sunken. Companies should continuously invest in R&D to enhance the probability of their investments being recovered. This is a result of the innovation process being characterized by complexity and uncertainty, and the accumulation of knowledge not being continual. Although R&D investments does not warrant innovation, one can expect that persistent R&D companies have a higher probability of innovation than non-persistent R&D companies (Triguero & Córcoles, 2013). Similarly, it is recommended that companies constantly innovate because perseverance in profits or productivity is explained by perseverance in innovation (Cefis & Ciccarelli, 2005; Triguero & Córcoles, 2013).

2.5.2.1 The Five Drivers of Persistence in Innovation Activities

As mentioned, perseverance is an influential driver of the innovation process and activities. Additionally, five other drivers also influence the innovation process and activities: Technological opportunity, incentives to exploit opportunities, appropriability conditions, organisational capabilities and firm's capabilities (Dosi, 1997; Triguero & Córcoles, 2013).

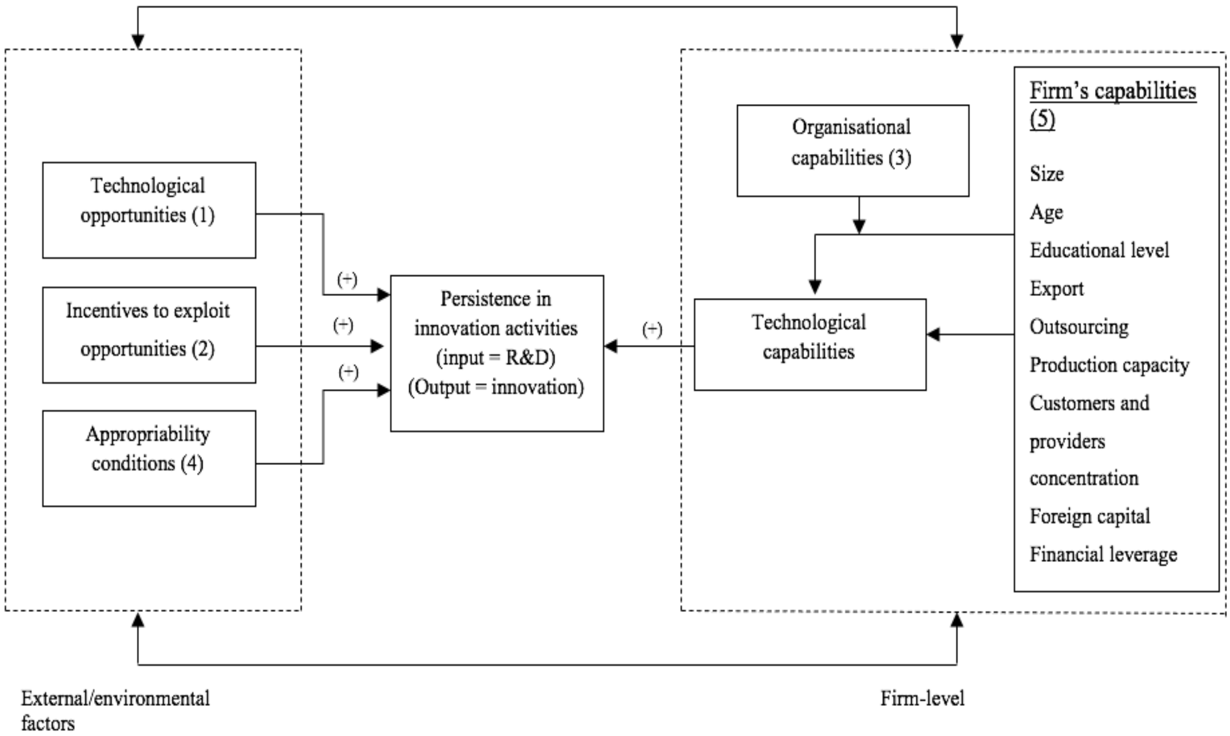

Figure 3: Five drivers (Le Bas & Latham, 2004)

The first driver, *technological opportunities,* accounts for the relative cost and ease of implementing R&D and innovation across industrial sectors. High technological opportunities are expected to present more irregular and turbulent innovation patterns regarding low stability in firms' hierarchies and technological entry and exit. Therefore, high technological opportunities conditions reduce the persistence of innovation activities at the firm level due to the continuous entry of new innovators. Similarly, low technological opportunities conditions increase the persistence of innovation activities at the firm level since established innovators might be more stable (Triguero & Córcoles, 2013). Technological opportunities are discussed more thoroughly in chapter 2.8.1.

Innovation and technological opportunities are related; therefore, the persistence level in innovation activities is also explained by the degree of absorptive capacity (Cohen & Levinthal, 1990; Klevorick, Levin, Nelson & Winter, 1995; Becker & Peters, 2002; Triguero & Córcoles, 2013). According to Cohen & Levinthal (1990) - cited in Triguero & Córcoles (2013) - the development of absorptive capacity and innovative performance are path- or history-dependent. They further argue that the lack of investment early on in an area of expertise may preclude future technical capabilities. Absorptive capacity explains the decisions made by companies regarding the allocation of resources to innovation activities, and companies are susceptible to characteristics of the technological regimes and learning environments in which they operate. Companies conduct R&D in order to generate new knowledge and enhance their absorptive capacity, furthermore creating a capacity to accommodate and exploit new knowledge. Therefore, persistence in the decisions regarding R&D leads to high persistence in innovation activities through the company's level of absorptive capacity (Triguero & Córcoles, 2013).

The second driver, the *incentives to exploit technological opportunities,* revolves around the ease of entry for new companies and the strength of the competition (Triguero & Córcoles, 2013). When explaining the innovation process, the incentives themselves are most likely not as important as the competitive pressure. However, the demand-pull hypothesis claims that a significant driver of innovation activities is the demand conditions (Schmookler, 1966; Dosi, 1997; Le Bas & Latham, 2004; Triguero & Córcoles, 2013). Thus, in this context, positive demand conditions that lead to increased incentives to exploit technological opportunities will increase the persistence of innovation activities (Triguero & Córcoles, 2013).

Innovation activities also depend on the *organisational capabilities*, which is the third driver shown in figure 3. This driver refers to a firm's capacity to implement and coordinate different resources through specific organizational processes. Persistence in innovation activities originates from firm-level organisational features (Malerba, Orsenigo & Peretto, 1997; Triguero & Córcoles, 2013). These are organisational mechanisms and arrangements through which searches and implementation of technological advances are executed. Said mechanisms and arrangements are crucial in the persistence of innovation activities (Triguero & Córcoles, 2013).

Appropriability conditions, the fourth driver, are essential for maintaining and generating revenues from innovation activities. Without the ability to protect their innovation activities, firms, especially leading firms, would not generate a sustainable revenue from their activities (Levin, Klevorick, Nelson & Winter, 1987; Triguero & Córcoles, 2013). On the one hand, high knowledge accumulation indicates high levels of appropriability of the innovations at the firm level (Malerba, 2002; Triguero & Córcoles, 2013). On the other hand, there is a link between the ability to shield innovations from imitation and the extent to which current innovation efforts are built upon prior innovation activities (persistence and appropriability). Therefore, the probability of observing a “deeper” pattern of innovation activities increases when there are protection mechanisms in place (Mark II), which is discussed more thoroughly in chapters 2.8.2 and 2.8.5. A stable and concentrated population of innovators would result from the high firm-level accumulation and appropriability conditions (Klevorick et al., 1995; Breschi et al., 2000; Triguero & Córcoles, 2013).

The last and fifth driver, *the firm's capabilities*, refers to the information-based, intangible or tangible processes specific to the firm. Capabilities are developed over time through complex interactions between the firms’ resources (Amit & Schoemaker, 1993; Triguero & Córcoles, 2013). In this sense, one can view firms as a collection of unique tangible and intangible capabilities and (or) resources (technological, organizational, human, physical, and financial resources). It is believed by Triguero & Córcoles (2013) that all internal characteristics of a firm affect the persistence in innovation activities. This is due to the difficulties of separating technological and non-technological capabilities as sources of persistence in innovation activities (Malerba et al., 1997).

2.5.3 The Pavitt Taxonomy

Pavitt (1984) - cited in Bogliacino & Pianta (2016) - identified four classes in what is known as the Pavitt Taxonomy; Science-Based industries, Specialized Suppliers industries, Scale Intensive industries, and Supplier Dominated industries.

Science-Based industries (e.g., electronic and pharmaceutical industries) involve sectors where innovations are derived from advances in R&D and science. In such industries, research laboratories are essential, which leads to concentrated product innovation and a high tendency to patent (Pavitt, 1984; Bogliacino & Pianta, 2016).

Specialized Suppliers industries involve sectors that produce equipment and machinery, and the products they provide are new processes for other industries. Although R&D is still present, tacit knowledge and design skills incorporated in the labour force are essential innovative input. Innovation is here executed in cooperation with customers (Pavitt, 1984; Bogliacino & Pianta, 2016).

Scale Intensive industries (e.g., primary metals and automotive) involve sectors in which scale economics are relevant. A certain amount of inflexibility characterizes the production processes; thus, technological change is generally incremental. Significant process innovation coincides with the development of new products (Pavitt, 1984; Bogliacino & Pianta, 2016). Incremental innovation follows more predictable and linear processes, making additions or improvements to a company while maintaining its core service model or product (Bagno, Salerno & Silva, 2017; Rubin & Abramson, 2018; Gomes, Facin & Hourneaux, 2019). Conversely, radical or disruptive innovation consists of the development and introduction of breakthroughs that fundamentally change a firm's business model and the market surrounding it. In addition, it is also characterized by the presence of uncertainty (Leifer, McDermott, O'Connor, Peters, Rice & Veryzer, 2000; Christensen, 2016; Rubin & Abramson, 2018; Gomes et al., 2019).

Supplier Dominated industries (e.g., textile and food) involve traditional sectors in which technological change is implemented through the machinery and inputs provided by suppliers operating in other industries. Firms included in such sectors do not emphasize R&D and innovation activities (Pavitt, 1984; Bogliacino & Pianta, 2016).

2.6 Evolutionary Theory

The relationship between industrial dynamics and innovation has been analysed in recent years, resulting in a wide selection of empirical and theoretical contributions. Within this selection, one finds empirical consistencies and stylized facts regarding the high within-industry heterogeneity in innovation (Malerba, 2007; Triguero & Córcoles, 2013). According to Dosi (1997) - cited in Triguero & Córcoles (2013) - heterogeneity in innovation across firms implies that specific capabilities are present in each firm, indicating that firms can perform the same activities in different ways.

An essential building block in the recent evolutionary theory introduced by Nelson & Winter (1982) is firm heterogeneity, which is the concept of companies following different learning activities and having different approaches to innovation. The evolutionary theory suggests that the "learning by doing effect" improves knowledge stocks, thus enhancing the probability of future innovations. The reason why firms have different degrees of persistence in innovation activities is explained by firms' heterogeneity in the knowledge accumulation process (Peters, 2009; Triguero & Córcoles, 2013). Jensen, Johnson, Lorenz & Lundvall (2007) emphasized firms' heterogeneity concerning innovation and innovation activities, presenting two different perspectives related to innovation and innovation activities: Science, Technology, and Innovation (STI) and Doing, Using, and Interacting (DUI). The former perspective, STI, is based on a company's production of explicit and codified knowledge using formal research and development processes. The latter perspective, DUI, emphasizes a company's competence development from internal and external informal interactions.

Evolutionary theorists have not always considered firm heterogeneity as crucial as they do today. Previous research tried to demonstrate that companies within the same industry shared one of the two following types of knowledge bases: Analytical (science-based industries) or synthetic (engineering-based industries) (Asheim & Coenen, 2005; Clausen, 2013). Furthermore, it tried to demonstrate that companies within the same industry shared similar characteristics and thus tended to follow identical innovation strategies. In this way, one can see that evolutionary theory moved from trying to prove firm homogeneity to proving firm heterogeneity (Clausen, 2013).

The evolutionary theory identifies three tasks; 1) identifying the economic mechanisms that cause variation in behavior, 2) identifying selection mechanisms and their respective properties, which eliminate behaviours that generate results scoring below a definite level of performance, and 3) identifying mechanisms, such as endogenous innovation and increase of returns, providing feedback from the process of the selection to the generation of variations. Firm performance is an essential element in evolutionary theory; therefore, it must be defined what one means by performance (Le Bas & Latham, 2004).

Metcalfe & Gibbons (1986) - cited in Le Bas & Latham (2004), have defined three dimensions of firm competitive performance:

- *Efficiency* - A firm's ability to transform innovation (technological success) into profit (economic success). Efficiency is measured by the firms' technological performance, which is an indicator of profits (economic performance).
- *Fitness* - The willingness and ability of a firm to transform profits into growth and new capital. It includes both the capacity to invest in intangible capital, primarily intellectual capital, to increase the firm's productivity and the capacity to invest in physical capital to enhance its productive capacity. Fitness is measured by the ratio of the firm's profit growth rate per unit of output to its growth rate of productive capacity. In other words, the dimension of fitness describes the firms' capacity to invest. Investments done by the firm in regards to R&D activities are included in this dimension.
- *Creativity* - A firm's ability to improve products and processes or innovate. Creativity refers to the firm's ability to conduct research successfully and transform the capital of knowledge into new technological and industrial competence. The technological performance and, to a certain degree, firm's creativity is substantiated by its core competencies, knowledge, and dynamic routines (especially in R&D activities). A firm's creativity works as a function of its capacity to manage intellectual capital.

The three dimensions of firm competitive performance are consistent with three capacities: The capacity to generate a particular level of profitability, to invest in knowledge activities and new capital goods, and to develop new industrial and technological knowledge. Within each of the three dimensions of performance, firms inescapably differ from each other (Le Bas & Latham, 2004). Le Bas & Latham (2004) proposed an evolutionary model of organisational innovative persistence, figure 4, which explicitly articulates the persistence in innovation activity and profitability above a specific level (generally close to the average level for the industry). Persistence in profitability above a specific level is a condition of persistence in innovation activity; hence firm persistence in innovation is linked with its profitability and growth.

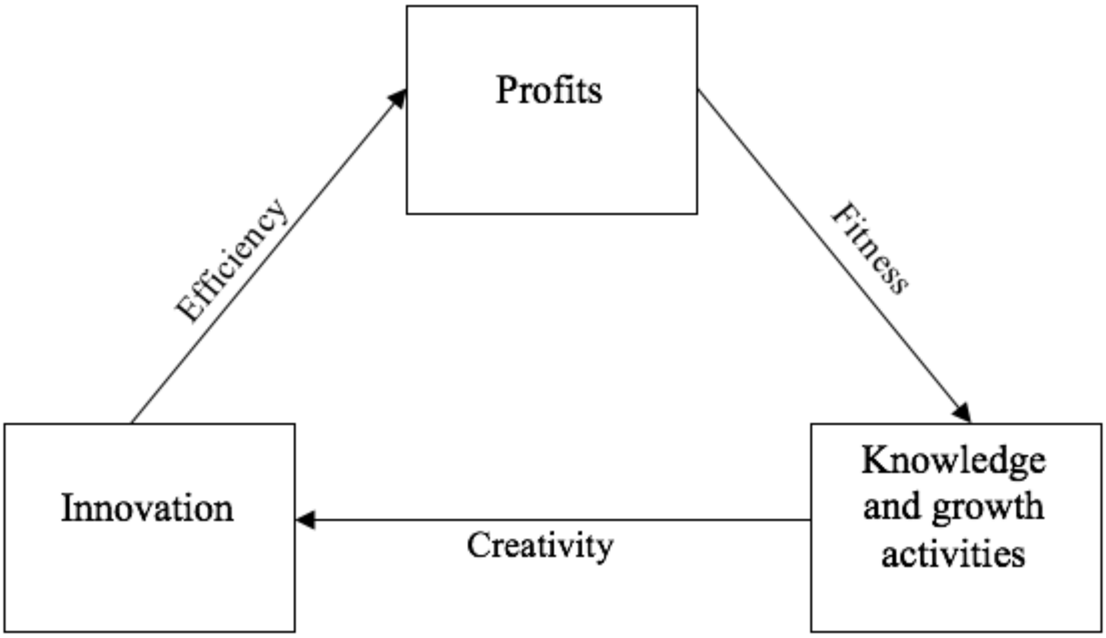

Figure 4: Innovation, profits and knowledge and growth activities (Le Bas & Latham, 2004)

The recent evolutionary theory emphasized the specific innovation strategy of each company (Hollenstein, 2019). It is argued that each company uses unique organizational, human, technological, and other various resources as well as dynamic capabilities to achieve competitive advantage (Prahalad, 1993; Teece, Pisano & Shuen, 1997). Therefore, innovation patterns are argued to be explicitly linked to companies and not to industries. This indicates an intra-industry heterogeneity of innovation strategies (Hollenstein, 2019). Inspired by Schumpeter´s work, evolutionary theorists have increasingly emphasized that the primary source of innovation progress is the qualitative differences between companies engaged in innovation activities (Nelson, 1991, 1995; Clausen, 2013). One of the main drivers of economic change within the evolutionary theoretical framework is the ability to develop and introduce innovations, or as Schumpeter called it - “new combinations” (Schumpeter, 1934: Clausen 2013).

Malerba & Pisano (2019) - cited in Trushin & Ugur (2020) - collected and summarized empirical research from recent times, showing the persistent heterogeneity across companies by age, size, productivity, and the ability to innovate. According to Malerba &

Pisano (2019), one of the main reasons such heterogeneity arises is that processes, products, and technologies often tend to follow trajectories with repetitive use of fixed sets of learning methods. In this way, heterogeneous companies learn and develop abilities differently (Trushin & Ugur, 2020).

In general, the recent evolutionary theory perspective revolves around the notion of companies building up unique capabilities and resources, and having different approaches to innovation. Furthermore, this results in the companies developing distinct types of innovations. However, despite the arguments that have been put forward for heterogeneity at the firm level, there is a lack of empirical basis and research within recent evolutionary theory. The fact that there is a lack of empirical basis means that there is a lack within a discipline where a dominant feature has been theorizations based on empirical studies (Nelson & Winter, 1982; Nelson, 1995; Fagerberg & Verspagen, 2002; Fagerberg, 2003; Clausen, 2013).

2.6.1 Perceptions

Another notion that is important to take note of within evolutionary theory is the theoretical idea that when companies perceive problems, they can change their knowledge base through search activities (Nelson & Winter, 1982; Nelson, 1991, 1995; Dosi, Malerba, Marsili & Orsenigo, 1997; Dosi & Marengo, 2007; Clausen, 2013). The qualitative differences between companies are thus more than just effort differences in R&D across companies; it also includes the different ways companies perceive the world (Clausen, 2013).

By looking at Schumpeter's (1934) - cited in Clausen (2013) - treatment of entrepreneurs, one can see how perceptions are related to innovation. Schumpeter (1934) argued that some individuals choose to become entrepreneurs based on differences in psychological traits and talent. Essentially the interpretation by Nelson & Winter (1982) - cited in Clausen (2013) - of Schumpeter's argument is that the organizational capacity to innovate is unevenly distributed in the firm population. Therefore, an important cause for firm heterogeneity is related to differences in psychological characteristics across companies, hence companies' different ways of thinking and perceiving the world (Clausen, 2013).

Within behavioral and evolutionary theory, it is well documented that companies have different perceptions and cognitions (Cyert & March, 1963; Nelson & Winter, 1982; Nelson, 1991; Clausen, 2013). These differences arise because companies lack perfect information and have limited rationality (Cyert & March, 1963; Nelson & Winter, 1982; Clausen, 2013). In this context, one can consider innovation as a result of companies' learning processes in which they search with limited rationality for new routines (Kline & Rosenberg, 1986; Nelson, 1995; Dosi et al., 1997; Clausen, 2013). These routines play a significant role in why companies differ from each other, as pointed out by both Nelson & Winter (1982) and Cohendet & Llerena (2003).

In behavioral theory regarding companies, it is noted that seeking efforts are implemented by companies in relation to management's perception of problems. A key element concerning search and innovation at the firm level is thus how problems are perceived. One can then discuss the extent to which companies within the same industry perceive problems similarly, and the extent to which they perceive the same problems as important (Clausen, 2013). According to literature on technological regimes, the management's perception of problems and the implementation of problem-solving activities will be limited by the prevailing technological paradigm implanted in their industry. A consequence of this may be "lock-in" and "path–dependence" to a limited range of technological alternatives (Dosi, 1982; Clausen, 2013).

In contrast to the literature on technological regimes, the recent evolutionary theory argues that firms have different cognitive skills and perceptions. In addition to psychological characteristics, cognitive skills are also a significant cause of firm heterogeneity. If companies have different perceptions and mindsets, then different organizational learning processes will also be implemented, leading to heterogeneous search paths for innovation (Dosi et al., 1997; Dosi & Marengo, 2007; Clausen, 2013). In the sense that the latter perspective is valid, leaders and managers within the same industry will have different perceptions and cognitions. "Lock-in" and "path-dependencies" to a limited range of technological alternatives within an industry can therefore be avoided because such heterogeneity is associated with search and innovation (Clausen, 2013). Heuvel & van den

Bergh (2009) - cited in Cecere, Corrocher, Gossart & Ozman (2014) - argues that one should ensure technological diversity to avoid “lock-ins.”

Although theoretical research on these topics has been important for discussions about “path-dependency” (David, 1985; Arthur, 1994) and innovation studies, there is a lack of empirical research (Clausen, 2013). In order to gain relevant information on the extent to which companies are limited by their industry and its respective technological regime, researchers must empirically examine questions concerning the influence of industry factors on companies’ perception in relation to innovation (Clausen, 2013).

2.6.2 Firm heterogeneity and technological regimes

Earlier one was made aware of the lack of empirical analysis of firm heterogeneity in evolutionary theory, despite the central role “diversity” plays in evolutionary theory (Fagerberg, 2003; Malerba, 2005; Clausen, 2013). However, research studies have been conducted on the subject of inter-industry differences within innovation activities. Several research studies were undertaken early on in the discipline where the focus was on the effect of market structure variables to explain R&D intensity at the industry level (Kamien & Schwartz, 1975; Levin, Cohen & Mowery, 1985; Cohen & Levin, 1989; Klevorick et al., 1995; Cohen, 1995; Clausen, 2013). Schumpeter's hypothesis (Schumpeter, 1934) and the argument that R&D intensity is significantly affected by market structure variables and the concentration of the industry, have primarily been the essence of these studies. This research has recently been expanded by arguing that market structure variables are not the primary drivers of industries’ R&D intensity, but that the differences in appropriability conditions and technological possibilities across industries are (Levin et al., 1985; Klevorick et al., 1995; Clausen, 2013).

Inter-industry variations in appropriability conditions and technological capabilities have been extensively documented in empirical literature as notably related to differences in R&D intensity at the industry level (Levin et al., 1985; Levin et al., 1987; Klevorick et al., 1995; Clausen, 2013). These studies have become significant for the empirical literature on technological regimes. The literature is based on Nelson & Winter’s (1982) argument that the nature of technology sets limits to industrial competition and the pattern of innovation.

Nelson & Winter's statement is essentially about the technological environment, or the prevailing technological regime setting limits on learning processes and seeking activities at the company level (Clausen, 2013).

What emerges from the empirical literature on technological regimes is the notion of companies within the same industry sharing the same knowledge bases and innovation characteristics (Clausen, 2013). Therefore, equivalent innovation strategies are often pursued by companies as a result of underlying similarities in technological regimes (Nelson & Winter, 1982), sectoral innovation systems (Malerba, 2005), and sectoral patterns of technical change (Pavitt, 1984). According to Clausen (2013), there is a potential conflict between the empirical literature on technological regimes and recent evolutionary theory. This potential conflict illustrates the argument that advancements in recent evolutionary theory have a loose foundation (Fagerberg, 2003; Clausen, 2013). It is thus essential to emphasize the need for empirical research on this topic so that the theoretical understanding of innovation can be improved (Clausen, 2013).

2.7 Technological Regimes

The concept of technological regimes is a well-debated topic. It was first introduced by Nelson & Winter (1982) and Winter (1984) to describe the technological environment firms within the same industry encounter (Breschi & Malerba, 1997; Breschi et al., 2000; Leiponen & Drejer, 2007; Wersching, 2010). Although the notion of technological regimes was not familiarized before the 1980s, Schumpeter (1934 & 1942) laid the foundation for it much earlier with his publication “Schumpeterian pattern of innovation.” Here the notion of Mark I and later Mark II was introduced, characterizing the differences in industries' innovation conditions (Wersching, 2010).

The former, Mark I, is characterized by a widening innovation pattern where new innovative firms enter the industry and challenge the established innovative firms with their innovative activities and innovations. The entry of new firms is possible due to the industry's high technological entry (Breschi & Malerba, 1997; Breschi et al., 2000; Wersching, 2010; Frenz & Prevezer, 2012). On the other hand, if an industry is characterized by low technological entry, resulting in a deepening innovation pattern, it is classified as Mark II. The low technological entry allows established firms to dominate the market since the low degree of entry acts as a barrier for firms looking to enter the industry (Breschi et al., 2000; Castellacci & Zheng, 2010). In the following years, it became apparent that there was a need for characterizing differences in the structure of innovative conditions, resulting in the introduction of technological regimes (Wersching, 2010).

In their publications, Nelson & Winter (1982) and Winter (1984) emphasized two factors within an industry: The technological opportunity and appropriability of innovation as the technological regime. These two factors were seen as the main characteristics within an industry that affected the dynamics of market structure and innovation: *The intensity of innovations*, *degree of industrial concentration*, and *technological entry* (Breschi & Malerba, 1997). The early notion of technological regimes, created by Nelson and Winter, was later expanded by Malerba & Orsenigo (1990, 1993, 1994). Instead of explaining an industry's technological entry, degree of industrial concentration, and intensity of innovations as a result of just the technological opportunity and appropriability of innovation, they emphasized two more affecting factors. These two factors were the cumulativeness of technological knowledge and the knowledge base (Breschi & Malerba, 1997). These four factors combined form the concept of an industry's technological regime, which in the perspective of this theory, leads to homogeneous innovation activities among firms within the same industry (Breschi et al., 2000; Leiponen & Drejer, 2007; Castellacci & Zheng, 2010; Peneder, 2010).

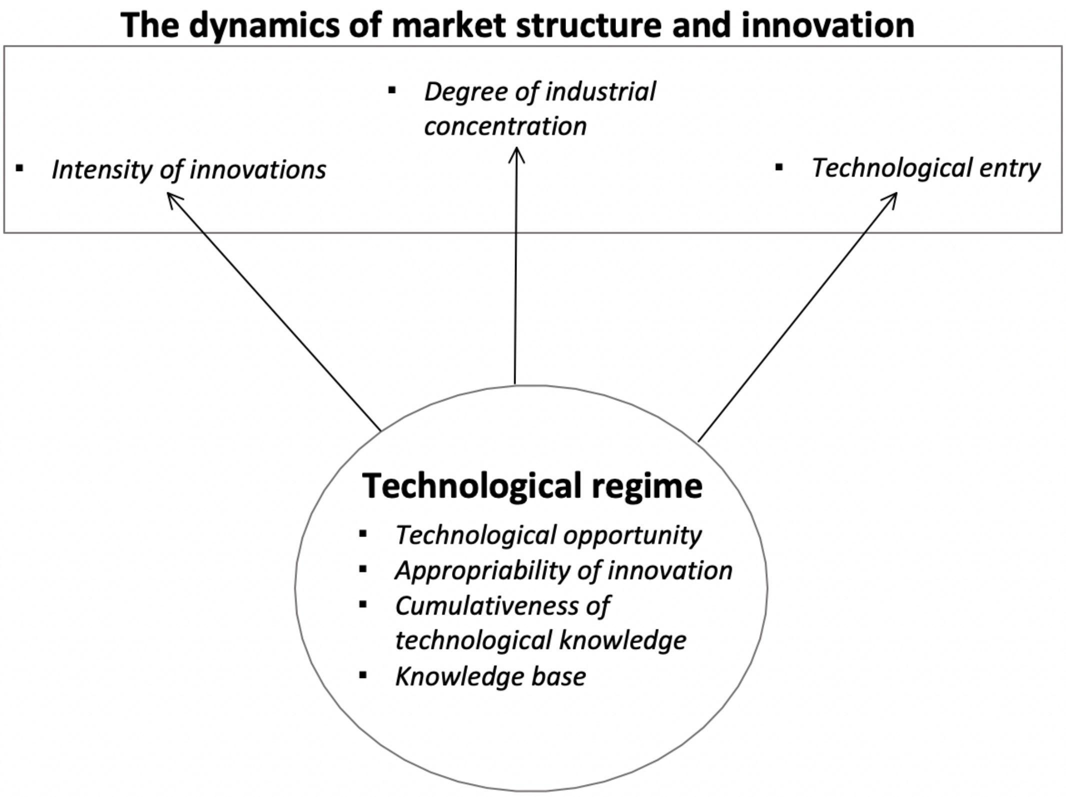

Figure 5: The dynamics of market structure and innovation

2.7.1 Technological opportunity

Breschi et al. (2000) explained the first affecting factor, technological opportunity, as "*a reflection of the likelihood of innovating for any given money invested in the search*." If there is a high level of opportunity within an industry, there is abundant knowledge external to that industry (Wersching, 2010). Strong incentives to undertake innovation activities exist because of the abundance of knowledge (Breschi et al., 2000). Technological opportunity can be seen in different dimensions. Revilla & Fernández (2012) emphasizes the *level* and the *sources* of technological opportunity. In addition to these two, Breschi & Malerba (1997) also emphasize the *variety* and *pervasiveness*.

The *level* of technological opportunity reflects the relation between firms' invested resources into innovation activities (input) and the expected results (output) (Revilla & Fernández, 2012). It can be distinguished between high or low levels of technological opportunity (Breschi & Malerba, 1997). Peneder (2010) addresses a potential problem in identifying whether an industry has a high or low level of technological opportunity. It may seem natural to measure the success rate of innovation within the specific industry, as a high success rate should imply high opportunities and vice versa. The mistake is that opportunity does not reflect an actual realization of innovations, just the potential. When measuring whether an industry has a high or low technological opportunity, the emphasis should be directed to data on the effort and resources invested into innovation activities by firms operating within that industry (Peneder, 2010).

Variety in technological opportunity refers to whether the technological activities, approaches, and solutions conducted by firms within an industry follow a specific or broader trajectory (Breschi & Malerba, 1997). This can be explained by thinking of an industry where no dominant design has emerged. Since no dominant design exists, firms within that industry do not follow a specific trajectory as they all try to develop their own technological solution. However, if or when a dominant design emerges, the trajectory shifts from wide to specific due to the need for radical different technological solutions diminishing. Therefore, firms emphasize enhancing the performance of their existing products and production process (Breschi & Malerba, 1997).

When firms develop new knowledge, it can either be used together with a specific or several different products and markets. In the same way that variety refers to a specific or broad trajectory of activities, approaches, and solutions, the industry's *pervasiveness* reflects whether the firms' new knowledge has a general or specific area of use. If the pervasiveness is high, the new knowledge has a general area of use and can be applied to different products and markets. However, a low pervasiveness indicates that the knowledge is more specific and can only be applied to a limited number of products or markets (Breschi & Malerba, 1997).

The last dimension of technological opportunity is the *sources* of opportunity. The sources of technological opportunity refer to where the opportunity to innovate originates from. Most common are sources such as advances in internal R&D, collaborations with external parties, improved equipment, and customer groups (Breschi & Malerba, 1997; Revilla & Fernández, 2012).

2.7.2 Appropriability of innovation

The second factor that constitutes an industry's technological regime is the appropriability of innovation. This factor reflects the possibilities firms within an industry have to protect their innovations against imitations from competing firms (Breschi & Malerba, 1997; Breschi et al., 2000; Peneder, 2010; Castellacci & Zheng, 2010). Firms can use many different methods to protect their innovations, however it depends on the nature of the knowledge they seek to protect (Peneder, 2010). Firms can choose between formal and informal methods, where formal methods include patents and trademarks (IPRs) whilst informal methods consist of process secrecy, "know-how," and complexity (Peneder, 2010; Castellacci & Zheng, 2010; Revilla & Fernández, 2012). Appropriability can be divided into two dimensions; *levels of appropriability* and *means of appropriability* (Breschi & Malerba, 1997).

Levels of appropriability refer to whether there exist ways for firms within a specific industry to successfully protect their innovations against imitation from competing firms. High levels of appropriability mean that there exist ways to protect innovations, and low levels signify that there are limited (or no) ways for firms to protect their innovations (Breschi & Malerba, 1997). If an industry has high levels of appropriability, Breschi et al. (2000) point out that it will have two different effects on the innovation within the industry. Firstly, there will be strong incentives resulting in increasing resources being invested into R&D by individual firms. However, as the conditions within the industry facilitate firms to protect their innovations from imitation, the industry's overall technological advance may stagnate. The protective measures put in place prevent firms from benefiting from other firms' technological advances.

While levels of appropriability signify if an industry has sufficient or insufficient conditions for protecting innovations, *means of appropriability* reflect the different ways firms can protect their innovations from imitation. There is a general distinction between formal and informal ways to protect innovations. Formal ways include IPRs, whereas informal ways are centered around measures not protected by the law (Breschi & Malerba, 1997).

2.7.3 Cumulativeness of technological knowledge

An industry's cumulativeness of technological knowledge defines to which extent a firm's innovations and innovative activities are correlated to its already accumulated knowledge and competence (Breschi & Malerba, 1997; Castellacci & Zheng, 2010). Suppose the cumulativeness is high within an industry. In that case, firms that are already innovative will have an advantage because "*today's knowledge and innovative activities form the base and the building blocks of tomorrow's innovations*" (Breschi et al., 2000: 392).

Breschi & Malerba (1997) identified four levels of cumulativeness: *Technological level, firm level, sectoral level,* and *local level.* The most basic level, the *technological level,* refers to the specific characteristics of technologies and the natural learning process firms go through when conducting innovation activities. Cumulativeness at *the firm level* refers to the situation where a firm's future innovation activities depend on its knowledge and competence. For cumulativeness to exist at a sectoral (industry) level, two conditions must be in place: Low appropriability and relevant knowledge bases being available for all firms within the industry. Cumulativeness can also exist on a *local* level, meaning that cumulativeness is not related to firms within a specific industry but to firms located in a geographical area.

2.7.4 Knowledge base

The fourth and last factor that forms an industry's technological regime is the industry knowledge base (Breschi & Malerba, 1997; Breschi et al., 2000). Across industries, the relevant knowledge base firms build their innovation activities upon differs. To understand the properties of an industry's knowledge base, two characteristics should be emphasized: The *nature of knowledge* and the *means of knowledge transmission* (Breschi & Malerba, 1997; Breschi et al., 2000).

The *nature of knowledge* can be divided into various degrees of specificity, tacitness, complexity, and independence (Breschi & Malerba, 1997). The first dimension within an industry's nature of knowledge is whether the knowledge is *generic* or *specific*. As it dictates, generic knowledge is knowledge of broad nature, while specific knowledge is more specialized for specific situations (Breschi et al., 2000). The degree of tacitness refers to whether or not the knowledge within the industry is easily transferable between the firms operating in it. An essential aspect of knowledge is its degree of complexity, which can vary between low and high. An important notion is that even if the nature of knowledge is generic, it does not mean it cannot be complex or that specific knowledge must be complex. The last dimension of the nature of knowledge within an industry is the degree of independence. Knowledge degrees of independence refers to whether the knowledge is isolated in the sense that only the relevant knowledge is identified or identified as a part of a more extensive system of knowledge (Breschi & Malerba, 1997).

The second characteristic of an industry's knowledge base is the *means of knowledge transmission*. In short, it refers to which actions can be implemented to transmit knowledge between firms within an industry. The type of means best suited to transmit knowledge is greatly influenced by the knowledge degree of specificity, tacitness, complexity, and independence (Breschi & Malerba, 1997). It can be divided into informal (training and recruitment of personnel) and formal (patents and licenses) means of knowledge transmission.

2.7.5 Technological regime and schumpeterian pattern of innovation

Breschi et al. (2000), Castellacci & Zheng (2010), and Peneder (2010) argued that an industry's technological regime, to a high degree, influences its specific pattern of innovation activities. Since industries more or less have their own unique technological regime, their technological regime could explain differences across industries regarding innovation activities. In their work, Breschi et al. (2000) build their theory on the "Schumpeterian tradition" that an industry can follow one of the two main patterns of innovation: Creative destruction or creative accumulation. Whether an industry has a creative destruction or creative accumulation pattern of innovation can be perceived in the context of the Schumpeterian pattern of innovation (Mark I and II), as mentioned earlier. As creative destruction is a pattern of innovation where previous non-innovative firms start being innovative, the pattern relates to Mark I. On the other hand, a creative accumulation pattern of innovation refers to when future innovations are developed by firms that previously were innovative, thus relating to Mark II.

Breschi et al. (2000) explained the relationship between the Schumpeterian pattern of innovation and an industry's technological regime by looking at the dynamics of market structure and innovation. The variables forming the dynamics of market structure and innovation are influenced by the specific values of the four factors in a technological regime. As mentioned, those four factors are *technological entry*, *appropriability of innovation*, *and cumulativeness of technological knowledge* and *knowledge base*.

A simplified approach to the four factors will be used when discussing how they affect technological entry, intensity of innovation, and degree of industrial concentration. Even though different dimensions of the factors have been described, the following chapters will only focus on how high vs. low levels and specific vs. generic (knowledge base) affect technological entry, intensity of innovation, and degree of industrial concentration.

2.7.5.1 Technological entry

The variable "technological entry" refers to the entry of new innovative firms into an industry, and it is primarily influenced by three of the four factors which constitute the technological regime. *Technological opportunity* is the first influencing factor. As mentioned, the level of technological opportunity reflects the relation between the input (invested resources) and the output (expected results) (Revilla & Fernández, 2012). In other words, it describes whether a firm has high or low economic incentives to engage in an innovative activity (Breschi et al., 2000). Therefore, high levels of technological opportunity benefit an industry's technological entry since it provides strong incentives for firms to enter.

Nevertheless, even though high levels are usually in favour of the constant entry of new firms, it can also lead to the opposite in some instances. High technological opportunities can result in substantial technological leaps for established firms, eliminating competing firms in the industry (Breschi & Malerba, 1997; Breschi et al., 2000). However, the first situation is most common, and it is recognized that technological entry has a positive correlation to technological opportunity. Therefore, low levels of technological opportunity provide weak incentives and negatively affect technological entry (Breschi et al., 2000).

The second influencing factor is *cumulativeness of technological knowledge*. Since this factor reflects the correlation between firms' future innovations/innovative activities and accumulated knowledge, the relation between cumulativeness and technological entry is negative. This relation is negative because high cumulativeness favours the established firms and acts as an entry barrier for new firms entering the industry. Conversely, low cumulativeness improves the conditions for the entry of new firms looking to engage in innovation activities since there is no need for already accumulated knowledge (Breschi & Malerba, 1997; Breschi et al., 2000).

The third and final factor that influences the technological entry of an industry is the *knowledge base*. The most manageable parameters to use here are "generic" or "specific." Conditions in favour of a high technological entry are when the knowledge's nature is specific (Breschi et al., 2000). This may appear unnatural as it seems likely that new entrants would struggle to grasp specific knowledge rather than generic. However, as Breschi et al. (2000) argue, firms must already have accumulated dynamic capabilities to integrate and use generic knowledge, which is not the case with specific knowledge. Therefore, generic knowledge leads to lower technological entry and vice versa.

For the best conditions to be in place for an industry to have a high technological entry, it must have high technological opportunities, low cumulativeness of technological knowledge, and a specific knowledge base.

Relationship between Technological Entry and Characteristics of Technological Regime		
	Technological Entry	
	High Entry	*Low Entry*
Technological Regime: *Technological Opportunity*	*(High)*	*(Low)*
Cumulativeness of Technological Knowledge	*(Low)*	*(High)*
Knowledge Base	*(Specific)*	*(Generic)*

Table 3: Technological Entry and Technological Regime

2.7.5.2 Intensity of innovation

An industry's intensity of innovation refers to the width of innovative firms operating within that industry. High intensity means that there is a limited population of innovative firms, whereas a low intensity indicates that there is a vast population. When it comes to influencing factors, *technological opportunity* does not have a clear positive or negative correlation with the intensity of innovation (Nelson & Winter, 1982; Winter, 1984; Iwai, 1984; Jovanovic & Lach, 1988; Dosi, 1995). High technological opportunities favour new innovating firms entering the industry, diluting the concentration. However, similar to technological entry, high technological opportunities can lead to significant technological leaps. Innovation intensity will increase if the right conditions (high appropriability and cumulativeness) are in place.

Suppose conditions are in place for firms to protect their innovations and innovative activities, thereby reducing the knowledge spillovers. In that case, the level of intensity is expected to increase as established innovators get an advantage. Therefore, high levels of *appropriability* will lead to a greater concentration of innovation. The correlation between the intensity of innovation and appropriability is thus positive, and low levels of appropriability will result in a broader population of innovative firms (Breschi et al., 2000).

As high appropriability conditions are an advantage for innovative firms, high levels of *cumulativeness* are the same. When conditions are in place for firms to build upon their previous innovations, innovative activities, and accumulated knowledge, innovation intensity will increase. On the contrary, low levels of cumulativeness open up for firms with no previous innovations or accumulated knowledge, decreasing the concentration of innovative firms (Breschi et al., 2000).

The last factor influencing the intensity of innovation is the industry's *knowledge base*. In the same way as the knowledge base affects technological entry, it also influences the intensity of innovation. As discussed, a generic knowledge base may seem more open for a wider variety of firms, but it requires firms to possess dynamic capabilities. On the other hand, specific knowledge does not require dynamic capabilities and therefore lowers the intensity of innovation (Breschi et al., 2000).

A combination of generic knowledge base, high level of cumulativeness, and high level of appropriability are conditions favouring a high concentration of innovative firms within an industry. Technological opportunity, as mentioned, has no fixed positive or negative correlation to the intensity of innovative firms, but with the conditions mentioned, both high and low levels of technological opportunity will result in increased concentration of innovative firms.

Relationship between Intensity of Innovation and Characteristics of Technological Regime

	Intensity of Innovation	
	High Intensity	*Low Intensity*
Technological Regime:		
Technological Opportunity	*(Low/High)*	*(High)*
Appropriability of Innovation	*(High)*	*(Low)*
Cumulativeness of Technological Knowledge	*(High)*	*(Low)*
Knowledge Base	*(Generic)*	*(Specific)*

Table 4: Intensity of Innovation and Technological Regime

2.7.5.3 Degree of industrial concentration

The last variable forming the dynamics of market structure and innovation within an industry is the degree of industrial concentration. This variable refers to whether already innovative firms are the ones that will engage in innovative activities in the future, or if stability in the ranking of innovators will be rearranged. The degree of industrial concentration is highly related to the former variable, intensity of innovation, and has the same correlations regarding *technological opportunity*, *cumulativeness*, *appropriability*, and *knowledge base* (Breschi et al., 2000).

With conditions characterized by high levels of applicability and cumulativeness, the top-ranking innovating firms in the industry can protect their innovations and innovative activities. Furthermore, they can build upon their existing knowledge, increasing the stability in the ranking (Breschi & Malerba, 1997). Once again, technological opportunity would usually negatively correlate to the degree of industrial concentration as high levels are usually in favour of the entry of new firms. Nevertheless, high levels can lead to significant technological leaps and favour already established firms (Breschi et al., 2000). For the stability in the ranking to change, the conditions in the industry must be characterized by high levels of technological opportunities and low levels of cumulativeness and appropriability.

Relationship between Degree of Industrial Concentration and Characteristics of Technological Regime

	Degree of Industrial Concentration	
	High Concentration	*Low Concentration*
Technological Regime: *Technological Opportunity*	*(Low/High)*	*(High)*
Appropriability of Innovation	*(High)*	*(Low)*
Cumulativeness of Technological Knowledge	*(High)*	*(Low)*
Knowledge Base	*(Generic)*	*(Specific)*

Table 5: Industrial Concentration and Technological Regime

2.7.5.4 Mark I and II

Looking further into the Schumpeterian pattern of innovation Mark I and II, one can better understand how an industry's technological regime shapes firms' patterns of innovation. As explained earlier, Mark I has a *widening* pattern with a large and ever-changing population of innovating firms. The following features characterize the innovation pattern known as Mark I: High technological opportunity, low appropriability of innovations, low cumulativeness of technological knowledge, and a specific knowledge base.

The pattern of innovation known as Mark II, also referred to as the *deepening* pattern, has a limited and stable population of innovative firms. Features such as low technological opportunity, high appropriability of innovation, high cumulativeness of technological knowledge, and a generic knowledge base are favourable conditions for this pattern.

3 Research method

3.1 Theory of science

Researchers may share many similar perspectives and values; however, they may also disagree on several issues. For instance, there can be differences in their views on reality, knowledge, and how knowledge may best be acquired. In other words, they may have different views and different philosophies about how to use said philosophies during the research process. The question “how to research'' is undoubtedly a philosophical question, making the differences between researchers essential. Therefore, researchers must articulate a philosophical stance to guide their views and work. When articulating a stance, assumptions become more explicit to both the researchers and potential readers (Savin-Baden & Howell-Major, 2013). In terms of views of reality and knowledge, there are two major perspectives within scientific theory; ontological views (philosophies that address the nature of reality) and epistemological views (philosophies that address the nature of knowledge) (Savin-Baden & Howell-Major, 2013; Ringdal, 2018).

There are two key positions within ontological views: Realism (an objective perspective) and idealism (a subjective perspective). The position of realism proposes that there is an objective known and external reality that exists independent of individual means of understanding it. The position of idealism proposes that reality is subjective and constructed by individuals and groups. Within idealism, knowledge is viewed as the meaning that research participants appoint to their lives. Hence, knowledge is a product of the participants' minds and may therefore be acquired by learning about the knowledge that they possess (Savin-Baden & Major, 2013).

Our ontological view while undertaking this study was most consistent with the perspective of realism. We consider there to be an objective reality to the social world that could be discerned with the possession of sufficiently sophisticated tools. However, we also recognize that when studying the social world, our tools such as interpretation and human understanding, are inescapably context-dependent, theory-laden, and value-laden. Therefore, we strive to derive and generalize an approximation of truth through continual efforts toward multiple data analysis, methodological rigor, and theory-building and testing (Fox, 2008).

Epistemology is, as mentioned, also a major perspective that researchers must consider when conducting studies. In addition to considering their views of reality, researchers must also consider their views of knowledge and how knowledge may be uncovered. Within epistemology, one finds perspectives such as empiricism, rationalism, historicism, instrumentalism, experientialism, structuralism, and existentialism (Savin-Baden & Major, 2013). Our epistemological views during this study are most consistent with the perspective of rationalism, more specifically critical rationalism, in which knowledge is gained through reason and our ability to be critical of our own and others' perceptions (Savin-Baden & Major, 2013; Ringdal, 2018). According to Popper (1981) - cited in Ringdal (2018) - science is an eternal pursuit of empirical truths. However, this pursuit is characterized by the limitation that the truth can never entirely be found, meaning we have to settle for preliminary and not final truths.

Popper (1981) claimed that humans have an innate trait to look for and expect connections: *"We try to discover similarities and interpret the world using laws invented by us. Without waiting for the premises, we go directly to the conclusions. These must later be rejected if the observations show that they are wrong."* The principle of falsifiability was introduced by Popper (1981), which states that even though we cannot prove a theory true, if it is not consistent with observations of reality, we can discard theories that are wrong. This is because one can conclude that universal statements (such as theories and hypotheses) are incorrect if relevant observational statements are accepted as true (Ringdal, 2018). During this study, two hypotheses was generated based on prior studies and theories, and observations were made to find out if these hypotheses was to be discarded or not.

Within scientific history, several research paradigms have been developed, such as positivism and post-positivism (Lende, 2017; Savin-Baden & Major, 2013; Hatch, 2002). A research paradigm is a worldview or belief system used to guide the researcher and the research process. On the one hand, the research paradigm of positivism is associated with natural sciences which are built upon natural phenomena with their respective properties and relations. Hence, knowledge is viewed in this paradigm as something that is to be discovered, thus researchers obtain knowledge by identifying facts. Elements such as neutrality, objectivity and rationality are valued by positivists, who have the goal of reducing knowledge to universal and abstract principles (Savin-Baden & Major, 2013). The belief in absolute truths is the foundation of positivism, meaning that subjective interpretation or influence is not allowed. Hence, the research must be independent of the researcher's evaluation of facts (Grønmo, 2004).

On the other hand, post-positivism challenges the structure of positivism, although some common beliefs are still retained, such as the perspective of realism. Additionally, objectivity is also valued in post-positivism, in which findings are viewed as most likely or probably true (Savin-Baden & Major, 2013). Within post-positivism, it is argued that a researcher cannot be an independent observer of the social world. Furthermore, factors such as the identity and ideas of a researcher influences what is observed which thus affects the conclusions made. Objective answers can, therefore, only be pursued by attempting to identify and work with such biases (McGlinchey, 2022). The research paradigm used to guide us and our research process was post-positivism. We believe that the research cannot be completely independent of a researcher's assessment of facts, and that it is not possible to find absolute truths. As researchers, we continuously make our own choices throughout the process, which could impact the research results.

The hypothetical-deductive method was deemed the most suited approach when conducting this study. This method includes induction and deduction, as illustrated in figure 6. It first starts with theories that generate hypotheses, where the goal is to test said theories. Observations are then made in order to determine whether or not to discard the hypotheses, possibly leading to new empirical contexts, which furthermore contributes to new theories (Ringdal, 2018). The reasoning behind this choice of approach is that in order for us to conduct a solid quantitative analysis, we should know the phenomenon we are studying. Therefore, unambiguous definitions and operationalization of variables that we are going to use are provided. Additionally, we should know the field we are studying well enough to establish relevant and well-worded hypotheses. The hypotheses made in this study are based on theories presented in chapter 2.6 and 2.7, and are tested by conducting a questionnaire where the observations made will help validate or discard the hypotheses.

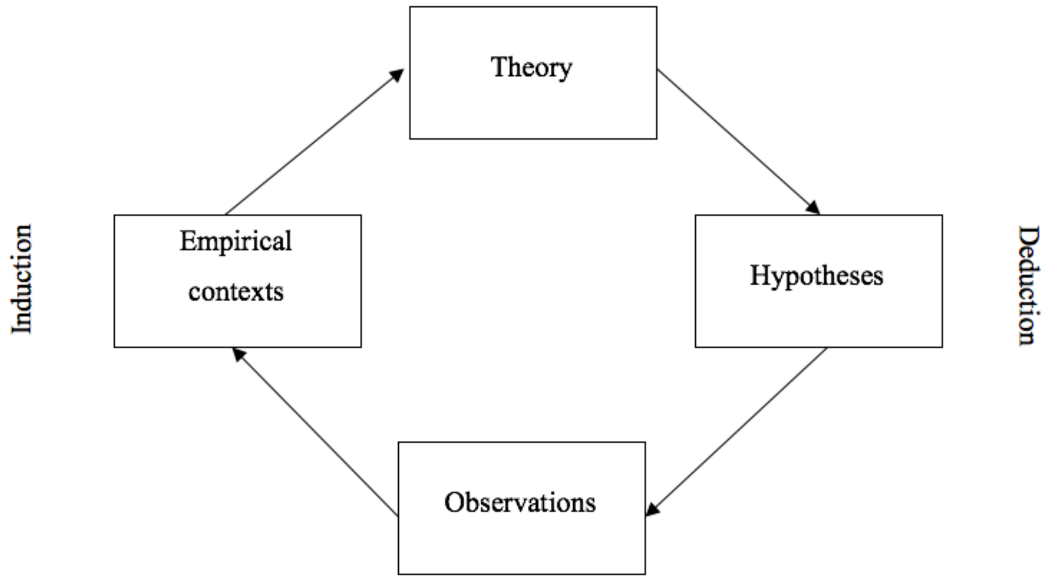

Figure 6: The circle of science (Wallace, 1971)

3.2 Nature of the research question

The choice of what to study is the most significant decision throughout the study. It determines the scope, lays the foundation for the research question, and decides which data should be collected and how to analyse it. A research question is defined as an inquisitive sentence that emphasizes the phenomenon to be studied, and that stipulates what the researcher wishes to uncover. In other words, the research question sums up what is unknown and needs further exploration (Savin-Baden & Major, 2013).

3.2.1 Steps in the process of developing the research question

A specific process for developing research questions is suggested in most research methods. The general idea of the process is that researchers choose a subject area, identify a topic, identify a research question, and define the research purpose. After these four steps, researchers will be ready to formulate the research question (Savin-Baden & Major, 2013).

3.2.1.1 Choosing the subject

A common perspective is that the researcher's field naturally sets boundaries regarding the knowledge area. The subject area in which the researchers choose, determines where the researchers will spend their time (Savin-Baden & Major, 2013). At the beginning of deciding which subject area we wanted to limit ourselves to, we were drawn towards the subject of innovation. Innovation is a subject growing more and more relevant and thus has several exciting topics and problems to explore. Therefore, the chosen subject area of this thesis was innovation.

3.2.1.2 Identifying a topic

When the subject area of the thesis is chosen, one can start identifying the research topic, which is a specific unit or category of the subject. When identifying a suitable topic, it is crucial to consider that it should capture both the researcher's and the intended audience's interest and attention. When defining the topic, one needs to make sure that it is not too broad since it may become too unmanageable. Additionally, one must make sure that the topic is not too narrow since that may make it impossible to produce something meaningful or interesting (Savin-Baden & Major, 2013).

The topic that we identified within the subject of innovation was "*Innovation activities within an industry; are they heterogeneous or homogeneous?"* We found this topic to be of great interest, and we believe that the intended audience will also find this topic interesting. We also believe that the topic is not too broad or too narrow.

3.2.1.3 Identifying the research question

After a specific research topic has been identified, the research question must be created to solidify the study's direction further. There are several sources from which research questions may originate, such as previous research, life experiences, or insufficient literature (Savin-Baden & Major, 2013).

"How are a company's innovation activities affected by the industry in which it operates?"

The research question we have identified originates from the contradicting theories regarding innovation activities within industries. As we saw it, the insufficient literature about evolutionary and technological regime theories had created a gap that we wanted to investigate. Since there were two contradicting theories, we thought it would be exciting to investigate the two theories to figure out which one was the most consistent with reality.

Together with the research question, two hypotheses were also created:

H_1: *"Companies´ innovation activities are only influenced by the industry's technological regime."*
H_2: "*Evolutionary theory and technological regime theory are not complementary."*

The background for these hypotheses was that we wanted to investigate whether companies' innovation activities could be affected by both theories at the same time, or if companies were affected by only one of the theories, excluding the other. In addition, if H_1 is false, we wanted to investigate whether they were complementary or not.

3.2.1.4 Defining the research purpose

According to Locke, Spirduso & Silverman (1987) - cited in Savin-Baden & Major (2013) - the objective of the research purpose is: "*The purpose statement should provide a specific and accurate synopsis of the overall purpose of the study.*" Ritchie & Lewis (2003) - cited in Savin-Baden & Major (2013) - present several key purposes that can be found in research studies:

- Contextual: Describes the nature or form of what exists.
- Generative (Exploratory): Assists the development of theories, actions or strategies.
- Evaluation: Assessment, measurement, or evaluation.
- Ideological: Advancing an ideological position.
- Explanatory: Examines the reasons for what exists, or the association between what exists.

The purpose of our research study is most consistent with the explanatory purpose. Our main objective is to examine the association between a company's innovation activities and its industry.

3.3 Choice of research method and design

3.3.1 Research method

The choice of research strategy should be established as early as possible to ensure that a structured plan is being followed. In today's research community, the choice of the research strategy is seen as a choice that should be heavily influenced by the research question and the competence of the researchers who will conduct the study (Ringdal, 2018).

The choice of strategy can be divided into two options: A quantitative or qualitative strategy. The most common difference between the two is in regards to the data they collect. A qualitative strategy collects data on a phenomenon consisting of text, whereas a quantitative strategy collects data describing a phenomenon through numbers (Ringdal, 2018).

Ringdal (2018), in addition to pointing out the differences in the data the two strategies collect, also emphasizes other differences dividing the strategies. A quantitative strategy justifies using measurements and quantitative descriptions because the phenomenon under investigation is perceived as “stable.” Qualitative strategies, however, are built upon the notion that the actions of individuals construct the social world, resulting in phenomena changing regarding the context they appear. Quantitative strategy is deductive, theory-driven, and seeks to use questions and create hypotheses relevant to the phenomenon. In contrast to the quantitative strategy, qualitative strategy is inductive, meaning the researcher seeks to establish key terms used to understand the phenomenon being studied.

There are also differences between the two strategies regarding how the researcher relates to the subjects. One the one hand, large selections where the researcher “keeps distance” from the subjects are characteristics of a quantitative strategy. On the other hand, a more limited number of subjects that the researcher stays closer to, obtaining deeper information, is common for a qualitative strategy. The deeper information a qualitative strategy seeks to obtain, results in the data being transferred into text and analysed with informal techniques. Conversely, when quantitative strategies are being used, data is obtained in the form of numbers which more easily can be analysed using statistical analysis techniques (Ringdal, 2018).

Although research questions that ask “what” or “how” traditionally are linked to qualitative strategies and research questions asking “why” to quantitative strategies, this thesis chooses to not follow the traditional approach (Ringdal, 2018). This thesis´s research question asks “how,” but the research strategy of choice is quantitative. There are several reasons behind this choice, the most important being the approach we want to take. Because of the phenomenon of study, it is seen as necessary to have a large sample of objects to obtain as many different perspectives as possible.

3.3.2 Research design

The research design of choice constitutes the researcher's sketch of how the thesis will illuminate and answer the research question. Even though there are several different research designs, Ringdal (2018) emphasizes what he describes as the five most common designs; experimental, cross-sectional, longitudinal, case study, and comparative.

Based on how we envisaged that the thesis would have the best possible result, several of these research designs did not fit. An experimental design is traditionally used to investigate a causal relationship and often consists of an experimental and a control group (Ringdal, 2018), which we did not find fitting for our thesis. A longitudinal design intends to follow one or more objects over a time period (Ringdal, 2018), which we did not find appropriate for the thesis either. The same conclusion was also drawn regarding case study and comparative design. As they both focus on one (case study) or a few cases (comparative) (Ringdal, 2018), they seemed to not fit as our thesis intended to get in contact with as many firms as possible. In addition to this, we did not view each participating firm as an individual case, nor did we view the different industries in which the chosen firms operate within as a case. Industries were considered more as a variable to distinguish firms with different assumptions from each other.

The last remaining design highlighted by Ringdal (2018) is the cross-sectional. This is also the design that felt most appropriate for this thesis, as it fits well together with a survey intended for a large number of objects (Ringdal, 2018). Nevertheless, it must be clarified that a cross-sectional design also can include surveys that are used several times over a given time period to follow a phenomenon over time. However, as mentioned with the longitudinal design, this was not the thesis intent. Therefore, a simple cross-sectional design with a survey completed in just one time period is chosen as the research design for this thesis.

3.4 Design of the survey

Surveys are the most commonly used method to gather data in social science as it is an effective and systematic way to obtain a statistical description of a population (Ringdal, 2018). Groves, Fowler, Couper, Lepkowski, Singer & Tourangeau (2004) - cited in Ringdal (2018) - schematic representation of the process of developing a survey was used as a guide to ensure a survey of high quality. Figure 7 consists of seven steps, starting with the purpose of the study and ending with the data ready to be analysed.

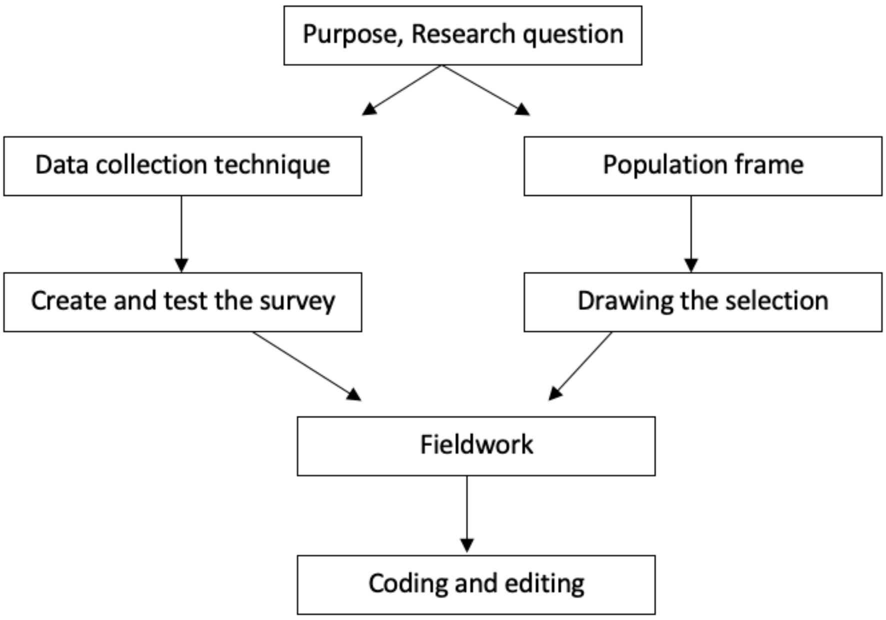

Figure 7: Steps when creating a survey

3.4.1 Specify the purpose

When creating a survey, the first step is to *s*pecify the purpose of the study. The purpose, as discussed during chapter 3.2.1.4, was to examine the association between a company's innovation activities and its industry. Specifying the purpose of the study is essential for the survey because it delimits the scope and provides better conditions to create the questions, choose the best-suited data collection technique and identify the population frame.

3.4.2 Data collection technique

Once the purpose of the study has been determined, one has to choose the technique for collecting the data. As mentioned in chapter 3.3.2, a cross-sectional design was chosen. However, there are several different approaches to conducting a survey, the most common being face-to-face, over the phone, and self-completion forms (Ringdal, 2018).

Several aspects influenced the choice of what approach would yield the best results. Firstly, the timeframe was short as the study itself had a time span of a semester. With only two students working on the study, face-to-face or over the phone techniques would take up too much time. There would also be problems with these two techniques in relation to our budget, which had zero expenses. Traveling to different firms to conduct face-to-face surveys would cause significant travel expenses, and it was unlikely that firms would travel to us to participate in the study. In addition to the time and budget aspects, the potential unintended influence we could have on the participant if we were in contact with them was also deemed undesirable (Ringdal, 2018). We wanted to maintain a distant relationship with the objects, therefore, these two approaches were considered unsuitable. However, there were also some benefits associated with the two methods. If something about the survey was unclear or the participants did not understand a question, it would be possible to discuss it. A more significant response rate would also be expected when using one of the two mentioned approaches.

The use of self-completion forms had some drawbacks as well. It is outdated to send the survey to firms by mail, so it must be done through email. The downside was that we had little control over whether the email ended up in the firm's inbox or spam folder. Another disadvantage was that we could not control who in the firms would answer the survey. If unqualified employees answered the survey, it could hurt their credibility. The response rate percentage was also likely to be low. On the other hand, a survey based on a self-completion form can be distributed to many objects quickly and is free of charge. Therefore, a self-completion form became the chosen data collection technique, despite the potential downsides.

3.4.3 Population frame

The population frame constitutes the population from which the selection is made (Ringdal, 2018). When choosing the population frame, it was necessary once again to emphasize the purpose of the study to ensure that the correct population was chosen. It was clear that the population frame would consist of firms, but it had to be more specific than that.
There were five exclusion criteria established:

1. Firms located outside of Norway.
    - The reason behind this criterion was to limit the population significantly.
2. Firms that are not operating within one the following four industries: Forestry and fishing, building and construction, accommodation and catering, and research and development.
    - We wanted to focus on these four industries as statistics, provided by Statistics Norway, showed significant differences between the average level of innovation activities for each industry.
3. Firms with a lower operating income than 3 000 000 NOK.
    - By excluding firms with a lower operating income than 3 000 000 NOK, firms perceived as too small to provide relevant data were eliminated. It must be noted that this criterion applies to operating income, not operating profit.
4. Firms with only one employee.
    - Firms that were seen as too small to provide relevant data were eliminated.
5. Firms without a registered email.
    - As the data collection technique was survey based on a self-completion form delivered by email, all firms without an email would be excluded.

An overview was created by utilizing "proff.no," which has a register of all Norwegian-based firms. The website also allowed all the exclusion criteria to be applied, resulting in a population frame of 6 749 firms. A total of 1 137 988 firms were excluded due to exclusion criteria two to five (exclusion criteria one was already implemented as "proff.no" only has a register over Norwegian-based firms).

3.4.4 Create and test the survey

The next step was to create and test the survey (Ringdal, 2018). EasyQuest was used to create the survey as it provides a large selection of options and is free of charge. We were already familiar with the topic as we had conducted a preliminary project, so any further investigation on what type of data should be gathered was unnecessary.

Before the questions were developed, we created a draft of the information we wanted to gather. This information had a solid connection to the research question and the variables we wanted to measure. As it was not possible to measure the research question directly, various compound measures had to be utilized (Ringdal, 2018). Therefore, several different measures on how each firm experiences the industry they operate within were used as compound measures to give insight. When creating the questions, various factors were taken into account to ensure that they were formulated in the most suitable way possible so that the participants would understand them (Ringdal, 2018):

- Questions should not overestimate the participant's level of knowledge.
- Questions should not be leading.
- Questions should consist of clear and distinct language.
- Multidimensional questions should be avoided.

Traditionally, closed questions have dominated surveys, meaning that the question has a set of fixed answers (Ringdal, 2018). This also applied to our survey, where 35 out of 37 questions were closed. The majority of the closed questions were measured on an ordinal level based on the Likert scale, ranging from “Very low” to “Very high” (Ringdal, 2018).
To increase the likelihood of participants completing the survey, the order of the questions was emphasized. Questions that were "harmless" and "neutral" were asked first to motivate the participants to continue with the survey. The following questions were presented to address one topic at a time to avoid confusion (Ringdal, 2018).

With the survey draft completed, a pilot survey was conducted, as it is advised to test the survey to ensure that it is ready (Ringdal, 2018). The pilot survey was tested on a selection of acquaintances with different academic backgrounds. Optimally, the pilot survey should have been tested on a few firms from the population frame, however it was unlikely to get firms to participate and give feedback on the pilot survey. The feedback from the pilot survey was positive, with only a few remarks about some questions which later were reformulated. Finally, an informative text that was going to be sent along with the survey was created. It contained general information about the survey such as the purpose, what it would ask about, anonymity, and estimated completion time. The informative text was the final step before the survey was ready to be sent to the selection.

3.4.5 Drawing the selection

When drawing the selection, it must be well thought out to ensure that the study is representative. As all objects are unique, all parts of the spectrum must be covered. The population frame has already been set, as presented in chapter 3.4.3, and measures must be implemented to form a comprehensive picture within this frame. Two main selection methods can be distinguished: Probability selection and non-probability selection (Ringdal, 2018). A non-probability selection was not advantageous for this study since the method cannot lead to statistical generalization (Ringdal, 2018). Conversely, probability selection can and was therefore deemed as the preferred method. It is based on a selection process with a known probability of choosing a random object (Ringdal, 2018). Two different probability selection methods were considered.

Simple random sampling (SRS) is a probability method where n selections are drawn from the population frame N. Each object within the population frame, therefore, has the same probability of being selected (n/N) (Ringdal, 2018). The simple random sampling method is widely used as it creates a representative selection in most cases. Any selection that deviates from the population when using SRS is due to coincidences (Ringdal, 2018).

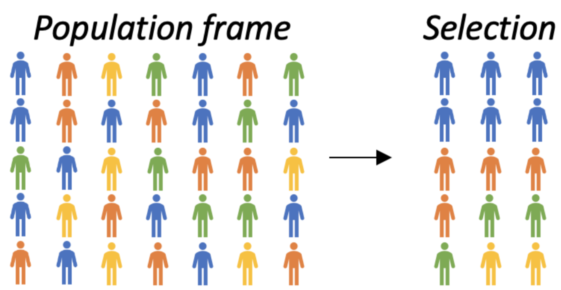

Figure 8: Simple random sampling

Another well-established probability selection method is stratified sampling. Stratified sampling can be viewed as a development of SRS, which ensures greater representation of the population frame. When the population frame is established, it is then divided into subcategories (strata) depending on the purpose of the study. The selection is then made from the strata, either proportionally or disproportionate. The difference between proportional and disproportionate selection is that the former is based on the selection's size being proportional to the strata's size in the population frame. On the other hand, the disproportionate selection is if each strata, for example, is represented equally despite not being the same size within the population frame (Ringdal, 2018).

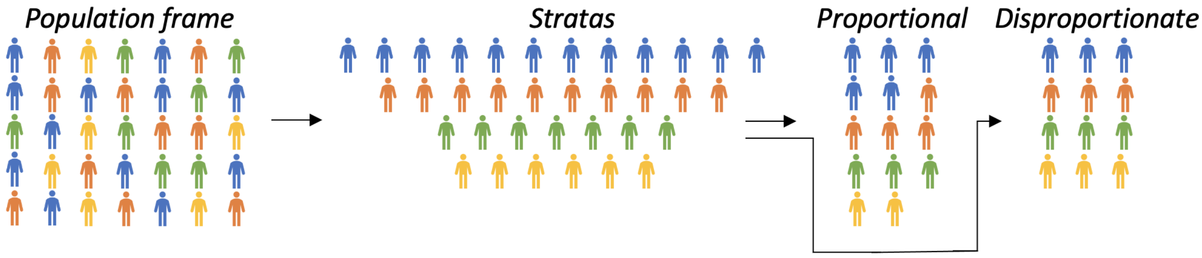

Figure 9: Stratified sampling

Simple random sampling was seen as the most appropriate method of choice. A stratified sampling method is commonly used to ensure that small groups within a population frame is not excluded, thus it was not seen as necessary to use this method. There are no small groups within this study's population frame, only four big, divided between the four industries. The population frame consisted of 6 749 firms, as explained in chapter 3.4.3. Capacity and time constraints were considered when deciding how many objects within the population frame should be contacted. As each firm selected had to be sent a personal email with the link to the survey, a selection of 600 firms (8,9% of the population frame) was seen as the highest number of firms we would have the capacity and time to contact. From the population frame, 600 firms were randomly chosen, making the probability for any given firm within the population frame to be chosen 600/6 749 (*n/N*).

3.4.6 Fieldwork

The step "fieldwork" marks the end of the theoretical planning of the survey and the beginning of the work of distributing the survey and gathering data (Ringdal, 2018). Firstly, the survey had to be delivered by email to the selection consisting of 600 firms. Therefore, it was necessary to identify each firm's email address. As "proff.no" did not have the email to each firm registered, they had to be identified manually by visiting each firm's website.

With all the email addresses collected, the delivery of the survey could start. However, as mentioned in chapter 3.4.2, one of the downsides of using email was that we had little control over whether the emails would end up in the recipient's inbox or spam folder. If it ended up in the spam folder, we saw it as very unlikely that they would answer the survey. For that reason, some research was conducted on how we could avoid our emails ending up in the recipient's spam folder. The conclusion was that there are no specific methods to guarantee avoidance, however there were some measures that could reduce the probability (Sander, 2019):

- Avoid words associated with spam or virus (free, discount, save).
- Avoid the use of big letters and exclamation marks.
- Avoid sending links.
- Avoid using a new email address to send the emails.
- Avoid sending all the emails simultaneously.

Each of these measures was implemented to the best of our ability. However, for instance, links had to be included in the emails as it was the only way to give the selection access to the survey. The emails were then sent to the selection. After 14 days, 50 answers were registered, which constituted a response rate of 8,3 percent.

A reminder was sent to the selection to increase the response rate, asking the firms who had not answered the survey if they could do so. Before sending out a reminder to the selection, potential advantages and disadvantages were discussed. Whereas a reminder could result in a greater response rate, it could also result in one or more firms answering the survey two times. Because the survey was anonymous, there was no way of identifying who already had answered it, therefore a reminder had to be delivered to the whole selection. The choice of sending a reminder was made as it was believed that the possible benefits from obtaining a greater response rate were higher than the potential downside of some firms answering twice. To reduce the possibility of firms answering two times, it was stated in the email that firms who had already answered the survey could disregard the email. Eighteen days after the survey was first delivered, 71 responses were registered, resulting in a response rate of 12 percent.

3.4.7 Coding and editing

Usually, after data has been gathered it has to be coded and edited before it can be analysed (Ringdal, 2018). But by using EasyQuest for our survey, the answers could be downloaded from the site into an Excel file ready for analysis. Although EasyQuest prepared the data, it was essential to quality assure it. During the review of the Excel file, some errors were discovered. Two of the questions had one of their answer alternatives wrongly referred to. Both measured a variable at interval level, however one of the interval levels used in the survey was assigned a random number in the Excel file. These two errors were changed back to their correct interval levels.

3.5 Quantitative data analysis

Analysis of the collected data is an important part of the study as concluding remarks about the research question is based upon said data. IBM SPSS Statistics (SPSS) is one of the most used computer programs for analysing quantitative data, and was therefore the program used during this analysis (Ringdal, 2018).

The first step in analysing the data is to choose variables and prepare them. As this study uses the results from the surveys, also known as primary data, the variables had to be clarified in advance of the data gathering (Ringdal, 2018). The choice of variables was therefore made in the early stages of the design of the survey, as presented in chapter 3.4.4. The analysis process of the survey is explained in more detail in chapter 4.

3.6 Research ethics and quality

3.6.1 Research ethics

The doctrine of morality, that is, of what is right and wrong, is what ethics is about. Research ethics is thus the fundamental moral standard of scientific practice. According to sociologist Robert Merton, research is, to a great extent, governed by informal norms that affect all researchers to a greater or lesser extent (Ringdal, 2018). Merton & Storer (1973) - cited in Ringdal (2018) - noted the following informal norms, also referred to as CUDOS: *Communalism*, *universalism, disinterestedness, originality,* and *skepticism.*

Communalism refers to the principle that research results belong to mankind and thus should be openly published in order to share it with everyone. Research should be appraised by established criteria independently of the researcher's age, gender, reputation, position or nationality, which is what *universalism* is all about. *Disinterestedness* refers to the notion that the researcher should not consider the interests of parties in the execution and publication of research results. Furthermore, the researcher should not be influenced by his or her own views, or by favouritism, in regard to explanations of the phenomenon being studied. It is essential in research that researchers possess *originality*, meaning that the scientific work that the researcher provides should be innovative and increase people's knowledge. *Skepticism* means that one should challenge all beliefs in authorities, moreover that researchers should in principle go through studies done by other researchers with a critical premise. It is crucial that the research community is self-critical in regard to the creation of new knowledge and making the science cumulative (Merton & Storer, 1973; Ringdal, 2018).

Providing research ethical guidelines that promote responsible and good research are the main assignments of the National research Ethics committee for Social science and law, Humanities and theology (NESH). There are six categories in which guidelines are presented under (Ringdal, 2018; NESH, 2021):

1. Research, society and ethics
2. Consideration of people
3. Consideration of institutions and groups
4. The research society
5. Commissioned research
6. Research dissemination

However, in regard to our study, only categories 1, 2, 4 and 6 are relevant and will be discussed further.

3.6.1.1 Research, society, and ethics

National research Ethics committee for Social science and law, Humanities and theology (2021) states that any researcher must follow reputable research ethical norms. This duty includes for instance that any researcher must reflect and account for how his or her own views and values can influence the choice of theme, interpretations and data sources.

During the work on this thesis, there have been continuous efforts on our part to consistently reflect and account for how our views and values might influence certain choices made during the research. As mentioned in chapter 3.1, we believe that it is impossible for researchers to be completely objective independent observers. Additionally, it was also mentioned in chapter 3.1, that our epistemological view is consistent with critical rationalism, in which we as researchers gain knowledge through reason and our ability to be critical of both our own and others' perceptions. Therefore, we have throughout the conduct of this thesis been aware that we as researchers have influential powers.

3.6.1.2 Consideration of people

The main point within this category is that researchers must conduct their research on the basis of fundamental respect for human dignity, including for instance that certain specific requirements are set for the research process. These requirements are set in order to protect the people who partake in the research from harm and ensure privacy, and furthermore ensure their freedom and self-determination (Ringdal, 2018; NESH, 2021).

The golden rule is that the informed and free consent of participants is required in research projects that involve people. This means that researchers should not put pressure on the participants, furthermore, that rejection does not lead to negative sanctions. It is required that research participants are given sufficient enough information about the purpose of the research project, the type of information that is to be gathered, who has access to the collected information, what the intended use of the results are, and lastly what the consequences of participating in the research project are. All this information is to be provided to the participants in a neutral and understandable way. Additionally, the participants also need to be informed that participation is voluntary. Active consent is commonly given through the signing of a statement of consent, however in large population- or questionnaire-surveys it is common practice to not require active consent (Ringdal, 2018; NESH, 2021).

As mentioned in chapter 3.4.4, in this research project a self-completion survey was sent out to 600 companies via email. In these emails we made sure to provide sufficient enough information about our research project. It was also made clear in the emails that the survey is completely anonymous and that no questions that makes it possible to identify the company would be asked, ensuring that the companies' privacy and safety is protected. The emails were written in such a manner that it was understandable that it is voluntary to participate in the survey.

3.6.1.3 The research society

A prerequisite for verifiability is that all researchers follow good referral practice, this also provides the foundation for further research. Good referral practice involves for instance to provide accurate references to sources that have been used, including references to own publications. An important notion within this theme is plagiarism, which is unacceptable and a serious violation of reputable research norms. Plagiarism occurs for instance when a researcher publishes the results of others as their own, or when there is a lack of documentation of sources (Ringdal, 2018; NESH, 2021).

During this research project, we have made sure that all sources that have been used have been referred to and documented, and that no direct depreciation of other researchers' work has been made (with the exception of quotations). This master thesis is built upon the preliminary project we conducted in 2021, therefore we believe it is not necessary to continuously reference it and that we should rather reference to the sources used in the preliminary project.

3.6.1.4 Research dissemination

The responsibility of conveying scientific results, views and working methods to the society, lies on researchers and research institutions. The dissemination takes place in the form of a dialog between research and society, where researchers have a responsibility to promote a good and educated discussion culture with respect for critical thinking and factual argumentation. Researchers can share theories, hypotheses and preliminary findings with the society during the course of a project, however the preliminary results are not to be presented as final results. Scientific uncertainty and academic limitations should be communicated clearly by researchers, this is so that the public can more easily assess whether other conclusions could be made through other or supplementary professional perspectives (NESH, 2021).

In order for researchers from different disciplines and other participants in the exchange to be able to take a stand on claims and arguments, it is essential that researchers articulate themselves with clarity. Researchers should be objective, meaning that they should avoid tendentious representations and stick to the case. Dissenters should not be given erroneous views, and renderings of the contributions of others should not be distorted (NESH, 2021). This is consistent with the norm of disinterestedness, which states that researchers should not be influenced by their own views or favouritism (Ringdal, 2018).

In this thesis, findings have not been presented as final results but as preliminary results as it should. Additionally, we have made sure that our limitations and uncertainty have been communicated with clarity. We have not distorted the contributions of others, conversely, we have tried to render the contributions as accurately as possible. Similarly, dissenters have not been given erroneous views since we have tried to stay as objective as possible.

3.6.2 Research quality

Methodological quality is a well debated term that includes several different perspectives on what quality is and how to accomplish it when conducting research (Savin-Baden & Major, 2013). Although there are different perspectives on what the term quality entails, reliability and validity are recognized as key parts of the term.

3.6.2.1 Reliability

The concept of reliability refers to how reliable the data that has been collected is. Reliability is generally defined as the degree of correspondence between different collections of data regarding the same phenomenon based upon the same research design (Grønmo, 2004). In chapters 3.1 to 3.5, the research process has been thoroughly described and arguments regarding our methodological choices were made. This way, readers of the thesis are able to evaluate the execution of the research process, step-by-step (Isaksen & Kasin, 2020). According to Ringdal (2018), there are three ways to assess the reliability of the data: General source criticism, the test-retest technique and internal consistency.

The method of general source criticism refers to researchers having to familiarize themselves with available materials that are used in the study. This means that the researchers should know how the available materials were collected and how relevant questions are formulated, in order to detect possible sources of error (Ringdal, 2018; Isaksen & Kasin, 2020). We saw it necessary to accumulate some prior knowledge about innovation, technological regimes and evolutionary theory before we started our thesis. Furthermore, it was essential for us to acquire knowledge and insight of which factors that have previously been shown to be of importance in regards to firms' innovation activities. These factors were presented in chapters 2.5, 2.6 and 2.7.

In our thesis, we have taken inspiration from previous research on innovation, technological regimes and evolutionary theory, for the preparation of our own questionnaire. We thoroughly went through how the materials used in our study, from previous research, was collected. Furthermore, we went through how various relevant questions asked in previous research were formulated, and then we made adjustments to make it fit the context of our thesis. In the end, we were left with the final questions that would be put in the questionnaire. The questionnaires were sent to relevant firms from industries with various innovation activity levels, which indicates that the questionnaire was answered by the right objectives.

The test-retest technique is, as mentioned, another general way of assessing the reliability of data. This technique can be used for all types of purposes and refers to the measurement of the degree of correlation or correspondence between two repeated measurements of the same variable (Ringdal, 2018; Isaksen & Kasin, 2020). As mentioned in chapter 3.3.2, we chose a simple-cross-sectional research design with a survey completed at just one time period. Therefore, we did not perform two repeated measurements of the same variable. This choice was partially done due to the study's time limit being short, which resulted in the opportunity to repeat measurements and resend the questionnaire being diminished. If we had resent the questionnaire it would not have been reasonable to expect the respondents to answer the same form at such short time intervals. Nevertheless, we conducted a pilot survey, as mentioned in chapter 3.4.4, before we sent the final questionnaire to the firms. The main objective of the pilot survey was to ensure that the questionnaire was systematic and easy for the respondents to understand.

The third and final way of assessing the reliability of the data is limited to cross-sectional data. The purpose of this approach is to measure the internal consistency between indicators that are to be included in an index (Carmines & Zeller, 1979; Ringdal, 2018). The statistical reliability coefficient Cronbach's Alpha, which is a size ranging from 0 to 1, will be used to measure the internal consistency. If alpha has a high value, preferably above 0.7, the index has satisfactory reliability. The more correlations there are between indicators, and the stronger they are, the higher the value of reliability measured with Cronbach's Alpha is (Ringdal, 2018; Tufte, 2018; Isaksen & Kasin, 2020). In chapter 4.1.5, the reliability of the data will be measured with the use of Cronbach's Alpha.

A weakness one should be aware of with the use of Cronbach's Alpha is its positive relation to the number of variables. The more variables there are, even with equal intercorrelation, the higher the value of reliability. Meaning, one must interpret Cronbach's alpha in a cautious way, especially when it comes to factors with many associated variables (Hair, Black, Babin & Anderson, 2014: Isaksen & Kasin, 2020).

Furthermore, we are two students collaborating on this research project, in other words there have been more than one researcher involved in the project. This means that there have been an exchange of useful thoughts and opinions, and a close cooperation during the whole research process. This has contributed to various crucial decisions and good assessments. The study is thus based on different perspectives and views, which further leads to the study's reliability being strengthened. However, it is not sufficient enough that the survey possesses reliable data. The research question cannot be answered in a satisfactory way if the collected data does not measure the phenomenon that is being studied (Holme & Solvang, 1996; Isaksen & Kasin, 2020). This leads to the notion of validity, which is the second quality measure for the thesis.

3.6.2.2 Validity

Perhaps the most important standard within the term quality is validity. Validity is an indication on whether the researcher has measured what was intended to be measured or not, and is thereby an indication on how truthful the research results are (Savin-Baden & Major, 2013). The indicator is often exemplified by picturing hitting the bullseye when shooting. If you hit the bullseye, you hit what you aimed for and therefore have a high validity, and vice versa. Validity is therefore important to consider when both reading or conducting research.

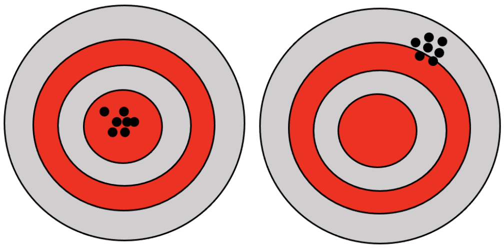

Figure 10: Illustration of validity

The terms construct validity and content validity has been emphasized throughout the survey to ensure a truthful research result. A high construct validity dictates that the theoretical term that was intended to be measured was measured (Ringdal, 2018). Therefore, it was essential that we possessed broad knowledge of the theoretical terms we intended to measure before creating the survey. During the preliminary project and the creation of this thesis´s theoretical framework, a deep understanding of the theoretical terms was achieved, preparing us to create questions which we were sure would have high construct validity. High construct validity was further secured by conducting the pilot-survey, where feedback was given on how the questions were understood by the participants. Although some research has high construct validity, it is not certain that it has high content validity. Content validity dictates if the different aspects within the theoretical terms are measured or not, thus high content validity covers all important aspects of the term (Ringdal, 2018). To ensure a high content validity, different questions which measure different aspects of the theoretical terms were asked.

4 Analysis

In the theoretical framework, factors that influenced companies' innovation activities were presented. These factors were based on innovation theory, evolutionary theory and technological regime theory. In this chapter, analysis of the data collected from the survey will be presented for the purpose of answering the research question. The analysis is therefore based around the factors from the theoretical framework. Using the analysis program SPSS, quantitative analyses methods have been conducted.

This chapter is structured in such a way that the preparation of the dataset is first conducted, before descriptive statistics are presented, to get an overview of important properties of the data. The analysis chapter then ends with cluster analyses. In this chapter, the analyses themselves will only be presented. There will therefore be no comments about the results of the analysis, as this will be conducted in chapter 5.

4.1 Preparation of the dataset

Before any analysis of the gathered data could begin, an examination of the dataset had to be conducted. This is because it enables the researcher to gain essential insights into the characteristics of the data, and control that it fulfils the requirements set for conducting an analysis. A better understanding of the data and the relationship between the variables is also obtained (Hair, Black, Babin & Anderson, 2019). In the preparation of the dataset, errors, missing data, outliers, and reliability were emphasized.

4.1.1 Errors

The first step conducted in the process of preparing the dataset for analysis was to look for errors in the Excel-file downloaded from EasyQuest, which resulted in two errors being discovered. In question three, one of the answer alternatives was stated wrong. Each respondent that had answered question three with the interval “1 - 15” was stated as 44576 in the Excel-file. The same error also occurred in question four, where any respondent that answered with the interval “11 - 50” was stated as 18568. Despite these two errors that were fixed, no more errors were detected.

4.1.2 Converting the dataset from String to Numeric

Before any analysis of the dataset was conducted in SPSS, the variables had to be converted from string to numeric. As each answer in the survey was text-based and not number-based, SPSS could not perform analyses as it only operates with numbers. By performing an automatic recode in SPSS, each text-based answer alternative was given a number that represented that answer.

Value Labels:

Value	Label
1	Very low
2	Low
3	Medium
4	High
5	Very high

Table 6: Value Labels

4.1.3 Missing Data

Missing data occurs when values on one, or several, variables cannot be analysed due to there being insufficient data value for the variables. (Hair et al., 2019). As missing data can reduce the sample size intended to be analysed, and thereby affecting the generalizability of the results, any research should address the potential problem of missing data. Since most of our survey had mandatory questions which had to be answered to deliver a response, just a small amount of missing data at construct-level (missing value of an entire construct of interest (Hair et al., 2019)) was discovered.

Only two questions contained missing data, and these two were the only questions which were not mandatory. Question 20 had 73,2% missing data and question 33 had 74,6%, which was rather high. Before any measures could be implemented, it had to be determined if the missing data could be ignored or not. Hair et al. (2019) states that the missing data must occur randomly for it to be ignored. Since our missing data did not appear to be random, it could not be ignored, and measures had to be implemented. Because of the extent of missing data in the two variables, it was concluded that they had to be deleted. This was justified by the high percentage of missing data that the two variables contained, and any results based on those two variables would not be in accordance with good research practice.

Statistics

		QR20	QR33
N	Valid	19	18

Table 7: Missing data

4.1.4 Outliers

"*Outliers…are observations with a unique combination of characteristics identifiable as distinctly different from what is normal"* (Hair et al., 2019: 85). When researchers seek to present a representative result, any observation that contains extreme values is usually unwanted as it can affect the result in a negative way. However, even though an observation contains extreme values and is classified as an outlier, it can also be beneficial for the analysis. Whether an outlier is considered beneficial or harmful depends on the context in which it occurs (Hair et al., 2019). The identification and categorization of outliers is therefore an important process when conducting analysis, it ensures that harmful outliers are excluded and that beneficial outliers are included.

A pre-analysis was utilized in the process of identifying outliers in our dataset. This is because we wanted to identify the objects which stood out from the population, and not on the basis of which objects that the analysis did not perform well on (Hair et al., 2019). By utilizing SPSS, a univariate detection of outliers was performed. A threshold value of 2,5 was implemented as the dataset contained less than 80 observations (Hair et al., 2019). In total, 54 outliers were detected.

Each observation that contained one to two outliers was included as we thought they would contribute towards the result and generalizability. Five observations contained between three to four outliers, which resulted in 8,6 - 11,4% of their variables being categorized as outliers. Despite the high percentage of outliers, the decision was to include them as well. This is because the context each outliner appeared in were natural and therefore would be beneficial for the result. However, one observation contained seven outliers, which constituted 20% of the response. These outliers did not appear to be natural in the context of where they appeared, and the percentage-level was also too high to be ignored. As a result of this, one observation was eliminated from the dataset.

4.1.5 Reliability

A reliability test was conducted in SPSS, based on Cronbach's alpha, to determine whether or not the factors derived in our study are reliable. The holistic value of Cronbach's alpha for all the factors are presented in table 8. Furthermore, in table 9, the values of what Cronbach's alpha would be if a particular variable was deleted from the scale are presented. Based on those values, an evaluation of elimination of variables was made.

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.890	.890	35

Table 8: Cronbach´s Alpha

As mentioned in chapter 3.6.2.1, a value of 0.7 and above is deemed as satisfactorily (Ringdal, 2018; Tufte, 2018; Isaksen & Kasin, 2020). Table 8 shows that the holistic value of Cronbach's Alpha is 0.890, thus the value is above the requirement and satisfactory. This means that the factors are consistent in what they are meant to measure. In chapter 3.6.2.1, it was mentioned that a weakness with the use of Cronbach's Alpha is the positive relation it has to the number of variables (Hair et al., 2014; Isaksen & Kasin, 2020). We have made the decision to only test the reliability of the variables as a whole, instead of testing for each factor group. Our questionnaire consists of only 35 questions after the elimination of two questions, therefore there would be very few variables within each factor group. This would thus affect the values negatively due to the relation Cronbach's Alpha has with the number of variables. Therefore, we considered it more appropriate to measure it holistically.

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
What age is the company?	110.06	225.939	.086	.	.895
How many employees does the company have?	110.67	221.238	.199	.	.893
To what extent does the company have a hierarchical governance system?	110.59	227.493	.120	.	.891
To what extent does the company insist on repetitive and structured work tasks?	109.94	232.142	-.066	.	.894
To what extent does the company have the will and ability to convert profits into tangible capital (eg money, machinery, equipment, fixtures, etc.)?	109.63	232.846	-.091	.	.895
To what extent is the company locked in and dependent on a limited range of technological options?	110.33	233.934	-.134	.	.895
To what extent does the company copy competitors' innovations?	110.54	232.020	-.061	.	.894

Table 9: Cronbach´s Alpha if item deleted

An evaluation was also conducted in regards to whether or not certain variables should be deleted to increase the value of Cronbach's Alpha. There were seven variables out of the total 35 that would increase the Alpha value if deleted, which is presented in table 9. However, these increases were marginal with an increase value between 0.001-0.005. The high original value and the minimal increases exclusion would entail, led us to consider it unnecessary to conduct the exclusions.

4.2 Descriptive statistics

The purpose of descriptive statistics is to describe the characteristics of a dataset by using numbers and visualizations in the form of diagrams and graphs. Datasets can often contain overwhelming amounts of numbers; therefore it is important to conduct descriptive analysis to better understand the features of the dataset (Hayes, 2022).

4.2.1 The selection

The survey's selection was presented in 3.4.5, and consisted of firms operating within one of the four industries: F/F, B&C, A&C, and R&D. In total, 71 out of the 600 firms contacted participated in the survey, resulting in a response rate of 11,8%. Out of the 71 respondents, 13 (18,3%) were from the industry of B&C, 17 (23,9%) from A&C, 18 (25,4%) from R&D, and 23 (32,4%) from F/F. The respondents' characteristics (industry, age, number of employees and turnover) are presented in table 10.

Variable		Number	Percent
Industry			
	Building and construction	13	18,3%
	Accommodation and catering	17	23,9%
	Research & development	18	25,4%
	Forestry/fishing	23	32,4%
Age			
	0 - 10	9	12,7%
	11 - 20	23	34,4%
	21 - 30	11	15,5%
	31 - 40	16	22,5%
	41 or more	12	16,9%
Employees			
	1 - 15	28	39,4%
	16 - 30	12	16,9%
	31 - 60	16	22,5%
	61 100	8	11,3%
	101 or more	7	9,9%
Turnover (mil NOK)			
	0 - 10	11	15,5%
	11 - 50	34	47,9%
	51 - 100	10	14,1%
	101 - 300	12	16,9%
	301 or more	4	5,6%

Table 10: Descriptive statistics

4.2.2 Analysis of the factors influencing firms' innovation activities

Throughout the theoretical framework, several factors that influence firms' innovation activities have been presented. It can be distinguished between factors in regards to general innovation theory, evolutionary theory and technological regime theory. Analysis of factors related to the general innovation theory will not be presented here, this is due to the two other theories being the main focus of this thesis. It is therefore considered appropriate to divide this chapter according to the two main theories and then analyse the factors that belong to each theory. The following analysis will present each individual answer, or the average values (mean), of each industry within the various variables. The values presented represent the answers from the survey (1 = Very low, 2 = Low, 3 = Medium, 4 = High, 5= Very high).

4.2.2.1 Evolutionary theory

The notion of recent evolutionary theory revolves around companies building up unique capabilities and resources, and thus having different approaches to innovation. Furthermore, this is what results in the companies developing distinct types of innovations. As presented in chapter 2.6, there are several different factors that lead to companies having heterogenous innovation activities. The following figures (11 to 19) illustrate how factors linked to the evolutionary theory are perceived by firms operating within each industry. In the following figures (11 to 19) R&D = red, A&C = blue, F/F = yellow and B&C = green.

4.2.2.1.1 Knowledge accumulation process

Firstly, the two questions *"To what extent does the company use research and development to increase competence?"* (figure 11*)* and *"To what extent does the company use internal or external interactions to develop the company's competence?"* (figure 12), refers to the two perspectives mentioned in chapter 2.6: STI and DUI. These two questions were asked in order to analyse how the companies accumulate knowledge.

Following, in figure 11 the spread of responses within each of the industries are illustrated. The companies within the R&D industry have to a large extent given responses with a high value, with only two companies out of the 18 giving a value below "High." Another industry where companies have given mostly high value responses was the F/F industry with ten companies out of the total 22 gave an answer with a value below "High"; thus, there is a slight more spread in the answers here. The A&C and B&C industries have the most spread in their answers, ranging from "Very low" to "High" ("Very high" for B&C).

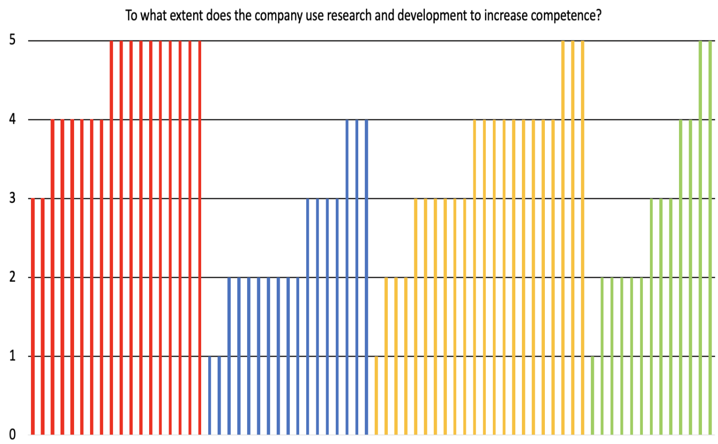

Figure 11: Knowledge accumulation process 1

In figure 12, one can see that in the R&D industry, 14 companies out of the total 18 gave responses with the value of «High" to "Very high," whereas the remaining four companies gave responses with the value "Medium." For the remaining three industries, the most common answer was "Medium." The industry of F/F was the only industry with all values represented in the responses, whereas A&C and B&C only had responses ranging from "Low" to "Very high."

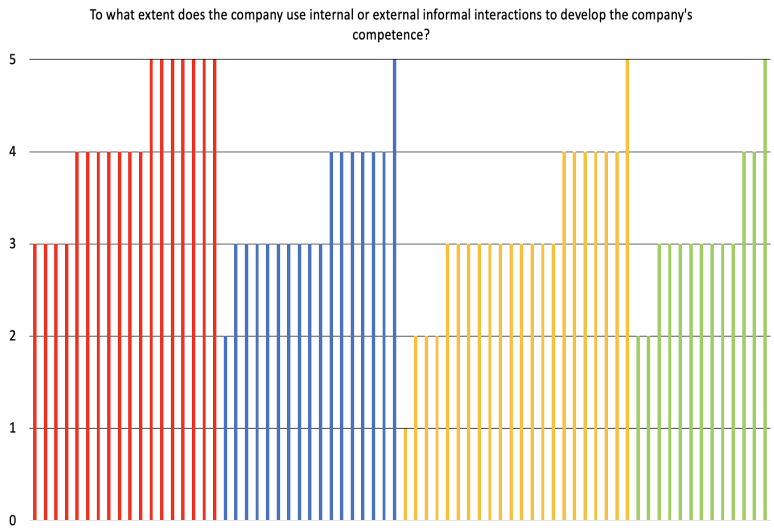

Figure 12: Knowledge accumulation process 2

4.2.2.1.2 Firm competitive performance

As mentioned in chapter 2.6, firm performance is an essential element in evolutionary theory. In relation to firm performance there were four questions asked, which are illustrated in tables 13 to 16. Although three dimensions of firm performance were mentioned in chapter 2.6, the four questions are only linked to the dimension of "*Fitness*." This is because the two other dimensions are covered in other parts of the questionnaire. These four questions were asked to analyse not only companies' capacity to invest in tangible and intangible capital, but also their willingness and ability to convert profits into tangible and intangible capital.

In figure 13, one can see that the most common response within the industries A&C, F/F and B&C was “High.” Within the industry A&C, the remaining responses were mainly “Medium”, with the exception of one response with “Very high.” The remaining responses within the F/F industry varied between “Very low” to “Very high.” Within the B&C industry, the remaining responses varied between “Low” to “Very high.” The most common response within the R&D industry was “Medium”, while the rest of the responses varied between “Low” to “High.”

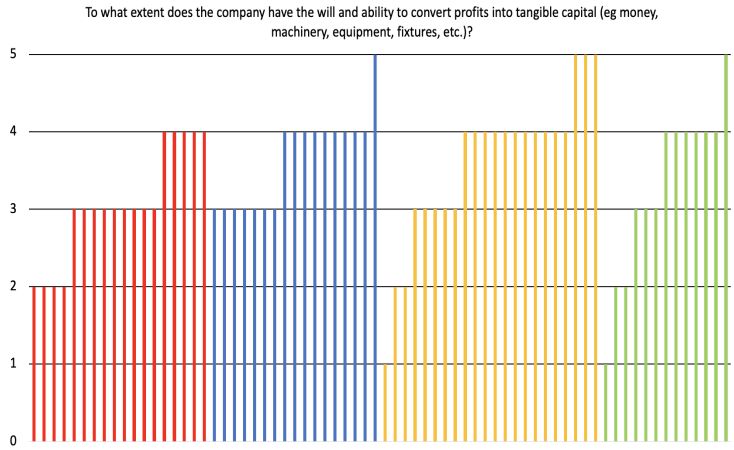

Figure 13: Firm competitive performance 1

In figure 14, it is visible that the most common response within the industries A&C, F/F and B&C was “Medium.” The remaining responses within the A&C industry varied between “Low” to “High.” The same applied to the F/F industry, with the exception of one response with the value ”Very low.” The remaining responses within the B&C industry varoed between “Low” to “Very high.” The most common response within the R&D industry was “High”, while the remaining responses varied between “Low” to “Very high.”

Figure 14: Firm competitive performance 2

On the one hand, figure 15 shows that the most common response within the industries R&D and A&C was "Medium." The remaining responses within the R&D industry varied between «Low" to "Very high." Within the A&C industry, the remaining responses varied between "Very low" to "Very high."

On the other hand, figure 15 shows that the most common response within the industries F/F and B&C was "High." The remaining responses within the F/F industry varied between "Low" to "Very high." Within the B&C industry, the remaining responses varied between "Very low" to "Medium."

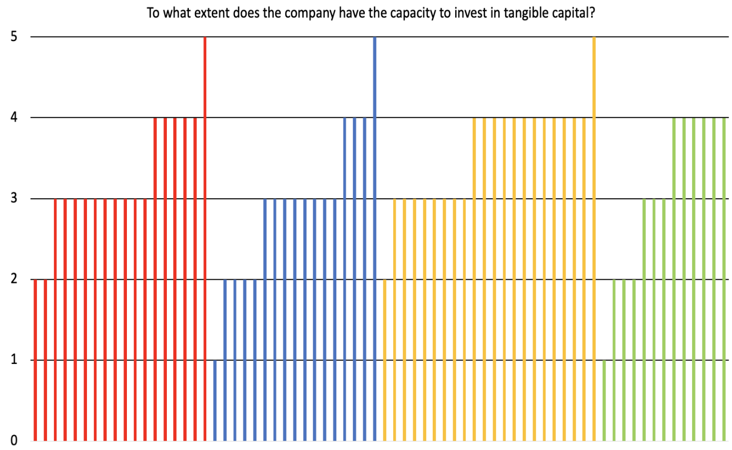

Figure 15: Firm competitive performance 3

In figure 16, one can see that the most common response within all the industries is «Medium." The remaining responses within the R&D industry varied between "Very low", "High" and "Very high." Within the A&C industry, the remaining responses varied between "Very low" to "Very high." Both for the industry of F/F and B&C, the remaining responses varied between "Low" to "Very high."

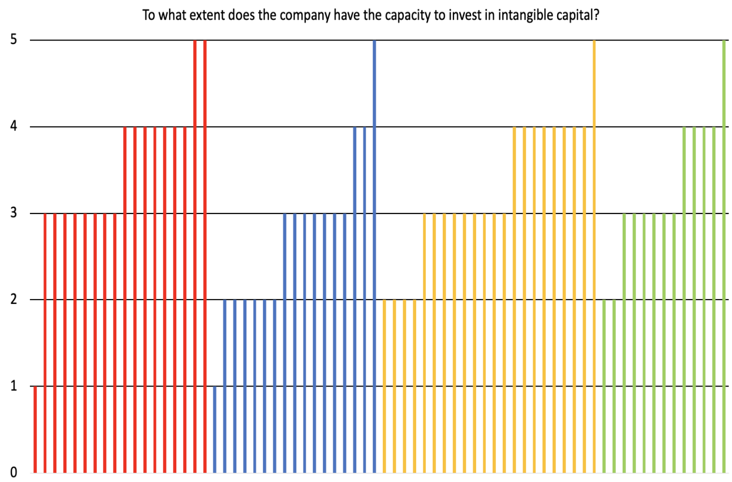

Figure 16: Firm competitive performance 4

4.2.2.1.3 Learning methods

In chapter 2.6, it was mentioned that products, processes and technologies tend to follow trajectories with repetitive use of fixed sets of learning methods. Thus, heterogeneity can arise due to companies learning and developing abilities differently. Therefore, the question *"To what extent does the company follow a repetitive systematic process when products, processes or technologies are developed?"* was asked in order to analyse the company's learning methods.

In figure 17, it is visible that the most common response within all of the four industries was "Medium." In the industries of R&D, A&C and B&C the remaining responses varied between "Low" to "High." On the other hand, the remaining responses within the F/F industry varied between "Very low" to "High."

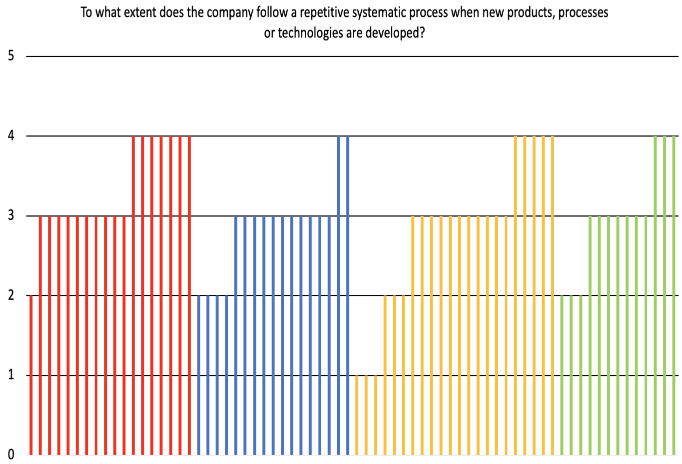

Figure 17: Learning methods

4.2.2.1.4 Perceptions

The question referred to within this chapter is linked to chapter 2.6.1 regarding perceptions. In order to analyse whether or not the management's perception of problems and the implementation of problem-solving activities is affected by prevailing technological paradigms, the following question was asked: *"To what extent is the company locked in and dependent on a limited range of technological options?"*

In figure 18, one can see that there was a lot more evenly spread in the responses within the R&D than the other industries. Meanwhile, the most common response within the three other industries was "Medium." Within the industries A&C and B&C the remaining responses varied between "Low" to "High." The remaining

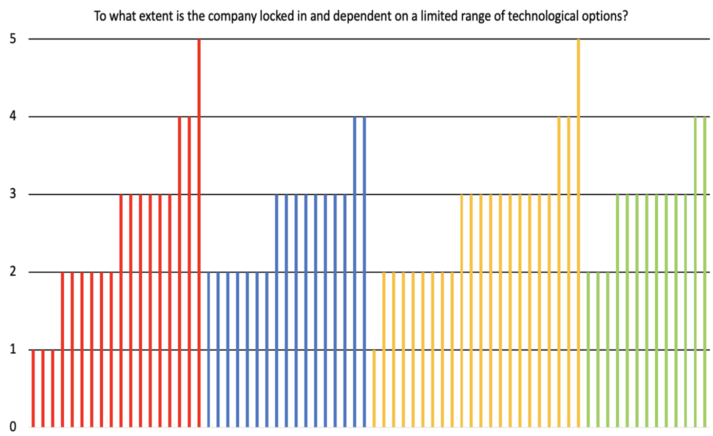

Figure 18: Perceptions

responses within the F/F industry varied between the values «Very low" to "Very high."

4.2.2.1.5 Resources and capabilities

As mentioned in chapter 2.6, the recent evolutionary theory perspective revolves around the notion of companies building up unique resources and capabilities and having different approaches to innovation. These factors lead companies to develop distinct types of innovation. Therefore, the question *"To what extent does the company possess unique resources and capabilities compared to companies in the same industry?"* was asked in order to analyse the company's resources and capabilities.

In figure 19, one can see that the two industries A&C and F/F both had "High" as the most common response. Within the A&C industry the remaining answers varied between "Low" and "Medium." The remaining responses within the F/F industry varied between "Low" to "Very high." The most common response within the R&D industry was "Very high", while the remaining responses varied between "Medium" to "High." Within the B&C industry the most common response was "Medium", with the remaining responses varying between the values "Low" to "Very high."

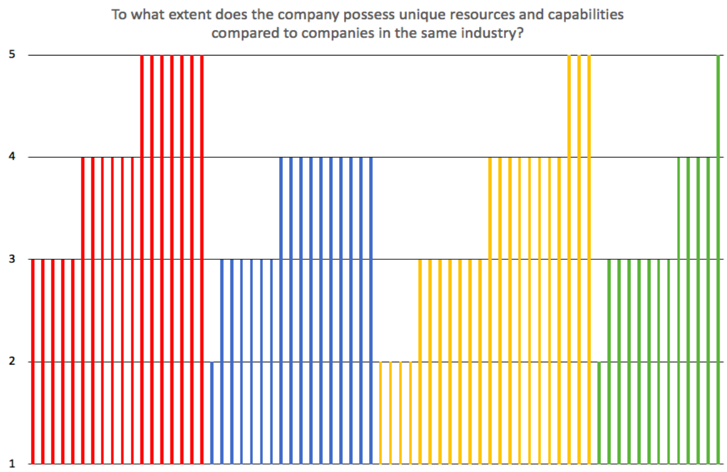

Figure 19: Resources and capabilities

4.2.2.2 Technological regime

As presented in chapter 2.7, the notion of technological regime is that each individual industry has a unique structure of innovative conditions. These innovative conditions influence firms' innovation activities as it leads to an industry either having an innovation pattern that corresponds to creative destruction or creative accumulation. To investigate the notion of technological regimes, each of the four factors that constitutes the technological regime has been measured in different dimensions. The following figures (20 to 31) illustrates how the factors of each industry's technological regime is perceived by the firms operating within that industry.

4.2.2.2.1 Technological opportunity

Figure 20 illustrates the perceived technological opportunity, throughout the question: "*To what extent will the company's innovation activities lead to financial results?*" The industry of A&C, and B&C had a mean value of 3.3. Forestry and fishing had a higher value of 3.6, whereas R&D obtained a mean value of 4.2.

Figure 21 illustrates the perceived pervasiveness of technological opportunity, measured by the question: "*To what extent does new uncovered knowledge have a wide range of uses?*" All the four industries had rather similar mean values, with respectively 3.2 for A&C, 3.3 for B&C, 3.4 for F/F and 3.5 for R&D.

Figures 22 and 23 illustrates the effort and resources allocated to innovation activities, measured by the question "*To what extent is time set aside for innovation activities?*" and "*To what extent does the company invest in research and development?*" Research and development were the highest scoring industry with a mean level of 3.8 and 4.3, followed by F/F with 2.9 on both, B&C with 2.6 on both and A&C with 2.5 and 2.1.

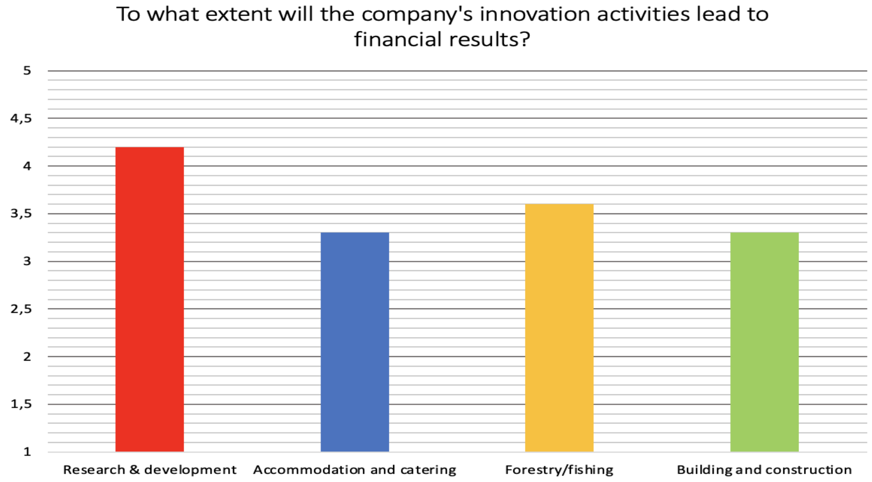

Figure 20: Technological opportunity 1

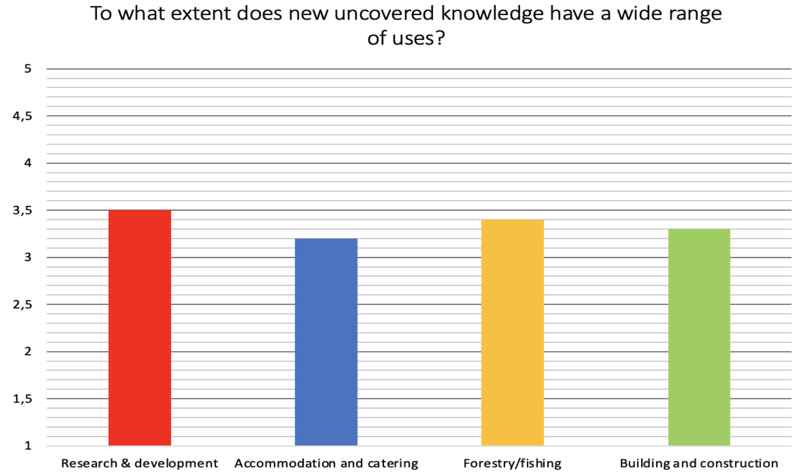

Figure 21: Technological opportunity 2

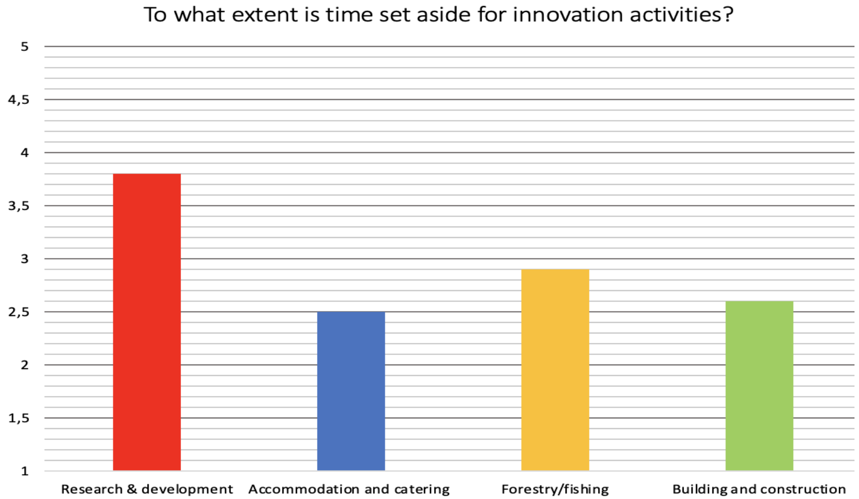

Figure 22: Technological opportunity 3

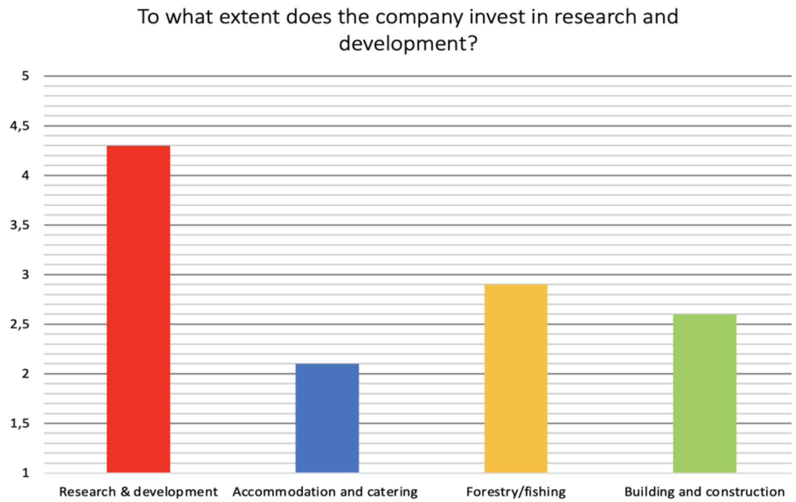

Figure 23: Technological opportunity 4

4.2.2.2.2 Appropriability of innovation

Figure 24 illustrates the level of appropriability of innovation, measured with the question: "*To what extent can the company's innovations be protected from being copied by competitors?*" Building and construction had the lowest mean value, with a score of 2.2. Forestry/fishing has a mean value of 2.5, whilst A&C scores a mean value of 2.7. Research & development is the highest scoring with a mean value of 2.9.

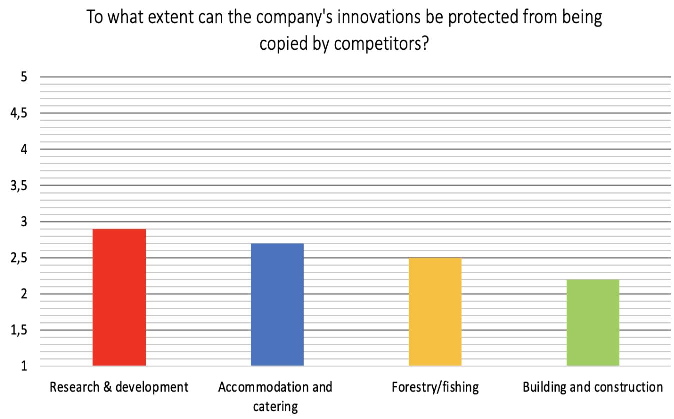

Figure 24: Appropriability of innovation 1

Figure 25 illustrates the degree firms copy other firms' innovations, measured through the question: "*To what extent does the company copy competitors' innovations?*" Research and development had the lowest mean value of 2.0, followed by F/F (2.6) and B&C (2.6). Accommodation and catering had the highest mean value of 2.8.

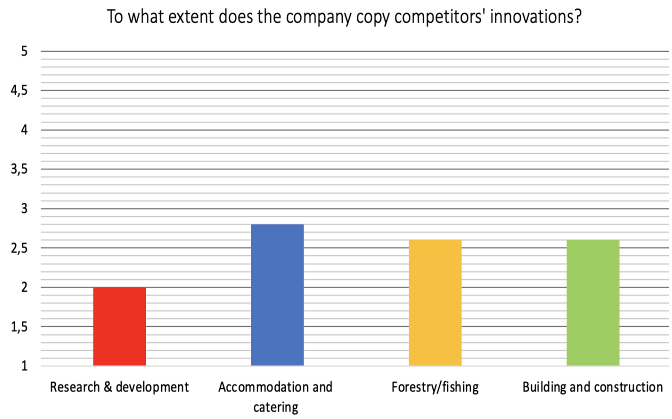

Figure 25: Appropriability of innovation 2

Figure 26 also illustrates the level of appropriability of innovation, measured with the question: "*To what extent can the company's innovation activities be protected from being copied by competitors?*" Building and construction had the lowest mean value (2.4), followed by F/F (2.5) and A&C (2.8). Research & development had the highest mean value (3.0).

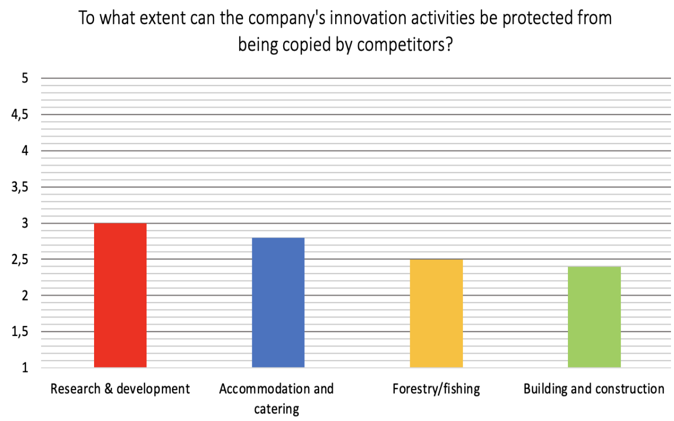

Figure 26: Appropriability of innovation 3

4.2.2.2.3 Cumulativeness of technological knowledge

Figure 27 illustrates the cumulativeness of technological knowledge, measured through the question: "*To what extent is the company's knowledge from previous innovations important for developing new innovations?*" Research and development was the highest scoring industry with a mean value of 4.2. Forestry and fishing had a mean value of 3.7, followed by A&C (3.5). Building and construction was the lowest scoring with a mean value of 3.3.

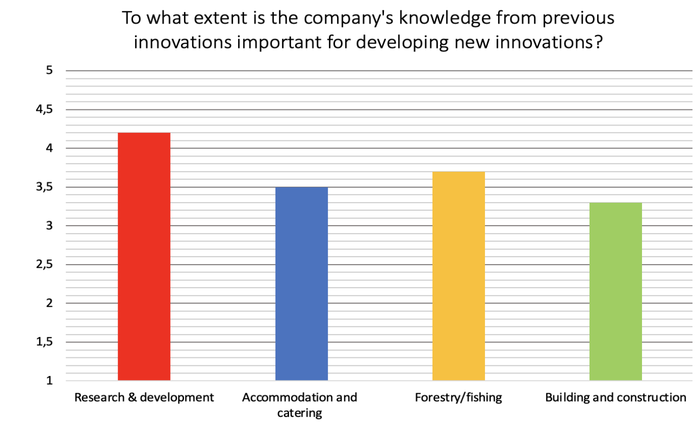

Figure 27: Cumulativeness of technological knowledge

4.2.2.2.4 Knowledge base

Figure 28 illustrates to what degree each industry relates to knowledge of a general nature, measured through the question: "*To what extent does the company relate to knowledge of a general nature?*" Research and development had the highest mean level, scoring 4.0. Accommodation and catering had a mean value of 3.7, followed by F/F (3.6) and B&C (3.5).

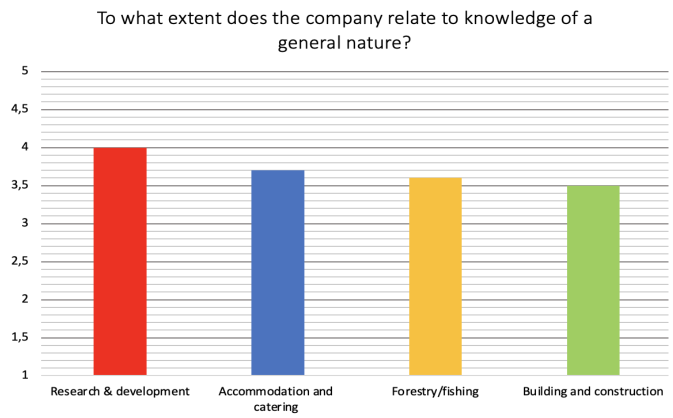

Figure 28: Knowledge base 1

Figure 29 measures to what degree each industry relates to knowledge of specific nature, through the question: "*To what extent does the company relate to knowledge of a specific nature?*" Research and development scored 4.4, both F/F and B&C scored 3.9, whilst A&C scored 3.5.

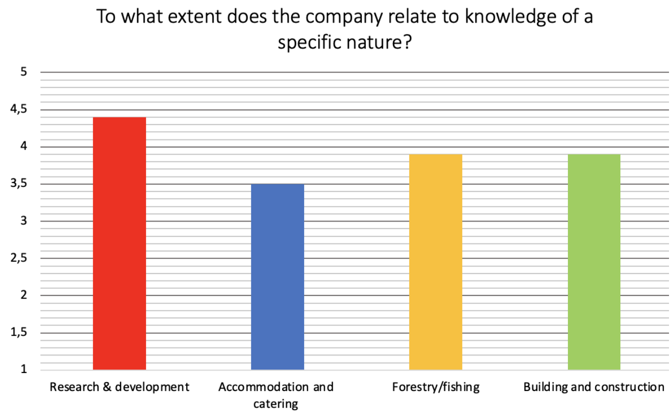

Figure 29: Knowledge base 2

4.2.2.2.5 Mark I and II

Figure 30 illustrates the firm's perceived view on the extent their industry consists of innovative companies. This is measured through the question: "*To what extent does the industry consist of innovative companies?*" Research and development were the highest scoring industry with a mean value of 3.5. Forestry and fishing were the second highest scoring industry with a mean value of 3.3. Both A&C and B&C scored rather low on this measurement, with mean values of 2.8 and 2.2.

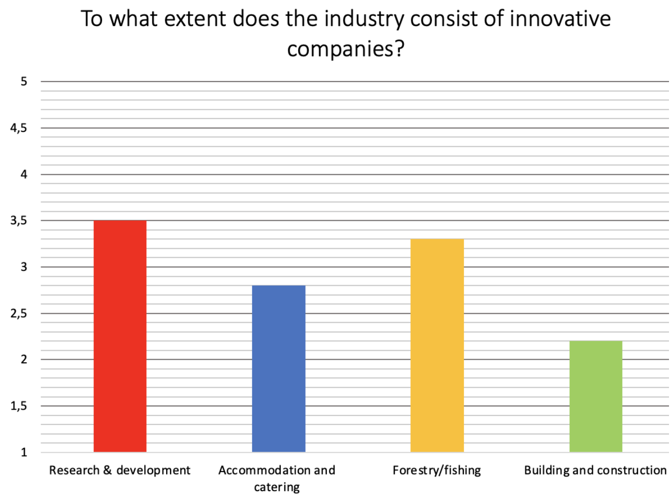

Figure 30: Mark I and II (1)

Figure 31 illustrates the perceptions of the firms on the degree new innovative firms enter their industry. This is measured through the question: "*To what extent do new innovative companies enter the industry?*" Building and construction was the lowest scoring industry, with a mean value of 2.4. Research and development were the second lowest scoring industry with a mean value of 2.8. Both accommodation and catering and F/F scored a mean value of 3.1.

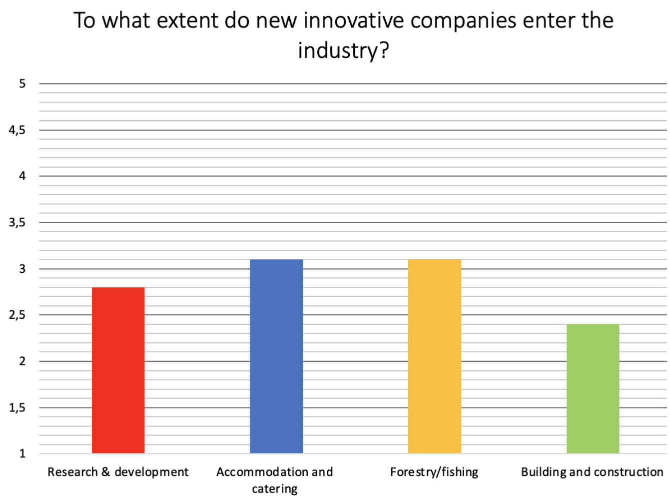

Figure 31: Mark I and II (2)

4.3 Cluster Analysis

Cluster analysis is a type of analysis technique with the purpose of creating groups (clusters) in which the objects of the data set are placed into based on their characteristics. Since each object within the same cluster has a similar set of characteristics, each cluster should therefore possess high internal homogeneity and high external heterogeneity (Hair et al. 2019). The reasoning behind utilizing cluster analysis was to analyse whether firms from the same industry would be placed in the same cluster, or if the clusters would consist of a mix of firms from different industries. The cluster analysis was therefore divided into two parts: One in relation to technological regime, and one in relation to evolutionary theory. The type of cluster analysis that will be utilized is a K-means cluster analysis.

Because of how cluster analysis works, the number of clusters has to be decided by us in advance. As this thesis focuses on four industries, it was decided that there should be four clusters, potentially one cluster for each industry. However, it was also seen as potentially beneficial to conduct an analysis of two clusters, therefore these will also be included.

4.3.1 Cluster analysis - Evolutionary theory

The cluster analysis performed in relation to the evolutionary theory concerns the variables measuring firm heterogeneity. Two illustrations of the clusters will be presented.
The first illustrates the values of the variables that are characteristic for each cluster, while the second illustrates the percentage distribution of each industry between the clusters.

Figure 32 illustrates which values of the nine questions, asked in relation to evolutionary theory, are characteristic to the different clusters. Cluster one consists of firms with mostly variables scoring from "Medium" to "High". There are however some exceptions with variables scoring between "Medium" and "Low". Cluster two consists of firms with variables scoring both high and low values, whereas cluster three consists of firms with mostly "Low" values on all variables. Cluster four however, consists of firms with high values on almost all variables, with the exception of one variable.

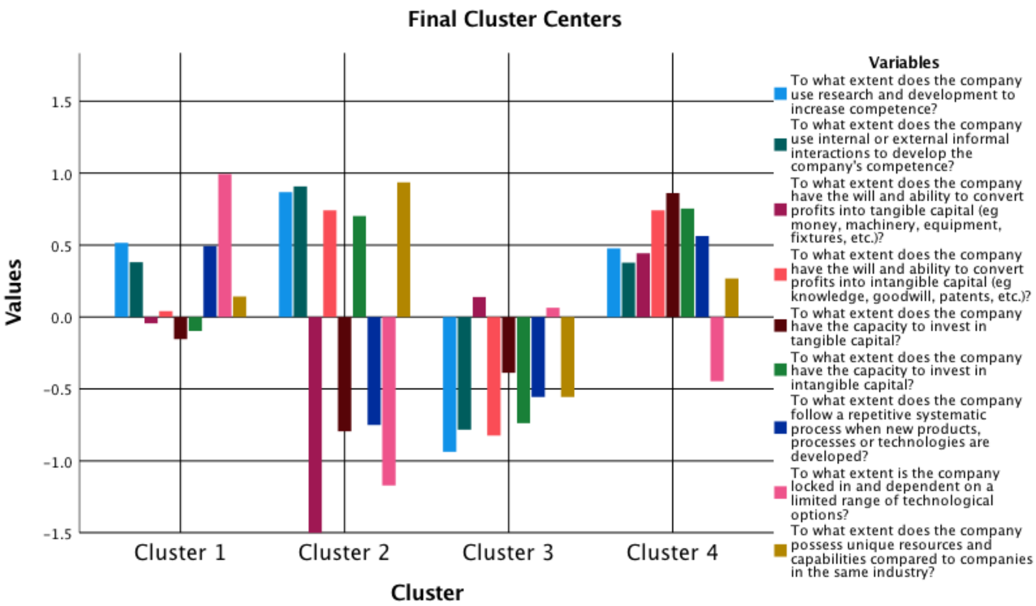

Figure 32: Cluster Centers with 4 clusters - Evolutionary theory

The percentage of how large of a part of the industries can be found within the different clusters is shown in figure 33. Cluster one consists of a mix of all four industries, however R&D and B&C are most dominant, with 39 and 38% of the industries located in this cluster. Accommodation and catering, and F/F have rather low percentages in cluster one with only 12 and 9%. Cluster two contains no firms from the A&C industry, only 17% of R&D, 14% of F/F and 8% of B&C. Within the third cluster it is evident that the A&C industry is the dominant one with 59%.

However, both F/F and B&C also have a large percentage in this cluster with 36 and 46%, while R&D only has 11%. Within cluster four, the dominant industry is F/F with 41%. Research and development and A&C are not far behind with 33 and 29%, however B&C only has 8% of its firms within cluster four.

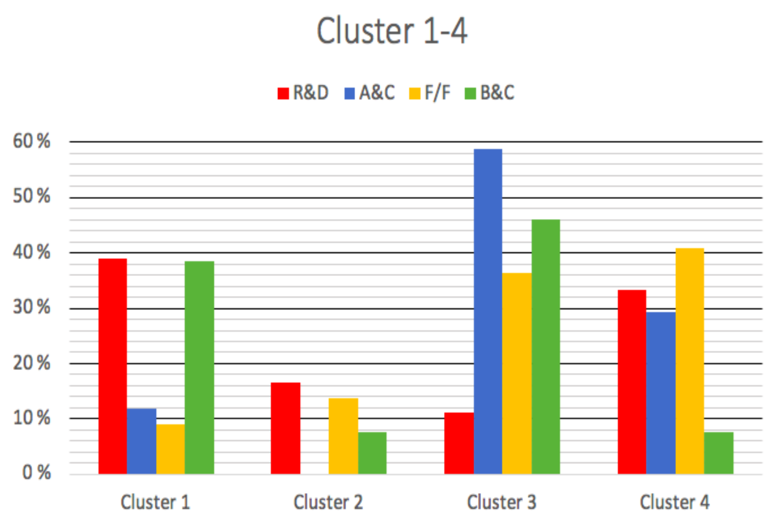

Figure 33: Cluster analysis with 4 clusters - Evolutionary theory

Since we saw it as potentially beneficial to conduct a cluster analysis with two clusters in addition to four, the following figures will illustrate a cluster analysis with two clusters.

Illustrated in figure 34 is the two different clusters and what type of responses that are characteristic of each cluster. There is a clear distinction of characteristics between the two clusters with cluster 1 being characterized by answers ranging from “Medium” to “Very low”, and cluster 2 being characterized by answers ranging from “Medium” to “Very High”. Furthermore, the same two questions can be seen differentiating from the rest of the answers in both clusters. These are questions regarding the will and ability to transform profits into tangible capital, and “lock-in” and dependency on a limited range of technological options.

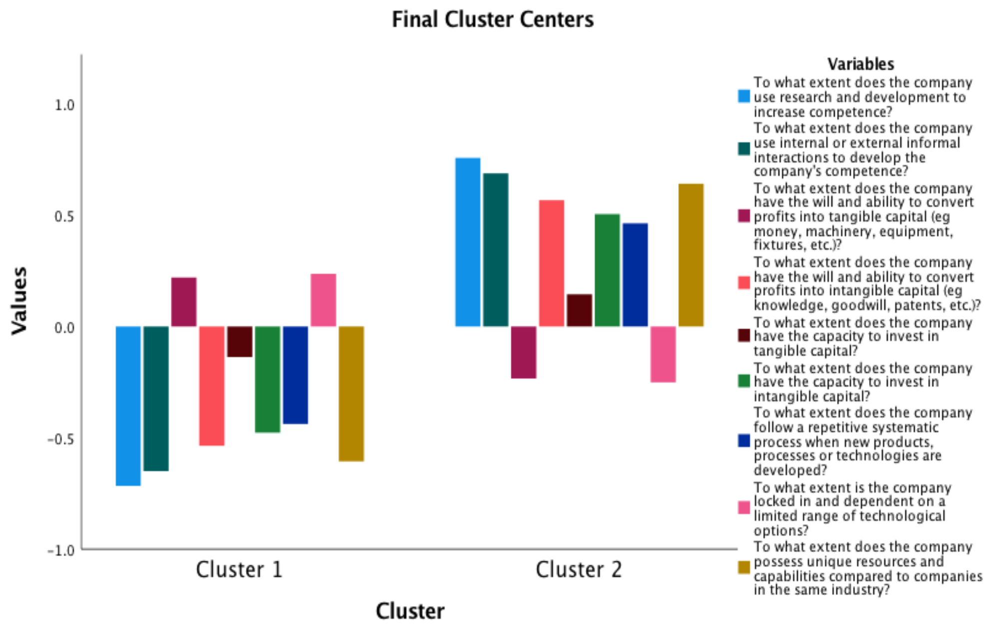

Figure 34: Cluster Centers with 2 clusters - Evolutionary theory

In figure 35, the four industries are placed into two clusters, in which both clusters contain all four industries to different degrees. The industries A&C, F/F and B&C is evidently dominant in the first cluster with the respective percentages of 76, 55 and 69. There is only a small percentage of the R&D industry represented in the first cluster. However, in the second cluster the R&D industry is visibly the dominant one with 89%. The F/F industry is only represented 10% less in the second cluster, whereas A&C and B&C is represented to a much lesser extent compared to the first cluster.

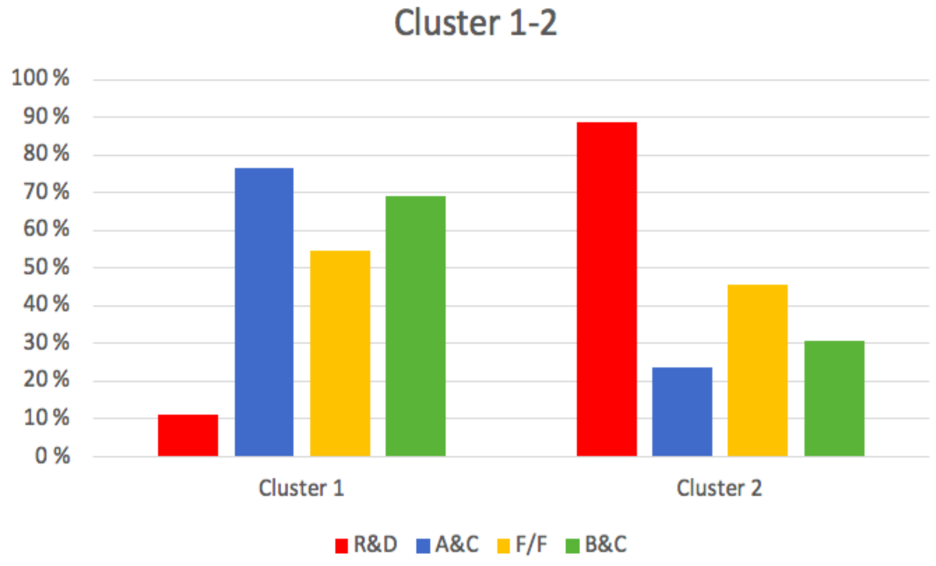

Figure 35: Cluster analysis with 2 clusters - Evolutionary theory

4.3.2 Cluster analysis - Technological regime

This cluster analysis that focuses on the notion of technological regime is based on the questions (variables) in the survey that measured each industry's technological regime. Each cluster created will therefore be based on the firm's responses on those variables.

Figure 36 illustrates the four different clusters, and what variables that are characteristic for that cluster. Cluster one consists of firms with variables between “Medium” and “High”. Cluster two consists of firms with very high variables, but at the same time also scores very low on the variable *“To what extent does the company copy competitors´ innovations?”* Cluster three consists of firms with very low scoring variables. On the other hand, cluster four consists of firms with variables between “Medium” and “Low,” but also scores highly on the variable *”To what extent does the company copy competitors´ innovations.”*

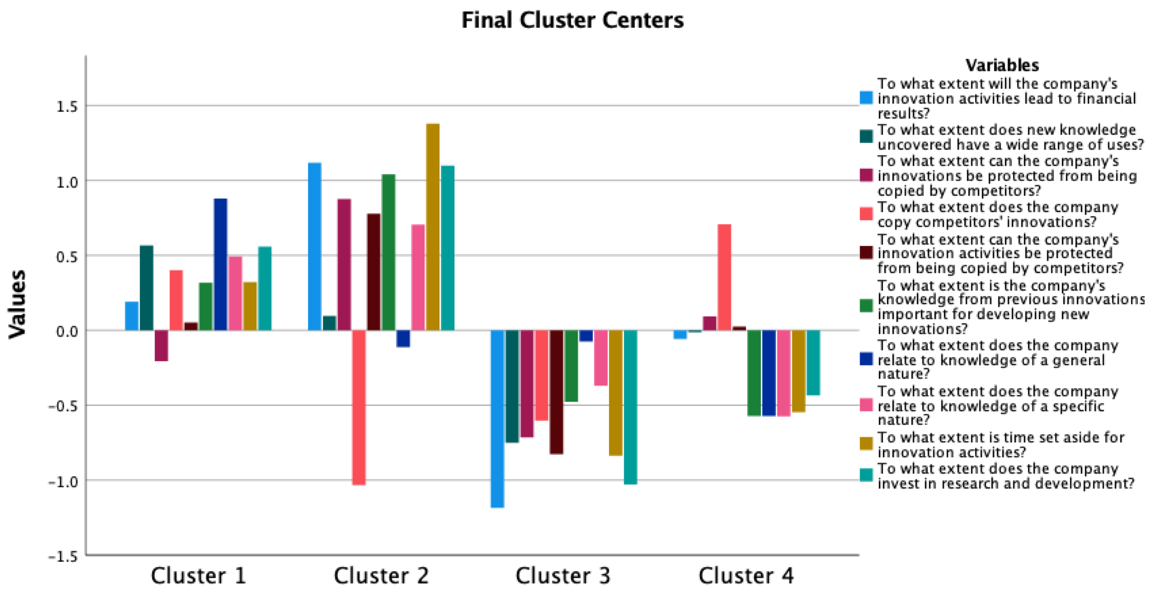

Figure 36: Cluster Center with 4 clusters - Technological regime

Figure 37 is an illustration on how large part of each industry is within the different clusters. Within cluster one, almost 40% of the whole R&D industry is located, whereas 50% is categorized in cluster two, and the remaining 11% in cluster four. In cluster three there are no firms from the industry of R&D. A rather modest percentage of the other industries are represented in these two clusters. Both cluster three and four are dominated by firms from the industries of A&C, F/F and B&C.

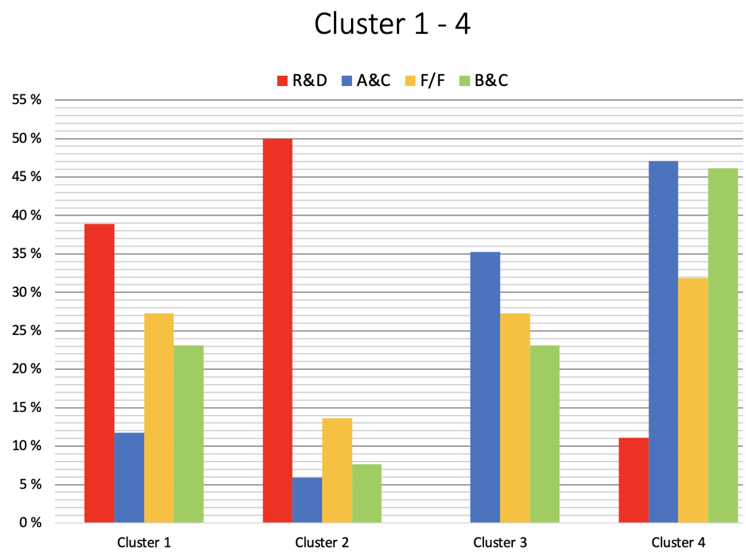

Figure 37: Cluster analysis with 4 clusters - Technological regime

Due to the classification of the four industries in the first cluster analysis, it was seen as potentially beneficial to conduct a cluster analysis with two clusters. The following figures illustrate a cluster analysis with two clusters.

Figure 38 illustrates the two different clusters and what type of response that are characteristic of each cluster. The difference in characteristics of the two clusters are rather visual as cluster one is characterized by firms with variables ranging from "Medium" to "Very high," whereas cluster two is characterized by firms with variables ranging from "Medium" to "Very low." In addition to this, each cluster's answer on the degree they copy competitors' innovations stands out from the rest of the answers.

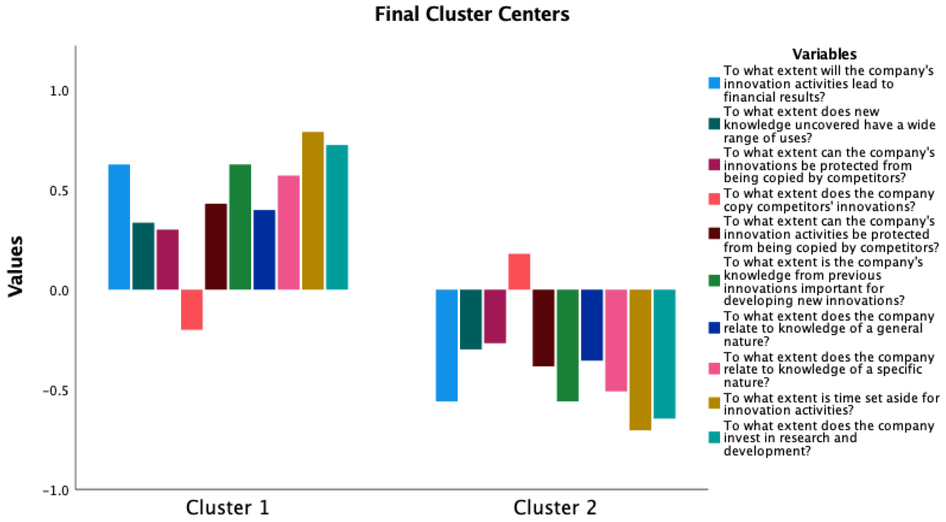

Figure 38: Cluster Centers with 2 clusters - Technological regime

Figure 39 is an illustration on how large part of each industry is within the different clusters. All the four industries are represented in the two different clusters; however, some are more dominant than others. Almost 90% of the R&D industry is represented in cluster one, with the remaining 10% in cluster two. Accommodation and catering and B&C are however highly represented in cluster two with about 80% of A&C and just under 70% of B&C. Forestry/fishing is spread between the two clusters, with 45% in cluster one and 55% in cluster two.

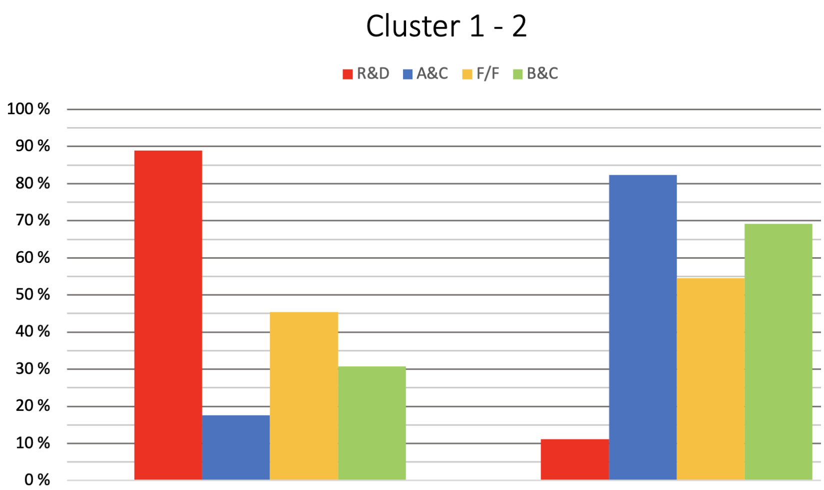

Figure 39: Cluster analysis with 2 clusters - Technological regime

5 Discussion

In this chapter, the results from the analysis in chapter 4 will be discussed together with the theoretical framework created in chapters 2.6 to 2.7. As the thesis emphasizes two theories, we saw it as most suitable to discuss evolutionary theory and technological theory separately. The discussion of the findings from the analysis of evolutionary theory and its theoretical framework will therefore first be presented, followed by technological regime theory.

5.1 The analysis of Evolutionary theory

In chapters 4.2.2.2 to 4.2.2.6, analyses were performed in regard to factors found to facilitate heterogeneity. The purpose of these analyses was first and foremost to see how the different industries respond in relation to the factors, and furthermore analyse whether or not companies within the same industry perceive the factors similarly. The cluster analysis, performed in chapter 4.4.1, will further build up under findings from chapters 4.2.2.1.1 to 4.2.2.1.5.

5.1.1 Knowledge accumulation process

Peters (2009) and Triguero & Córcoles (2013), as mentioned in chapter 2.6, argue that the reason for companies having different degrees of persistence in innovation activities is explained by a company's heterogeneity in the knowledge accumulation process. Jensen et al. (2007) emphasized company's heterogeneity concerning innovation and innovation activities, furthermore, they presented two different approaches in relation to innovation and innovation activities: STI and DUI. By analysing the two questions mentioned in chapter 4.2.2.1.1, one can see to what extent each of the companies use the two approaches. Moreover, whether companies within the same industry accumulate knowledge heterogeneously or homogeneously.

The first question that was asked in relation to the process of knowledge accumulation was: *"To what extent does the company use research and development to increase competence?"* This question refers to the STI approach where companies use formal research and development processes to produce explicit and codified knowledge (Jensen et al., 2007). As one can see in figure 11, the only industry where companies responded somewhat similarly is the R&D industry. It is not surprising that this industry contains high value responses due to the fact that the industry is based on research and development. There are only two companies that have given a value below “High”, and therefore it may indicate that the knowledge accumulation process within the R&D industry is more on the homogenous side in regard to the STI approach.

However, the three remaining industries can be seen in figure 11 to have more varied responses. The A&C industry has responses that vary between the values “Very low” to “High”, with the value “Low” being the most common. This means that the A&C industry to a lower degree uses the STI approach when accumulating knowledge. The spread in answers in the A&C industry may indicate that companies’ knowledge accumulation processes are more on the heterogeneous side when it comes to the STI approach. Within the F/F industry the responses vary between the values “Very low” to “Very high”, with the most common value being “High”. Thus, the STI approach is to a high degree used within the industry. However, the spread of responses may indicate that the knowledge accumulation process of the companies is more on the heterogeneous side in regard to the STI approach. The B&C industry also has responses that vary between the values “Very low” to “Very high”, however here the most common response was “Low”. The use of the STI approach within this industry is thus below average. Similar to the A&C and F/F industries, the spread in responses within the B&C industry indicates that the companies have heterogeneous knowledge accumulation processes in regard to the STI approach.

The second question asked in relation to knowledge accumulation was *“To what extent does the company use internal or external informal interactions to develop the company’s competence?”* This question refers to the DUI approach which emphasizes a company’s competence development from internal and external informal interactions (Jensen et al., 2007). In figure 12, it is visible that there is less spread in responses within the industries than it was in regard to the STI approach. Fourteen out of the total 18 companies within the R&D industry gave responses with the value “High” or “Very high”, with the remaining four companies responding with the value “Medium.” This means that companies within this industry to a high degree also use the DUI approach when accumulating knowledge. Due to the spread of responses being between such high values, it may indicate that the industry is more on the homogenous side in regard to the DUI approach.

In figure 12, one can also see that the most common response within the three remaining industries was “Medium,” meaning that there is an average use of the DUI approach. Within the A&C industry, the remaining responses have the value “High” with the exception of one firm responding with value “Low” and another with the value “Very high”. The minimal spread in responses may indicate that the industry is more on the homogeneous side when it comes to the DUI approach. The remaining responses within F/F varied from “Very low” to “Very high”, thus there is a little more spread to be found within this industry. Due to this spread one may argue that the knowledge accumulation processes within this industry is more on the heterogeneous side in relation to the DUI approach as well. Similar to the A&C industry, the remaining responses within the B&C industry vary between the values “Low,” “High” and “Very high.” However, because there are so few companies found to respond differently than the rest it could indicate that the industry is more on the homogeneous side in regard to the DUI approach.

5.1.2 Firm competitive performance

Le Bas & Latham (2004) emphasized the importance of firm performance in evolutionary theory and presented Metcalfe & Gibbons (1986) three dimensions of firm competitive performance; *Efficiency, Fitness and Creativity*. The three dimensions of firm competitive performance mentioned are consistent with three capacities; the capacity to generate a particular level of profitability, the capacity to invest in knowledge activities and new capital goods, and the capacity to develop new industrial and technological knowledge. The discussion regarding firm competitive performance will include findings found in chapters 4.2.2.2.1, 4.2.2.1.2 and appendix 9. These findings are included because elements found within the three dimensions can be found within both theories and the appendix, and thus will be included so a more informed discussion can be conducted.

Persistence in profitability above a specific level is a condition of persistence in innovation activity, hence firm persistence in innovation is linked with its profitability and growth (Le

Bas & Latham, 2004). Le Bas & Latham (2004) argue that firms inescapably differ from each other when it comes to the three dimensions of performance. Thus, based on this argument one should expect to see heterogeneity in the responses within the industries.

The question *"To what extent will the company's innovation activities lead to financial results?"* was analysed in chapter 4.3.1.2 in the form of mean values, however in this discussion the individual responses of each company is needed. Thus, findings from appendix 10 will be discussed here. This question measures the efficiency dimension which refers to a firm's ability to transform innovation into profit. In appendix 10, it is visible that the majority of responses within the R&D industry have high values, with only two responses giving the value "Medium." The marginal spread in responses indicates that the R&D industry's efficiency is more on the homogenous side. There is a little more spread in the responses within the A&C industry, in which the responses vary between the values "Low" to "Very high." Due to this spread one may argue that the industry's ability to transform innovation into profits is more on the heterogenous side. The most common response within the F/F industry was "Medium," however almost as many responded with value "High." Only three other companies answered differently, and thus it may indicate that the industry is more on the homogenous side due to the marginal spread. Similar to the A&C industry, there is slightly more spread within the B&C industry with values varying from "Low" to "Very high." This spread indicates that the B&C industry's efficiency is more heterogeneous.

Four questions were asked in relation to the fitness dimension regarding tangible and intangible capital. By analysing the figures 13 to 16, it becomes apparent that there is a fair amount of spread in the industries responses. The R&D industry can be seen responding with values varying between "Low" and "High" to the first question *"To what extent does the company have the will and ability to convert profits into tangible capital?"* The spread is significant enough to indicate that the R&D industry is more heterogeneous in regard to this question. Additionally, a significant spread can also be seen from the R&D industry in regard to the second question *"To what extent does the company have the will and ability to convert profits into intangible capital?"* Thus, indicating heterogeneity. However, the R&D industry responded to the two last questions regarding capacity to invest in tangible and intangible capital more consistently. The marginal spread found in relation to these two questions indicate that the R&D industry is more homogeneous when it comes to capacity to invest. It is difficult to classify whether the R&D industry's fitness as a whole is heterogeneous or homogeneous, because it is heterogeneous in relation to the first two questions and homogeneous to the two last.

The companies within the A&C industry can be seen in figure 13 responding quite similarly to the first question, indicating homogeneity in regard to will and ability to convert profits into tangible capital. However, the A&C industry has significant spread in responses when it comes to the three other questions, which indicates the industry's fitness as a whole to be heterogeneous. In figure 13, 14 and 16, the F/F industry can be observed having significant spread in responses. This indicates that the F/F industry is more heterogeneous in relation to the will and ability to convert profits into tangible and intangible capital, and the capacity to invest in intangible capital. The responses are more uniform in the F/F industry regarding the capacity to invest in tangible capital, indicating homogeneity. Overall, the F/F industry's fitness as a whole indicates heterogeneity. Lastly, the B&C industry can be observed having significant spread in responses in figures 13 and 15. This indicates that the B&C industry is more on the heterogenous side when it comes to tangible capital. The B&C industry responded to the remaining questions regarding intangible capital more consistently, which indicates homogeneity. Similarly to the R&D industry, it is difficult to determine whether the B&C industry's fitness as a whole is heterogeneous or homogeneous due to the split in indications.

Appendix 9 will be used to discuss the creativity dimension, which refers to the firm's ability to improve products and processes or to innovate (Metcalfe & Gibbons, 1986). By analysing appendix 9, it becomes evident that all industries except R&D have a significant spread in responses. Meaning that firms within the industries with a significant spread in responses, have varying levels of ability to innovate. Thus, one can argue that, in regard to creativity, R&D is homogeneous and the rest of the industries are heterogeneous.

5.1.3 Learning methods

Malerba & Pisano (2019) and Trushin & Ugur (2020) argued that products, processes and technologies tend to follow trajectories with repetitive use of fixed sets of learning methods. Heterogeneity can therefore arise due to companies learning and developing abilities differently.

It is observable in figure 17 that the majority of companies within the R&D industry have responded consistently. Therefore, it is fair to assume that the companies within the R&D industry to a similar extent follow a repetitive systematic process when new products, processes or technologies are developed. Thus, it is more likely that the companies within this industry learn and develop abilities similarly, indicating a homogeneous industry. The same applies to the A&C industry, where the spread is also found to be minimal. Conversely, significant spreads can be found within the F/F industry and B&C industry. Thus, one can assume that companies within these two industries learn and develop abilities more differently, indicating that they are heterogeneous.

5.1.4 Perceptions

The management's perception of problems triggers the implementation of seeking efforts, thus it is essential to understand the way problems are perceived in relation to search and innovation. Therefore, an effort has been made to understand if companies within the same industry perceive problems similarly (Clausen, 2013). According to the literature on technological regimes, the management's perception of problems and the implementation of problem-solving activities will be limited by the prevailing technological paradigm implanted in their industry. These limitations could result in "lock-in" and "path-dependence" to a restricted range of technological alternatives (Dosi, 1982; Clausen, 2013).

To better understand companies´ perception of problems it was deemed suitable to analyse whether or not the companies are limited to a restricted range of technological options. The recent evolutionary theory argues that firms have different cognitive skills and perceptions. If companies have different perceptions and mindsets, then different organizational learning processes will also be implemented, leading to heterogeneous search paths for innovation

(Dosi et al., 1997; Dosi & Marengo, 2007; Clausen, 2013). Therefore, if companies are not restricted it is more likely that they will perceive problems differently and thus conduct innovation activities heterogeneously.

In figure 18, it is visible that there is a large spread in responses within the R&D industry. The responses vary between all values, meaning that the industry contains different levels of “lock-in” and dependency on a limited range of technological options. The large spread in responses results in different perceptions of problems and thus different search paths for innovation. Additionally, most of the responses are from “Medium” and lower which means that the majority of the companies experience “lock-in” and dependency to a lower degree. Thus, since the companies are not restricted to a large degree, the different cognitive skills and perceptions within companies can shine more through. This could therefore result in different learning processes being implemented, which results in heterogeneous search paths for innovation. Overall, these findings indicate that the R&D industry is heterogeneous in regard to technological options.

Similar to the R&D industry, the F/F industry also has a significant spread in responses varying from “Very low” to “Very high.” The same arguments made for R&D being heterogeneous applies to the F/F industry as well. The industry of A&C have a marginal spread in responses where the majority of responses are valued “Medium.” Within the A&C industry almost as many have answered “Low” as “Medium,” therefore one could conclude that the level of “lock-in” and dependency within the industry is on the medium to lower side. This could thus indicate heterogeneity, because companies are more able to explore different innovation search paths. A marginal spread can also be found in the B&C industry, where the majority of companies have responded “Medium.” This means that most of the companies experience being locked in and dependent on a limited range of technological options to a moderate degree. It is thus difficult to classify whether the industry is more homogeneous or heterogeneous.

5.1.5 Resources and capabilities

Recent evolutionary theory emphasizes the notion that companies develop distinct types of innovations, resulting from them having unique capabilities and resources which leads to different approaches to innovation (Clausen, 2013). Thus, if an industry is characterized by companies with unique resources and capabilities one could assume that the companies develop different types of innovations. Similarly, if the industry is characterized by companies with common resources and capabilities one could assume that the companies develop similar types of innovations.

The R&D industry can be observed in figure 19 having a significant spread in responses. The responses vary between the values "Medium" to "Very high," where the majority of companies have to a larger extent unique resources and capabilities. The significant spread and the fact that the majority of the industry possess unique resources and capabilities indicates heterogeneity. The A&C industry has a marginal spread where the majority have responded "High," meaning that most of the companies possess unique resources and capabilities to a high degree. This could thus indicate that the industry is more on the heterogeneous side. The industries F/F and B&C have both significant spreads in responses. Therefore, one can assume that the companies within these industries have different types of innovations, indicating heterogeneity.

5.1.6 The clusters of evolutionary theory

Throughout this chapter, findings from the analyses conducted in chapters 4.2.2.1, 4.2.2.2.1 and appendix 9 – 10. The purpose of those discussions was to assess whether the industries are heterogeneous or homogeneous. After the discussion of those findings, several indicators have been identified in regard to which category the different industries belong to. The indications are that the industries R&D and A&C are homogeneous, and that the industries F/F and B&C are heterogeneous. These indicators can either be further confirmed by the cluster analyses or dismissed.

In chapter 4.4.1, a cluster analysis was performed on the variables related to evolutionary theory. This was conducted to analyse whether the industries would make up their own clusters or if the clusters would contain a mixture of industries. The clusters will be useful in the discussion of whether the industries are heterogeneous or homogeneous. If the clusters contain a mix of industries it could indicate that the industries are heterogenous, because the companies from different industries thus share similar characteristics. Similarly, if the industries have their own respective clusters it could indicate that their characteristics are unique, indicating that the industries are homogeneous.

It becomes apparent in the clusters, illustrated in figures 32 and 33, that the R&D industry to a large degree makes up the category for high value answers, while the A&C industry to a large degree makes up the category for low value answers. The B&C industry is represented in both high value and low value clusters, however it falls more into the low value category due to the larger representation in cluster 3. The F/F industry is nearly equally represented in both the high value category and low value category.

The second cluster analysis shown in figures 34 and 35 further confirms these categories. By analysing these two figures, it becomes evident that cluster one is characterized by low values and cluster two is characterized by high values. In figure 35, the R&D industry is only represented in cluster one with 11%, whereas the A&C industry is represented with 76%. On the other hand, the R&D industry is to a large degree represented in cluster two with 89%, whereas the A&C industry is represented with 24%. These results further confirm the indications of the industries R&D and A&C being homogeneous. This is because the high percentage of representation they have, in their separate clusters, indicate that companies within their respective industry to a large degree have similar characteristics.

In figure 35, the B&C industry is visibly more represented in cluster one with 69%, the remaining 31% is found in cluster two. Any percentage of representation close to 70 is viewed as an indicator of homogeneity due to it being such a high share of the population with similar characteristics. Therefore, the indication mentioned earlier regarding the B&C industry being heterogeneous can be dismissed.

Both clusters contain a fair amount of the F/F industry, where cluster one contains 55% and cluster two 45%. Because the percentage of representation is far below 70% in both clusters, we do not consider it to be an indicator towards homogeneity. Therefore, the indicator mentioned earlier regarding the F/F industry being heterogeneous is further confirmed.

5.2 The analysis of technological regime

The analysis of the factors that constitutes a technological regime had the goal of portraying how each industry was perceived by the firms operating within them. By investigating this, the industries could be classified as having a creative destruction- or accumulation pattern of innovation, which according to the theory would influence firms' innovation activities.

5.2.1 Technological opportunity

Peneder (2010) emphasized that when measuring the technological opportunity to not focus on the success rate of innovations within the industry. What is difficult is that there is no clear answer to what a successful innovation means. Some might argue that the first question measuring technological opportunity concerns the success rate of innovation activities, however we argue that it to a higher degree measures the incentives to conduct such activities. The second question measured the degree of pervasiveness, a dimension of technological opportunity introduced by Breschi & Malerba (1997). The third and fourth questions focuses on what Peneder (2010) described as the most correct way to measure the level of technological opportunity, which was to examine the efforts and resources used on innovation activities. Together, all four questions provide enough data to be able to have a discussion around each industry's technological opportunity.

Research and development are the highest scoring industry in each question, with mean values of 4.2 on the first question (figure 20), 3.5 on the second (figure 21), and 3.8 on the third (figure 22), and 4.3 on the fourth (figure 23). Question one indicates that there are incentives in the industry to conduct innovation activities. This perception is further strengthened by the industry's mean values on the third and fourth question. It is natural that in an industry with high incentives to perform innovation activities, that high amounts of effort and resources are invested into such activities.

Together, the data from those three questions points in the direction that the industry of R&D has high technological opportunities. However, question two is not as clear when it comes to whether the industry has high or low technological opportunities. With a mean value of 3.5, it is tough to interpret whether new knowledge has a broad or specific area of use. The mean value is not high enough that we comfortably can categorize the pervasiveness as high without looking further into the responses. Half of the respondents have either answered “High” or “Very high,” whereas only 11.1% has answered low. Since Breschi & Malerba (1997) only differentiate between high or low pervasiveness a choice must be taken. As exactly half of the respondents answered “High” or “Very high,” a low classification cannot be justified. The analysis of the second question is therefore thought to indicate a high pervasiveness, as new knowledge has a broad area of use. This further strengthens our view on the technological opportunities within the industry of R&D to be high.

For the remaining three industries it is more diffuse whether they have high or low technological opportunities. Accommodating and catering and B&C both have a mean value of 3.3 on the first question, indicating that the majority perceives the incentives to conduct innovation activities as medium. Forestry/fishing scores higher with 3.6, indicating the majority answered “High.” All three industries also have low mean values on the third and fourth question, ranging between 2.1 to 2.9. As discussed with R&D, if the industries perceive the incentives to conduct innovation activities as modest, limited effort and resources will be allocated to those activities. They also score lower than the industry of R&D when it comes to pervasiveness. As only between 30,8% to 40,9% of the respondents across the three industries have answered “High” or “Very high,” the majority of the answers are between “Low” and “Medium.” The pervasiveness of the industries is therefore seen as low, as the analysis indicates that newly discovered knowledge has to a low degree a broad area of use. Based on the analysis of question one to three, the industries of A&C, B&C and F/F have low technological opportunities.

5.2.2 Appropriability of innovation

All three questions regarding the industries appropriability of innovation had the purpose of measuring the level of appropriability. As stated by Breschi & Malerba (1997), levels of appropriability measures whether firms within an industry have the possibilities to protect their innovations or innovation activities from competing firms.

All industries score low mean values on all three questions, ranging from 2.2 to 3.0 (figures 24, 25 and 26). As question one and three asks to what degree the firms can protect their innovations and innovation activities from competing firms, they give a clear view that there is a lack of ways to protect their innovation and innovation activities from other firms. In the context of question one and three, the response to question two was quite surprising. Since there seems to be few measures across all the industries to protect innovations and innovation activities from other firms, it would be expected that firms tend to copy from other firms. It is therefore surprising that the mean value of all the four industries on this question is between 2.0 and 2.8, which indicates little copying of other firms' innovations and innovation activities. The low mean values can potentially be explained by the questions being formulated as: "to what extent does the company" instead of "to what extent could the company." As there are potential differences between how much each firm could copy and how much they do copy, this could be the reason behind the surprisingly low mean values.

Despite the surprisingly low mean values on question two, all four industries appear to have low appropriability of innovation as they all perceive their opportunities to protect innovations and innovation activities to be low.

5.2.3 Cumulativeness of technological knowledge

For the analysis on each industry's cumulativeness of technological knowledge, one question was used as measurement. Building and construction had the lowest mean value with a score of 3.3 (figure 27). As the score is so close to the value of 3.0, it is difficult to categorize whether the industry has a high or low cumulative level of technological knowledge. Malerba & Orsenigo (1990, 1993, 1994) distinguished only between high or low levels, which means that the industry cannot be categorized in between. Due to more respondents perceiving the industry's cumulativeness of technological knowledge as high (42,6%) rather than low (23,1%), it would not be justifiable to categorize it as low. However, the only reason it should be categorized as high is because there is no middle ground in the theoretical context of the factor.

The remaining three industries all score a higher mean value than B&C, which means that they all should be categorized as having high cumulativeness of technological knowledge since B&C also was so. It should also be mentioned that all three industries have mean values of 3.5 or higher, which makes it more justifiable to categorize them as high. Research and development are the only industry with a mean level exceeding 4.0, making it clear that the industry has high cumulativeness of technological knowledge. By categorizing all four industries with high cumulativeness of technological knowledge, we recognize that their accumulated knowledge and competence from previous innovations and innovation activities are important for future innovations and innovation activities (Breschi & Malerba, 1997; Castellacci & Zheng, 2010).

5.2.4 Knowledge base

The last of the four factors to be analysed was knowledge base. This factor was measured by two questions, where both questions' purpose was to measure the nature of knowledge, which can be divided into specific and generic (Breschi et al., 2000). However, on both questions, each industry had relatively high mean values (figures 28 and 29). This had to be interpreted as that all industries to a high degree deals with both general and specific knowledge. Such a result was not expected as it was thought that if the degree of general knowledge was high, the degree of specific knowledge would be rather modest, and vice versa. It is therefore difficult to take a stance on whether general or specific knowledge is most prevalent in the various industries.

5.2.5 The composition of the dynamics of market and innovation

As presented in the theoretical framework, an industry's technological regime forms what is referred to as "*the dynamics of market and innovation*". This notion is therefore affected by the values of the four factors in an industry's technological regime. Since all these factors have been analysed for each industry, it is now possible to get a deep view of how the dynamics of market and innovation is for each industry, and thereby uncover whether each industry has a creative destruction or creative accumulation pattern of innovation.

5.2.5.1 B&C, F/F and A&C:

For the industries of B&C, F/F, and A&C, the technological opportunity was categorized as low, which also was the state of the appropriability of innovation. The industry's cumulativeness of technological knowledge was on the other side deemed as high. In regards to the knowledge base, no certain choice was taken as it was rather difficult to take a stand. However, based on the three factors that were clear, the three industries seem to fit into the description of creative accumulation (Mark II - deepening pattern).

Technological entry

As presented in chapter 5.2.1 to 5.2.4, the factors of the three industries will lead to low technological entry. This is because low technological opportunity will lead to lower incentives to enter a new industry and be innovative (Breschi et al., 2000). However, if firms decide to enter the industry despite the lack of incentives to do so, the high levels of cumulativeness of technological knowledge will work as an entry barrier as they will not possess any accumulated knowledge from earlier innovations. The industries therefore point towards low technological entry, despite no clear conclusion being drawn about the knowledge base for any of the industries. We see it as unlikely that any conclusion on the knowledge base would change our perception of the technological entry. This is because technological opportunity and cumulativeness of technological knowledge seems more dominant in deciding whether the technological entry will be high or low.

Intensity of innovation

In regards to the three industries' intensity of innovation, it is more up for debate whether it should be classified as high or low. They all have low technological opportunity and firms therefore have few incentives to enter the industry and be innovative. Thereby, this factor is in favour of a high intensity of innovation. However, the industry's low appropriability of innovation is in favour of a low intensity, as firms can copy competing firms' innovations and innovation activities. The literature does not explain situations where an industry has both low technological opportunity and low appropriability of innovation. A classification made on a theoretical basis is therefore not possible. Nevertheless, low values are apparent in the second question "*To what extent does the company copy competitors' innovations?*" This indicates that the responding firms do not copy, even though they have the possibilities. When taking this discovery into consideration it becomes clearer that despite the industries low appropriability of innovation, the factor can be in favour of a high intensity of innovation.

The cumulativeness of technological knowledge also strengthens the classification of high intensity. Similar to technological entry, high levels of cumulativeness will act as an entry barrier, and thereby intensify the population of innovating firms. Because of these three factors, each of the three industries should be classified with a high intensity of innovation. This statement is made without considering the knowledge base as no conclusion was drawn about it. As with the technological entry, we feel comfortable not including it as we see the other three factors as more dominant when it comes to affecting the classification.

Degree of industrial concentration

The degree of industrial concentration for the three industries are high. As the degree is affected in exactly the same way as the intensity of innovation, we do not see it as necessary to do the same argumentation once more. If there is a need for further explanation as to why the degree is classified as high, we refer to the arguments under intensity of innovation.

5.2.5.2 Research and development

The industry of R&D is the only industry that stands out when it comes to the technological regime. It is the only industry with high technological opportunity. The remaining factors, appropriability of innovation (low) and cumulativeness of technological knowledge (high), are however the same as with the three other industries. Based on the three factors, the industry fits the description of creative accumulation (Mark II - deepening pattern).

Technological entry

With a high technological opportunity, the first affecting factor is in favour of high technological entry. As high opportunities give firms incentives to enter the industry and be innovative, it is in favour of high technological entry (Breschi et al., 2000). On the other hand, the industry's cumulativeness of technological knowledge is in favour of a low technological entry. This is because it indicates that there is a strong correlation between knowledge accumulated from previous innovations and innovation activities, and newly innovative firms would not possess this knowledge (Breschi & Malerba, 1997; Castellacci & Zheng, 2010). Due to the situation with the unclear knowledge base, the classification of whether the industry has a high or low technological entry, must be based on the two conflicting factors.

It is therefore a question about which of the two factors are the most dominant when it comes to affecting technological entry. The high cumulativeness of technological knowledge makes it more difficult for firms looking to be innovative for the first time, as there is a need for accumulated knowledge from earlier innovations or innovation activities. This is obviously a large disadvantage for new innovative firms. One can thus question whether firms are willing to try to become innovative in an industry with high incentives to be innovative, even though there are entry barriers making it difficult. As we see it, as long as there are incentives for firms to become innovative in an industry, they will try. This is by no means a statement saying that every firm would try, but we consider it as more likely that they would try rather than to stay away as a result of the entry barriers. The industry is therefore classified with high technological entry.

Intensity of innovation

When it comes to the intensity of innovation in the R&D industry, several perspectives must be accounted for. The industry's cumulativeness of technological knowledge is high. High levels of cumulativeness are in favour of a high intensity of innovation as it acts as an entry barrier for new innovative firms, thereby intensifying the concentration of innovative firms (Breschi et al. 2000). On the other hand, the industry's low appropriability of innovation is in favour of a low intensity of innovation. However, as previously discussed, each industry scored low on the question regarding the extent of copying other firms' innovations. Research and development were the lowest scoring industry out of the four. It could therefore be discussed if the industry has the characteristics of high appropriability of innovations, even though there are limited measures to protect their innovations and innovation activities. Despite the fact that the industry "on paper" has a low appropriability of innovation, it acts as if it has high.

The last factor, the technological opportunity, is high. There is no clear correlation between high technological opportunity and intensity of innovation, thus it is difficult to know how it will affect the intensity. As discussed during chapter 2.7.5.2, high technological opportunity can lead to both high and low intensity of innovation. This is because if the right conditions are in place (high appropriability, cumulativeness and technological opportunity), significant technological leaps can occur and established innovative firms will get an advantage. However, if the technological opportunity is high, but the appropriability and cumulativeness are low, the intensity will also be low. It is therefore, once again, a question about the classification of the industry's appropriability of innovation. If it is classified as high, the intensity of innovation would also be so, and vice versa. In this situation, even though the industry indicated having few measures to protect their innovations and innovation activities, we still want to classify it as high. This is because the industry acts as if they are protected. The intensity of innovation is therefore considered to be high.

Degree of industrial concentration

Since the degree of industrial concentration is affected by the factors in the same way as the intensity of innovation, it is considered to be high. If there is a need for further explanation as to why the degree is classified as high, we refer to the arguments under intensity of innovation.

Mark I and II

During this discussion, all four industries have, on the basis of their technological regime, been categorized as having a pattern of innovation similar to Mark II (creative accumulation). This type of innovation pattern is known for a limited and stable population of innovative firms (Breschi et al., 2000; Castellacci & Zheng, 2010). The survey asked questions related to the classification of Mark I and II, by asking about the degree the industry consists of innovative companies, and to what degree new innovative companies enter the industry. These two questions would provide indications to whether an industry belonged to Mark I or II.

The industry of B&C scored very low on each question, 2.2 (figure 30), and 2.4 (figure 31). This is a clear indication that there is a limited population of innovative firms, and that there are few new innovative firms entering the industry, resulting in a limited and stable population of innovative firms. These are the main characteristics of Mark II, which are strong arguments that the industry belongs to that classification.

Accommodation and catering also scored rather low on both questions with 2.8 (extent of innovative companies), and 3.1 (entry of new innovative companies). With a mean value of 2.8 on the first question it is clear that it is perceived to be a low degree of innovative firms within the industry. However, the second question got a mean score of 3.1. It is therefore more uncertain whether this response should be interpreted as there being a high or low degree of new innovative firms entering the industry. The most fitting description would be that there is a "medium" degree of new innovative firms entering, however the literature only specifies high or low categorization. No literature addresses the problem of when no clear categorization of "high" or "low" is apparent. One can therefore question if that means that any categorization that cannot be justified to be "high" should automatically be classified as "low". If that is the reality, the answers to the second question should be categorized as low as they do not exceed 3.5. However, we do not think this alone is a sound argument, but as the literature does not address this problem it is the only one we got. The two questions therefore support the previous analysis that the industry belongs to Mark II.

The same problem can also be found regarding the F/F industry because the mean value on the first (3.3) and second (3.1) questions is too high to easily be categorized as "low," but at the same time not high enough to be categorized as "high." As discussed during the classification of accommodation and catering, the literature is very "black or white" on the topic of classification. Either it is high or low, no middle ground. As we see it, the best argument we therefore can use is that the mean values do not exceed 3.5, which would be closer to "high" rather than "medium." Based on the two questions, the industry therefore fits into the description of Mark II as there is a low population of innovative firms and a low degree of new innovative firms entering the industry.

The last industry, R&D, has the highest scoring mean value on question one with 3.5. However, it scores rather low on the second question with 2.8. It can therefore be stated that there is a low degree of new innovative firms that enter the industry. The value of question one is, on the other hand, more up for debate. As argued during the classification of the other three industries, we only think values exceeding 3.5 could be justified with a classification of high. Research and development are therefore right at the border of what we would classify as low. Based on these two questions, R&D is also classified with the characteristics typical of Mark II. The result of the analysis of these two questions therefore argues for the same classification as the analysis of the technological regime.

5.2.6 The clusters of technological regime theory

During the discussion up till this point, each industry has been classified with their own technological regime, consisting of different levels of technological opportunity, appropriability of innovation and cumulativeness of technological knowledge (no conclusion was drawn regarding knowledge base). However, even though their technological regime has been "identified", it is still not certain that the notion about technological regime is real. By saying that it might not be real, we mean that even though we have presented each industry's level in regards to the different factors, we have still not discussed whether the firms within the same industry seem to have a joint foundation of prerequisites.

It is this joint foundation of prerequisites that each firm within an industry shares, due to the industry's technological incentives and limitations, that is the main point in the technological regime theory. The analysis and discussion about the notion of technological regime has just been based upon firms from the same industry's perception. A conclusion on whether the different industries have low or high technological opportunity could have been made regardless of whether the technological regime is real or not. To confirm whether the notion is real or not, we have to analyse if the responses from the firms within the same industry are similar or not. If the responses are not similar, it indicates that the firms from the same industry do not have the same perception about their industry, which rejects the idea that they share a joint foundation of prerequisites.

To analyse the similarity of responses within each industry a cluster analysis was performed, creating four clusters. As illustrated by figure 37, two distinct cluster categories were created. Eighty-nine percent of the industry R&D was located within cluster one and two, whereas 82% of A&C and 69% of B&C were in cluster three and four. It can therefore be argued that the four clusters seem to be categorized into two categories. The industry of F/F is the only industry which to a high degree is spread across three different clusters.
When taking figure 36 into consideration, it becomes clearer that there exist two categories of clusters. Both cluster one and two are characterized by responses from "Medium" and

upwards, although cluster two has consistently higher responses than cluster one. On the opposite side, cluster three and four are in a similar situation, however their answers range from “Medium” and downwards. Based on what we perceived as the creation of two cluster categories, we saw it as necessary to perform an additional cluster analysis with two clusters.

The second cluster analysis (figures 38 and 39) confirmed what we perceived as two cluster categories, as almost 90% of R&D was placed in cluster one, and 80% of A&C and almost 70% of B&C was placed in cluster two. The high percentage of R&D, located in cluster one, indicates that the firms within that industry has to a high degree the same perception on the factors of technological regime. This supports the idea that the industry of R&D has a joint foundation of prerequisites, supporting the notion of technological regime.

The notion of technological regime is also supported in regards to the industry of A&C. Such a large degree of firms from that industry is gathered in cluster two, indicating that they have the same perception of their industry. For the industry of B&C, almost 70% of the firms are in the same cluster. It is a rather high percentage, however it still has to be discussed whether it is high enough to indicate that the industry supports the notion of technological regime. Even though the theory about technological regimes states that each industry will have the same foundation of prerequisites, it does not necessarily mean that every single firm within that industry will have exactly the same perception of their industry and the factors of a technological regime. It is very unlikely that all firms will answer exactly the same on each question. Discretionary assessments must therefore be conducted on how large a share of similar answers is large enough for it to be possible to argue for a joint foundation of prerequisites. As we see it, any percentage close to 70 is such a high share of the population that it should be viewed as an indicator of a joint foundation of prerequisites. Building and construction has 69% of their firms within cluster two, therefore we see this as supporting the notion of technological regime.

The last industry, F/F, is more spread across the different clusters in both the first and second cluster analysis. In the second cluster analysis, 55% of the firms are located in cluster two, with the remaining in cluster one. As the percentage is far from the 70% we feel comfortable with, it cannot be viewed as an indicator towards a joint foundation of prerequisites, rather the opposite. This is further strengthened by the first cluster analysis, where the industry is spread across all four clusters.

5.2.6.1 The weaknesses of cluster analysis

However, cluster analysis contains some weaknesses. When performing such an analysis, the number of clusters has to be predetermined. This leads to clusters consisting of respondents that might not naturally fit into that cluster as every respondent has to be placed within one of the clusters. The higher the number of clusters used, the more "truthful" the clusters will be in regards to how similar characteristics each respondent shares. This is something we were very aware of when we performed the cluster analyses. The reason behind why we choose to use four clusters was because of the four industries. We wanted to examine whether the firms would divide into clusters consisting of their respective industries. As we perceived the results of the first cluster analysis to divide itself into two different cluster categories, we saw it as necessary to explore this further, even though the reduction of clusters could potentially be harmful. With both the first and second cluster analysis used as argumentation, we believed that the low number of clusters was justified as they both indicated the same conclusion: technological regimes exist within the industries of R&D, A&C, and B&C.

6 Conclusion

This thesis was written with the intention of answering the following research question;

"*How are a company's innovation activities affected by the industry in which it operates?*"

Through analyses of a quantitative survey conducted by companies from four different industries in Norway, it can be concluded that the two contradictory theories, technological regime and evolutionary theory, are both valid. This has been illustrated through several cluster analyses that support both theories. The implication this entails is that the degree industries affect companies' innovation activities, will vary across industries.

In industries where the "presence" of a technological regime is strong, companies' innovation activities will to a higher degree be homogeneous because of the joint foundation of prerequisites they share. The properties of the industry's technological regime will also affect whether or not companies do pursue innovations or not, and thereby affect how each company relates to innovation activities. How these different properties affect companies' pursuit of innovations can be explained through creative destruction and creative accumulation (Mark I and II). From the analysis it was concluded that the industries of R&D, A&C, and B&C, all had an innovation pattern similar to creative accumulation, which is characterized by a limited and stable population of innovative companies.

In industries where the "presence" of a technological regime is weak or non-existent, such as in the industry of F/F, evolutionary theory plays a larger role. In such industries, it became evident throughout the discussion that innovation activities are to a much larger degree affected by companies' unique resources, capabilities, perceptions, knowledge accumulation processes and learning methods. Therefore, one can conclude that in such industries innovation activities are more explicitly linked to companies and not to industries.

The hypothesis *"Companies´ innovation activities are only influenced by the industry's technological regime"* has been proven false. Both theories exist side by side, affecting companies' innovation activities at the same time. The result of this is that no industry's innovation activities are completely heterogeneous, but neither are they exactly homogeneous. Since H_1 was proven false, we had to investigate whether evolutionary theory and technological regime theory were complementary. Both theories explain different aspects of companies´ innovation activities, thus fulfilling each other, resulting in them being complementary. Therefore H_2: "*Evolutionary theory and technological regime theory are not complementary*" is also proven false.

As a result of the conclusion of this master's thesis, the literature within the subject area is strengthened. Our conclusion strengthens both Nelson & Winter (1982) and Winter (1984) theory about technological regime and evolutionary theory, as it at the same time addresses the relationship between the two. New findings have therefore been revealed about the relationship between the two theories as there is limited literature within this subject area.

6.1 Limitations of the thesis

In the preliminary project, a statement was made about utilizing a triangulation method to answer the research question. Due to the comprehensiveness of the thesis and the time limitations, we were not able to utilize a triangulation method. One or more in-depth interviews with companies, within and across industries, could have been advantageous to form a more detailed picture of how these companies experience their innovation activities. Furthermore, how their activities are affected by the industry they operate within. In addition to in-depth interviews adding qualitative data, this said data could have helped shape a better quantitative survey. Previously unknown phenomena could have been revealed in the in-depth interviews, which could have resulted in relevant questions being added to the quantitative survey.

Existing literature on the two main theories are primarily based on studies from the early 2000s, which is perceived to be outdated in relation to technological development and innovation activities. Thus, it could be a limitation of the study that the majority of the theoretical framework is built upon somewhat outdated studies. Furthermore, it has been identified several lacks in the existing literature. This made it difficult in some instances to interpret the data analyses.

A simple-cross-sectional research design with a survey completed at just one time period was chosen for this thesis. As mentioned in chapter 3.6.2.1, this was partially determined due to the study's short time limit. This resulted in us not being able to utilize the test-retest technique to further assess the reliability of the data. Additionally, we could have included more questions within each factor group so that a thorough Cronbach's Alpha analysis could have been conducted. This would have also helped further assess the reliability of the data.

Another limitation of the thesis is in regard to the survey reminder that was sent to the selection to increase the response rate. As discussed in chapter 3.4.6, this could have possibly resulted in one or more companies answering the survey two times. This may have an effect on the generalizability of the data. Furthermore, limitations in regard to the cluster analysis were discussed in chapter 4.4.2.

6.2 Further research

As mentioned throughout the thesis, there is a lack of literature regarding how the two theories describe different aspects of innovation and innovation activities. The existing literature primarily focuses on either evolutionary theory or technological regimes, meaning that only one side of the bigger picture is presented. In addition, there have been discovered some gaps within the existing literature on the two main theories as well. Therefore, there are several gaps in which further research could seek to fill.

For instance, it could be interesting to examine more thoroughly the perceptions of the different companies' management, and what role that plays in regard to innovation activities and the two theories. By for example conducting in-depth interviews with companies, within and across industries, one could get a better understanding of how the companies perceive problems. Furthermore, to what degree their perceptions affect their search activities and their approach to innovation.

It could also be interesting to further examine what exactly it is that determines whether it is evolutionary theory or technological regimes that influence companies' innovation activities the most. Additionally, as no literature addresses the problem of when there is no clear categorization of “high” or “low” in relation to factors within the technological regime theory, it may be worth researching further.

7 References

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8 Appendix

Appendix 1 - Survey conducted by SSB “Innovasjon i næringslivet”

2018 - 2020	**Prosent av alle foretak Innovasjons- aktivitet**
Alle næringer	63
Fiske, fangst og akvakultur	62
Bergverksdrift og utvinning	52
Næringsmiddelindustri	65
Drikkevareindustri	81
Tekstilindustri	67
Bekledningsindustri	55
Lær- og lærvareindustri	17
Trelast- og trevareindustri	61
Papir- og papirvareindustri	75
Trykking, grafisk industri	64
Petroleums-, kullvare- og kjemisk industri	76
Farmasøytisk industri	79
Gummivare- og plastindustri	75
Mineralproduktindustri	62
Metallindustri	65
Metallvareindustri	54
Data- og elektronisk industri	91
Elektroteknisk industri	87
Maskinindustri	77
Motorkjøretøyindustri	67
Transportmiddelindustri ellers	57
Møbelindustri	58
Annen industri	79
Reparasjon og installasjon av maskiner og utstyr	58
Kraftforsyning	72
Vann, avløp og renovasjon	67
Bygge- og anleggsvirksomhet	46
Agentur- og engroshandel	59
Transport og lagring	47
Overnattingsvirksomhet	49
Serveringsvirksomhet	43
Forlagsvirksomhet	84
Film- og TV-prod., musikkutgivelse	72
Radio- og fjernsynskringkasting	46
Telekommunikasjon	68
IT-tjenester	88
Informasjonstjenester	90
Finansiering og forsikring	63
Hovedkontortjen. og adm. rådgivning	75
Arkitekter og tekniske konsulenter	66
Forskning og utviklingsarbeid	94
Reklamevirksomhet og markedsundersøkelser	64
Annen faglig, vitenskapelig og teknisk virksomhet	67
Reisebyråer og reisearrangører	83
Forretningsm. tjenesteyt. ellers	57

Appendix 2 – Search 1

Search 1:				
Article	**Author**	**Definitions**	**Content**	**Findings**
"Firm heterogeneity within industries: How important is "industry" to innovation?	Tommy Høyvarde Clausen	Innovation activities, firm heterogeneity, firm homogeneity, technological regimes	Assesses how important industry is to innovation. It also adresses the conflict between the two theories, recent revolutionary theory and technological regimes theory	Industry factors matters little to how firms search for new innovation and that firms within the same industry have different perceptions of the obstacles constraining technological change. The results offer empirical support to the recent evolutionary theory where firms have hetereogenous capabilities and pursue different approaches to innovation. Structural variables at industry level are found to have a bigger impact on firm innovation. This result offers support to the sectoral innovation system approaches where firms are more constrained by underlying technological regimes.
Innovation strategies of Swiss firms: identification, dynamics and intra-industry heterogeneity	Hollenstein, H.	Innovation activities, firm heterogeneity, technological regimes	The study aims at providing new evidence with respect to the still unresolved question, whether the innovation behaviour of firms reflects industry-specific characteristics ("technological regime approach"), or whether it is the outcome of firm-specific strategies to gaining a competitive edge ("strategic management view")	The third part of the paper tends to support the "strategic management view" (high intra-industry heterogeneity), while the final one is rather in line with the "technological regime approach" (industry affiliation is more important as a factor determining firm performance). These opposite findings indicate that a company has a certain room of manoeuvre to choose an innovation strategy in line with its specific capabilities, but some structural characteristics at industry level restrict its strategic options
Intra-industry firm heterogeneity, sub-optimal adaptation and exit hazard: a fitness landscape approach to firm survival and learning	Trushin, E and Ugur, M	Firm heterogeneity	Draws on insights from the fitness landscape literature and from models of firm dynamics with learning to hypothesise that: (i) firms in industries with higher company age or size heterogeneity have higher exit hazard after controlling for age, size, and a variety of other predictors of firm survival; and (ii) higher levels of R&D investment mitigate the hazard-increasing effects of industry firm heterogeneity after controlling for the direct effects of R&D intensities at industry and firm level.	The findings offer two novel contributions to the literature: (i) firm heterogeneity is not just a passive precondition for subsequent selection process in industry evolution; this heterogeneity enhances selection as more firms might be stranded in suboptimal positions; (ii) firms in more heterogenous industries can mitigate the hazard-increasing effects through R&D investment that facilitates adaptation and search for better fitness locations.

Appendix 3 – Search 2

Search 2:				
Article	**Author**	**Definitions**	**Content**	**Findings**
The Path of Most Persistence: An Evolutionary Perspective on Path Dependence and Dynamic Capabilities	Vergne, JP and Durand, R	Dynamic capability, path dependence	Introduces an evolutionary perspective, which specifies the underlying selection mechanisms of the property of path dependence in internal and external firm environments.	Sheds new light on three paradoxes that currently blur the theoretical contribution of path dependence to research at the managerial, organizational, and industry levels: (1) the problematic coexistence of path irreversibility and managerial intentionality; (2) the ambivalent strategic value of lock-in with regard to competitive advantage; and (3) the relative homogeneity in observed dynamic capabilities, despite their (possible) path dependence that should lead to a wider variety of outcomes owing to the presence of contingency.
How much difference is there between industrial district firms? A net value creation approach	Molina-Morales, FX and Martinez-Fernandez, MT	Industrial district, shared resources, internal heterogeneity, knowledge, value creation	Argues that industrial district firms possess a number of shared resources that explain the competitive superiority of these firms. Using these shared resources the paper aim to address an unsolved question in the industrial district literature, namely, the internal heterogeneity of the clustered firms.	Findings suggest that, even assuming a certain degree of homogeneity among internal district firms, they develop their own particular relationships and networks and, as a result, exploitation of the shared resources is irregular. These differences can therefore be used to explain the differences in value creation among firms
Does homogeneity exist within industrial districts? A social capital-based approach	Molina-Morales, FX and Martinez-Fernandez, MT	Industrial district, heterogeneity, homogeneity	Industrial districts are made up of enterprises and organisations that are closely related, both physically and cognitively. From the social capital perspective, the district has been defined as a social network with a high degree of internal homogeneity. Nevertheless, good reasons can be found to justify a certain degree of heterogeneity among the member firms.	Two basic groups of firms can be distinguished. One of them has been identified as the core network, which is characterised by firms from the nucleus of the district that make up a more closed network with more intense relations and strong ties. The other is what is known as the periphery network, which consists of firms that are located on the borders of the district, with more outside relations and less cohesion and strength in their relations with the other members of the district.
Innovation Performance and Embeddedness in Networks: Evidence from the Ethiopian Footwear Cluster	Gebreeyesus, M and Mohnen, P	Industrial clusters, innovation performance, networks, heterogeneity	This study focuses on innovation in a cluster of informal shoemaking firms in Ethiopia—namely the Mercato footwear cluster. It examines how differently those firms are embedded in networks and how heterogeneous they are in absorptive capacity, and how this heterogeneity affects their innovation performance.	The study reveals that despite geographical proximity and homogeneity in social background the firms in the cluster behave and perform differently. Based on econometric analysis we document a positive and strong effect of local network position and absorptive capacity on innovation performance.

A practical perspective on the classification of service innovations	Hsieh, JK., Chiu, HC., Wei, CP., Yen, HR. & Cheng, YC	Service innovation, innovation,	Aims to link academic classifications of service innovation with practical activities by firms to detail the essence of service innovation.	This study shows that elements of service innovations vary by company size, service innovation experience, and industry life cycle.
The role of knowledge base homogeneity in learning from strategic alliances	Subramanian, AM., Bo, W. & Kah-Hin, C	Innovation, knowledgebase, homogeneity, heterogeneity, knowledgebase homogeneity	The study argues that the influence of technological distance on learning is best understood by not only measuring the distance between innovative outcomes, but by also taking into consideration the knowledge elements underlying the innovative outcomes.	The benefits of technological distance are enhanced and the cost of technological distance mitigated when the knowledge base homogeneity between alliance partners is high.

Appendix 4 – Search 3

Search 3:				
Article	**Author**	**Definitions**	**Content**	**Findings**
Technological regimes and Schumpeterian patterns of innovation	Breschi, Stefano., Malerba, Franco. & Orsenigo, Luigi	Innovation activities, technological regimes, firm homogeneity	Proposes that the specific pattern of innovative activities in an industry can be explained as the outcome of different technological regimes	The sectoral patterns of technical change are related to the nature of the underlying technological regime. Schumpeter Mark II patterns are related to high degrees of cumulativeness and appropriability, high importance of basic sciences. Schumpeter Mark I patterns are related to low degrees of cumulativeness and appropriability, and high importance of applied sciences
Schumpeterian competition, technological regimes and learning through knowledge spillover	Wersching, Klaus	Innovation activities, technological regimes, firm homogeneity	Technological regimes and the role of knowledge spillovers for innovation are examined	Show persistent structural differences between Schumpeter Mark I and Schumpeter Mark II conditions. The technological development in terms of process and product innovations is better in an industry that is characterized by Schumpeter Mark II conditions, but the improved technological development is connected with higher prices and profits.

What exactly are technological regimes? Intra-industry heterogeneity in the organization of innovation activities	Leiponen, Aija. & Drejer, Ina	Innovation activities, technological regimes, firm homogeneity	Suggests that firms' strategic differentiation or local search activities overcome pressures in the technological environment towards homogenous behaviour, at least in the short term.	Firms within most industries are indeed found to follow multiple patterns of innovation behavior. No systematic differences are found between industries with a dominant regime and those without one
Technological regimes, Schumpeterian patterns of innovation and firm-level productivity growth	Castellacci, Fulvio. & Zheng, Jinghai	Innovation activities, technological regimes, firm homogeneity	Investigates the relationships between technological regimes and firm-level productivity performance, and it explores how such a relationship differs in different Schumpeterian patterns of innovation	The mechanism of productivity growth differs in the two Schumpeterian regimes. While Schumpeter Mark II markets are characterized by an oligopolistic structure where large incumbent innovators continuously and cumulatively push the technological frontier further, firms in Schumpeter Mark I industries must pay close attention to make an efficient use of already available techniques, which is a crucial requirement to survive in competitive and turbulent markets.
Technological regimes and the variety of innovation behaviour: Creating integrated taxonomies of firms and sectors	Peneder, Michael	Innovation activities, technological regimes, firm homogeneity	The research presented in this paper aims to help remove the impasse between the meso- and micro-led perspectives on innovation. It specifically contributes to the literature by creating a novel set of integrated taxonomies for both firms and industries, which explain sectoral characteristics by systematic differences in the distributions of heterogenous firms.	The results demonstrate that innovation policies must not expect homogenous firms when targeting certain industries or technologies, but address them according to their characteristic diversity and distribution in the sector.
Technological paradigms, regimes and trajectories: Manufacturing and service industries in a new taxonomy of sectoral patterns of innovation	Castellacci, F	Technological paradigms, regimes, trajectories, innovation	Studying manufacturing and service innovation.	This article presents a new sectoral taxonomy that combines manufacturing and service industries within the same framework.

What Can CIS Data Tell Us about Technological Regimes and Persistence of Innovation?	Frenz, M and Prevezer, M	Technological regimes, persistence of innovation, Community Innovation Survey	This paper analyses the link between technological regimes and persistence in innovation at the firm level. It reviews the literature on persistence of innovation, measurement issues and technological regimes.	The majority of enterprises analysed in this paper, these are around 4,000 enterprises that responded to the last three UK versions of the CIS, do not innovate, or they innovate sporadically. Persistent innovation over time is comparatively rare. Further, where firms innovate persistently we find persistence only in the short run
The relation between firm size and R&D productivity in different technological regimes	Revilla, AJ and Fernandez, Z	Innovation, research and development, productivity, firm size, technological regimes, appropriability, cumulativeness, technological opportunity	This paper proposes a contingent approach where the prevailing technological regime of each firm impacts on the relation between size and R&D. The study formulates four propositions concerning the moderating effects that the different dimensions of the technological regimes (conditions of appropriability, technological opportunity, and knowledge cumulativeness) may exert on the size-innovation relation.	Environments characterized by high levels of technological opportunity favour more flexible organizations that are better able to react to technological change. And when the origin of these opportunities is external to the organization, the result will be more dense co-operation networks among firms. This situation favours small firms, which will also have an advantage in regimes with less cumulative knowledge.
Technological regimes and firm survival: Evidence across sectors and over time	Lin, PC and Huang, DS	Firm survival, technological regimes	Uses three R&D related variables to reflect two Schumpeterian technological regimes: creative destruction and creative accumulation.	The empirical results confirm the theoretical relationship between technological regimes and the survival rate of new firms: new firms are more likely to survive under the entrepreneurial regime.

Appendix 5 – Search 4

Search 4:				
Article	**Author**	**Definitions**	**Content**	**Findings**

Appendix 6 – Search 5

Search 5:				
Article	**Author**	**Definitions**	**Content**	**Findings**
The Pavitt Taxonomy, revisited: patterns of innovation in manufacturing and services	Bogliacino, F and Pianta, M	Innovation, innovation surveys, Pavitt Taxonomy, heterogeneity	This article discuss how to summarize the persistent and large heterogeneity in innovative behaviour and economic performance.	In analysing the heterogeneity of innovation and performance across manufacturing and service industries, the study have shown that the Revised Pavitt Taxonomy adopted is a highly effective tool for identifying key differences in: (a) levels and types of innovative efforts; (b) proximity in a multi-dimensional technological domains; (c) determinants of innovative performances; (d) the relationships between innovation and economic performance.
Understanding innovation: An analysis of persistence for Spanish manufacturing firms	Triguero, A and Corcoles, D	R&D, innovation, persistence, firm heterogeneity, market characteristics	The paper analyse whether persistence in firms' innovation activities over time is the result of previous experience, the dynamic capabilities of the firm or industry-market related characteristics.	The paper finds that R&D and innovation are highly persistent at the firm level. After controlling for unobserved heterogeneity and initial conditions and by using a dynamic random effects probit, it is concluded that there are similar determinants of persistence in R&D and innovative activities.

Appendix 7 – Search 6

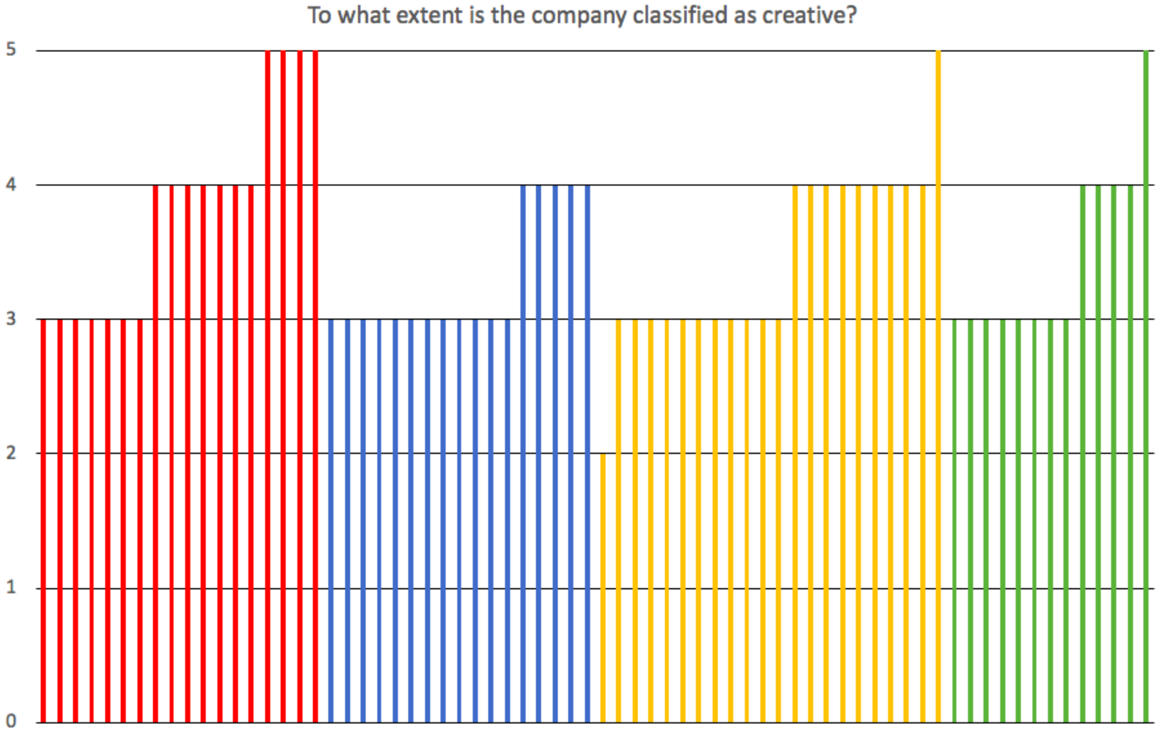
Search 6:				
Article	**Author**	**Definitions**	**Content**	**Findings**
The geography of innovation: A cross-sector analysis	Breschi, S	Technological regimes, innovation, cumulativeness, knowledge transmission	This paper attempts to identify some broad empirical regularities in the geographical distribution of innovative activities. The basic hypothesis which is advanced is that spatial patterns of innovation vary greatly amongst sectors according to the specific features of the underlying technology, as summarized by the concept of technological regime.	Two main results emerge. On the one hand, the empirical evidence shows the existence of remarkable diVerences across technological classes in the spatial patterns of innovation. On the other hand, one also typically observes the existence of quite remarkable similarities across countries in the spatial patterns of innovation within each technological class.

Appendix 8 – Search 7

Search 7:				
Title	**Author**		**Content**	**Findings**
Creating Value through Incremental Innovation: Managing Culture, Structure, and Process	Rubin, GD and Abramson, RG	Innovation, organization	This article explores cultural, structural, and process enablers for incremental innovation.	The article comes to the conclusion that nurturing a learning culture that embraces change and establishing formal organizational structures and processes for innovation are key to creating an environment where value-maximizing strategies are identified and the best ideas captured. Frequent and routine communication of practice vision and goals across the enterprise enhances the likelihood of success.
Innovation Cultural Models: Review and Proposal for Next Steps	Morente, F; Ferras, X and Zizlavsky, O	Innovation, culture, organization	An abundance of literature suggests a strong link between organization, culture, and innovation.The aim of this paper is to review the most commonly used and applied theoretical models, analyze them, and propose several new elements that must be integrated into future models.	The analysis of seven major ICMs suggests that there is a lack of some qualitative sensitivity, compulsory to dissect innovation, organization, and culture as a total social phenomena. The current analytical depth of the interdependencies between the three concepts is very limited. Only with ICMs faithful to reality, embracing the challenges of complexity and organizational plurality, the interdependencies between innovation, organization and culture can be understood.
FACTOR ANALYSIS ON INNOVATION INDUCTORS IN HIGH PERFORMANCE ORGANIZATIONS	Resende , PC and Fujihara, RK	Innovation, factor analysis, inducing innovation factors, PD&I Management Model, innovation culture, innovation strategies	The article aims to present, through the exploratory and confirmatory factorial analysis, the main inducing factors of organizational innovation in a set of 19 Brazilian companies. The research integrates the methodology of evaluation of awards, norms and models of innovation - APMNI.	The article presents a model that is composed by four factors considered as inducers of organizational innovation: 1) PD&I Management; 2) Leadership to Innovation; 3) Innovation Culture and 4) Oriented Strategy for Innovation.
Building a bridge between performance management, radical innovation, and innovation networks: A systematic literature review	Gomes, LAD; Facin, ALF and Hourneaux, F	Innovation, redical innovation, organization, innovation networks	This study aims to bridge radical innovation and network performance management through a systematic review of the literature.	The framework presented in the study suggests that overall, the performance management of radical innovation networks presents different features (e.g., recursive rather than linear) and constructs (e.g., openness and unintended performance) from those of innovation network management.

Innovation climate: A systematic review of the literature and agenda for future research	Newman, A; Round, H; (...); Mount, M	Innovation, innovation climate, organization	This article systematically reviews the literature surrounding the concept of innovation climate, focusing on its antecedents and outcomes, and empirical work where it has been treated as a moderator.	An agenda for future research was proposed that highlights the need to incorporate alternative theoretical perspectives to enhance the understanding of the innovation climate concept and its impact. In addition, opportunities for empirical advancement of the field were also highlighted. In particular, the need to examine the negative influence of innovation climate, adopt a more dynamic approach to examine how innovation climates develops over time, and explore the influence of cultural and institutional factors on the development of innovation climate.
Towards a framework for innovation orientation within business and management studies A systematic review and paths for future research	Norris, D and Ciesielska, M	Innovation, organization	The innovation orientation theory has emerged within the literature in the last 40 years particular within the development of other strategic orientations, but the bulk of seminal literature in the area has been developed in the past 11 years. The purpose of this paper is to revisit the concept innovation orientation in the light of recent research	Innovation orientation is a sub-construct positioned within the wider field of innovation and relates to an innovation-based strategic orientation. It is a multifaceted construct that includes a range of core common variables such as innovation culture, competition-based understanding, organisational flexibility and specific capital and knowledge capabilities. It is particular relevant for managers and executives to understand how to manage innovation at the firm level. Literature also reports links between innovation orientation and organisational performance.

Appendix 9: "To what extent is the company classified as creative?"



Appendix 10: "To what extent will the company´s innovation activities lead to financial results?"