Industry Maturity’s Influence on the Viability of Innovation- and Imitation-oriented Strategies

Assessing how elements of industry life cycles influence the viability of innovation and imitation-oriented strategies and its impact on industry development pace

A Qualitative Cross-sectional Study on the Cultured Meat Industry

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Abstract

There is extensive literature on the topic of first-mover advantages, not only with regards to whether such advantages exist or not, but also with regards to their sources. However, there is a scarce amount of research devoted to understanding how such advantages are affected by the maturity of the industry, specifically in emerging industries.

This research combines the first-mover advantages literature with the theory of industry transformation and path dependence in order to analyze how industry maturity and the presence of self-reinforcing mechanisms might influence the viability of adopting an innovation- or imitation-oriented strategy. The study used a qualitative approach with semi-structured interviews and a sample of four executives from four different cultured meat organizations, as well as four independent academic experts. The empirical findings are analyzed using a thematic analysis in order to answer the proposed research question and its sub-question.

The findings conclude that the level of industry maturity has implications on decisive elements that in turn are likely to influence the viability of adopting an innovation or imitation-oriented strategy, as the characteristics of an industry's technology, equipment, market, innovation and product changes as an industry matures. Further, the study suggests that regional disparities, product characteristics, technological hedging and co-branding are important factors to consider when assessing the viability of innovation and imitation-oriented strategies. The study concludes by sharing insights regarding theoretical- and managerial implication sprung from the revised synthesis of the study.

Keywords: Innovation strategies, Innovation-oriented, imitation-oriented, first-mover advantages, first-mover disadvantages, industry life cycles, industry transformation, path dependence, cultured meat industry

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List of Abbreviations

FBS	Fetal bovine serum
FMA	First-mover advantage
FMCG	Fast moving consumer goods
FMDA	First-mover disadvantage
GHG	Greenhouse gas
ILC	Industry life cycle
IP	Intellectual property

1. Introduction

This introductory chapter contributes with a brief background to both the chosen subject and the thesis's theoretical backbone. It covers a problem discussion as well as the overall purpose and aim for the thesis. Ultimately, arriving at the research question that the thesis aims to answer. Lastly, it concludes with a delimitation of what is regarded to be out of scope for this research.

1.1 Background

Innovation has emerged as an interesting field which has received great contribution from several of the most-well known economic thinkers such as Kenneth Arrow, Karl Marx, Adam Smith, and by the many argued to be the founding father; Joseph A. Schumpeter (Antonelli, 2009; Dosi, 1984). The knowledge contributed by these authors have been subsequently built on by many of the more contemporary innovation authors which combined lays the foundation of the current body of innovation literature (Damanpour & Schneider, 2006).

A myriad of literature has been added since the ideas of Schumpeter and others, ideas and revelations which further underpins its importance. For instance, The European Central bank (2017) stresses the value of innovation for industry- and economic growth. Whereas Anzola-Román et al. (2018) put attention on technological innovation to understand its relation to organizational performance and economic growth. This is important considering that innovation is essential for national- as well as corporate competitiveness (Freeman, 1995). Despite the fact that the foundation of the innovation literature stems from different viewpoints, they all convey the idea that innovation and technology advancements is one of the main pillars contributing to economic growth. From a wider perspective, innovation has the ability to improve quality of life (Freeman & Soete, 1997).

In more contemporary literature, these ideas have been further built upon and a link between innovative activity and expected competition has been discussed (Barro & Sala-i-Martin, 1995; Mukoyama, 2003; Zhou, 2006). In this line of thought, expected competition is largely concerned with competitors' propensity to imitate pioneers by launching products and services that are mimicries of previous innovations (Barro & Sala-i-Martin, 1995). This is what Mukoyama (2003) refers to as the *negative-incentive prediction from imitation-based competition*. In essence, meaning that firms have reduced incentives to innovate when they are concerned with imitation from competitors.

> "If anyone has in him all that pertains to success… then he (the innovator) can … make a profit which remains in his pocket. But he has also triumphed for others, blazed the trail and created a model for them which they can copy. They can and will follow him, first individuals and then whole crowds." (J.A. Schumpeter, The Theory of Economic Development, Harvard University Press, Cambridge, 1934, p. 133.)

To this background, the pace of innovation is expected to be dependent on competitors or follower's viability to imitate (Barro & Sala-i-Martin, 1995). This dependency is important not only due to its implication on economic growth, but also due to its implications on the pace of technologic and innovative development (Barro & Sala-i-Martin, 1995). However, there seems to be a slight discrepancy in this area of literature. Whereas Barro and Sala-i-Martin (1995), Mukoyama (2003) and Zhou (2006) explains how the incentive for firms to innovate lessens when there is opportunity for imitators to imitate, other literature such as Schumpeter (1942) and Bessen and Maskin (2009) claims that imitating might actually spur innovation. The latter of the two perspectives underlines how industries characterized by large means of imitators due to weak patent protection have witnessed a large degree of innovative advancements, largely due to the fact that firms who are being imitated need to innovate rapidly in order to gain a competitive advantage. This thesis aims to dig deeper in this field and contextualize these ideas to understand how industry maturity might influence the viability to innovate or imitate, and if this might affect the emergence of an industry.

However, the viability for firms to imitate is not the only factor that has an implication on innovation. In contrast, there are several frameworks and theories contributing to the understanding of industry transformation and the pace of technology development (Teece, 1986); Anderson & Tushman, 1990; Abernathy & Utterback, 1978; Malerba & Orsenigo, 1997). More specifically, why do some innovations substitute old innovations within the blink of an eye, whereas other innovations see rivalry between regimes for protracted amounts of time. How quickly innovations develop and diffuse is important considering the fact that innovations have the possibility to contribute to solving many of the most pressing global challenges, not only for firms, but for the planet as a whole. In connection to this, there are a myriad of examples of innovations that propelled human quality of life by an order of magnitude, such as antibiotics, the telephone and electric light, but also process innovations, such as the assembly line or scientific plant breeding in combination with synthetic fertilizers. The latter innovation is estimated to have reduced worldwide starvation, ultimately giving rise to more than 2 billion human lives (Borlaug, 2002).

Drawing from the earlier discussion of innovations' potential to contribute to overcoming challenges (Freeman & Soete, 1997; The European Central Bank, 2017). One of today's most pressing global challenges is being able to sustainably feed the soon to be 8 billion people in the world. The meat industry has been a large part of this endeavor, where global demand has increased dramatically, to an extent that supply has more than tripled since the 1970s (Ritchie & Roser, 2017), and is expected to further increase by 73% by 2050 (Ritchie & Roser, 2020). This evolution has laid the foundation for great debate, the environmental-, human health-, and ethical concerns have been staggering, and rightly so. Today, global agriculture accounts for 25% of all greenhouse gas emissions (GHG), where meat production is associated with a considerably higher carbon footprint in comparison to plant-based food (Petrovic et al., 2015). The current animal welfare is adding to the concern, where approximately 192 million animals are being slaughtered daily for food production (Poore & Nemecek, 2018). Furthermore, many serious diseases have derived from intensive animal farming conditions (Bhat & Hina, 2011). Where the prevalence of antibiotic use is further adding to the concern (Muaz et al., 2018). Combined, these externalities provide great incentives to transition current production and consumption towards more sustainable alternatives.

A myriad of partial solutions are being explored, both by transitioning to more sustainable methods of production, as well as transitioning into more sustainable foods (Takefuji, 2021). Among aforementioned solutions are the potential diffusion of *cultured meat* as an alternative to traditionally produced meat. In contrast to traditionally produced meat, cultured meat is produced within bio reactors in laboratories by the usage of animal cells (Schwartz, 2021). This novel production technology has great potential to improve both environmental sustainability and animal welfare, while simultaneously limiting human health consequences (Tuomisto & Mattos, 2011; Rubio et al., 2020; Schwartz, 2021)

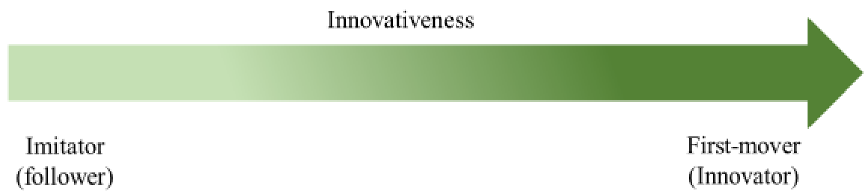
1.2 Problem Discussion

As stated, the importance of innovation has been underlined by many (Freeman & Soete, 1997; The European Central Bank, 2017; Anzola-Román et al., 2018). To this note, Tushman and O'Reilly (1997) goes even further saying that an organization's survivability is largely determined by its ability to innovate. As this statement surely holds some truth, there are scenarios that are more complex, where incentives for individual firms to innovate are less obvious. Such incentives might deviate from the utility derived from the industry and society as a whole. Bessen and Maskin (2009) theoreticized this by claiming that there are instances where the social benefit of an innovation is of paramount value, but the cost to incur such innovations exceeds the return reaped by any given firm willing to undertake such innovations, in these scenarios, it does not make sense for the innovator firm to incur those costs.

Knowledge spillovers and appropriability concerns might allow followers to imitate which could create a scenario where innovative firms bear the main cost of their innovative efforts, whereas the benefit of such innovation is dispersed among free riding imitators. This in turn could reduce incentives for firms to innovate within their industry, ultimately forestalling industry advancements (Mukoyama, 2003). These insights synergize poorly with literature of Bessen and Maskin (2009); Raustiala and Springman (2006) and Schumpeter (1942) who explains how imitation might actually be a driver for innovation.

Therefore, it is expected that the viability of imitation-oriented strategies influences the willingness to innovate among firms within an industry, but it is not exactly clear how these topics are interrelated. In this setting, innovation and imitation-oriented strategies are regarded as two sides of a continuum where a firm can be a first-mover with new products or processes, hence pursuing an innovation-oriented strategy. This is largely in accordance with the radical strategy definition provided by Malerba and Orsenigo (1993). Conversely, firms can also be imitators, seeking to mimic competitors and hence pursue an imitation-oriented strategy or follower strategy, this is largely in accordance with the imitative strategy defined by Malerba and Orsenigo (1993), as illustrated in Figure 1.

Figure 1
Continuum of innovation strategies



Note: Self-constructed

To this background, factors that affect the viability of innovation strategies are especially important for this study, as it lays the foundation for the theoretical section. Sprung from the fact that innovation- and imitation-oriented strategies are dependent on circumstantial conditions, which strategy is most viable is dependent on external factors such as the market and technology, as well as more internal factors such as knowledge and other firm resources

(Kerin et al., 1992; Lieberman & Montgomery, 1998; Szymanski et al., 1995). To this background, three frameworks have been selected that have proven to be fruitful in regard to understanding the industry, technological and firm-specific dynamics. These frameworks include models of industry transformation, path dependence and technological regimes which will be elaborated in depth in the theoretical section.

1.3 Purpose and Aim

The main purpose of this study is to explore if and how the viability of innovation- and imitation-oriented strategies is dependent on the maturity of the industry. The study is also concerned with exploring how the choice between innovation- and imitation-oriented strategy might affect the development pace of the industry and its technology. More specifically, this study is concerned with emerging, hereafter also referred to as infant industries. This is argued to be of certain importance due to the global need of innovative- and technological advancement to transition industries, not the least the current meat production industry which this study investigates. Furthermore, the field of innovation-orientation is largely a neglected area of research, even more so in emerging industries (Forbes & Kirsch, 2011; Chandler & Lyon, 2011; Davidsson & Wiklund, 2001). However, the lack of research within such areas is not accidental. Forbes and Kirsch (2011) underlines how the difficulty of empirically analyzing industries in emerging phases is problematic due to the fact that the industry has not yet matured. Theoretically, it is difficult as many industries fail to mature (Macmillan & Katz, 1992). Nevertheless, the increased difficulty of analyzing such industries reveals little about its need. Conversely, the lack of theory in this field incentivizes this study in contributing to the innovation literature in emerging industries specifically. In addition, the field of imitation is drastically less researched in relation to innovation. According to Schnaars (1994), there were more than 9 000 articles on the topic of innovation but merely 145 on the topic of imitation.

The aim is therefore to contribute to the understanding of how the viability of innovation- and imitation-oriented strategies is dependent on the maturity of the industry, more specifically in infant or emerging industries, in this case the industry of cultured meat. With the aim of ultimately arriving at insights revealing hampering factors that might forestall the potential advancement of industries. As well as how the strategic choice of firms to be innovative or imitative might influence the development pace of an industry. Such factors could then be mitigated by taking adequate actions, such as adapting the regulatory landscape or tweaking the firm-specific strategies in order to spur innovation in an industry that in this case, is of paramount value to our planet.

1.4 Research Questions

Drawing from the introductory section, this thesis seeks to answer the following research question:

RQ. *What incentives are there for firms to adopt an innovation-oriented-, respectively an imitation-oriented strategy in the cultured meat industry?*

- ***Sub RQ.*** *How might the viability of aforementioned strategic orientations affect the development pace of the cultured meat industry?*

1.5 Delimitation

Certain delimitations have been made in order to direct the research of the thesis. The purpose of such limitations is to ensure a reasonable scope and focus. Firstly, this thesis will not be targeting consumers and potential diffusion barriers from a demand-side perspective in any depth, i.e., that no qualitative data will be sampled from potential consumers. Secondly, it is acknowledged that cultured meat is only one of many possible solutions for reducing concerns regarding environmental sustainability, animal welfare and health issues. To this background, the thesis will not cover other meat analogs such as vegetarian- or vegan meat substitutes, even though this thesis supports further research into adjacent markets. Thirdly, the regulatory landscape is of importance in the cultured meat industry as it has implications on the future development and diffusion of cultured meat products, this is partially relevant for the thesis and will be covered to the depth necessary in relation to its implications on innovation strategies. However, no direct qualitative data sampling will be conducted with regulatory parties.

2. Industry Background

This chapter gives a brief overview of both the traditional meat production industry as well as the cultured meat industry. The motivation for the chosen structure is derived from the importance of understanding the overall production process in order to analyze the industry from a technology life cycle- and path dependence perspective. This, in combination with the empirical and theoretical data will reveal insights about the viability of innovation- and imitation-oriented strategies which are argued to be of importance for the industry progress.

2.1 Current State of the Traditional Meat Industry

The current state of the traditional meat industry is associated with severe externalities, including negative impacts on environmental sustainability, animal welfare and human health. This is increasingly problematic as future projections suggest a 73% increased meat production by 2050 (Ritchie & Roser, 2017; Ritchie & Roser, 2020). The United Nations coined the expression of “the nexus of sustainable development”. The nexus itself is an equation of food, energy and water, all inputs needed to produce the 340 million tons of meat produced in 2018 (Ritchie & Roser, 2020). Further, the environmental footprint of agriculture and food production is paramount. Contributing to 26% of global emissions, it covers 50% of the habitable land area, consumes 70% of global freshwater withdrawals and leads to 78% of global eutrophication (Poore & Nemecek, 2018). In addition, there are over 70 billion animals slaughtered for food production annually, for context, this amounts to the slaughter of approximately 192 million animals per day (Poore & Nemecek, 2018).

2.2 Cultured Meat Industry

The concept of cultured meat, also known as in vitro meat, lab-grown meat, synthetic meat, cell-based meat or cultivated meat is produced by growing cells in a culture setting, most commonly by the usage of stem cells in laboratories (Cohen et al., 2022). The different terminologies are largely interchangeable, whereas the term simulated meat is used for non-animal products seeking to mimic real meat (Kadim et al., 2015). This concept has been foreseen far back. Already in 1932, Winston Churchill wrote “Thoughts and adventures” with a quote commonly used within cultured meat spheres:

> “With a greater knowledge of what are called hormones, i.e., the chemical messengers in our blood, it will be possible to control growth. We shall escape the absurdity of growing a whole chicken in order to eat the breast or wing, by growing these parts separately under a suitable medium”. - Sir Winston Churchill

Even in practice, bio-artificial muscles generated from cell culture is not a new phenomenon; this has been explored since the millennium shift, primarily for medical- or research purposes (Post, 2012). However, the technology is novel within food science (Kadim et al., 2015). The technology was first used for meat consumption in 2000 by two groups of researchers, one college team that was supported by NASA and another group that consisted of bio-artists (Stephens et al., 2018). Since then, cultivating meat in vitro has been accomplished in experimental trials for an array of animal products ranging from more common animals such as beef and chicken to other alternatives such as goldfish, turkey, and frogs (Kadim et al., 2015).

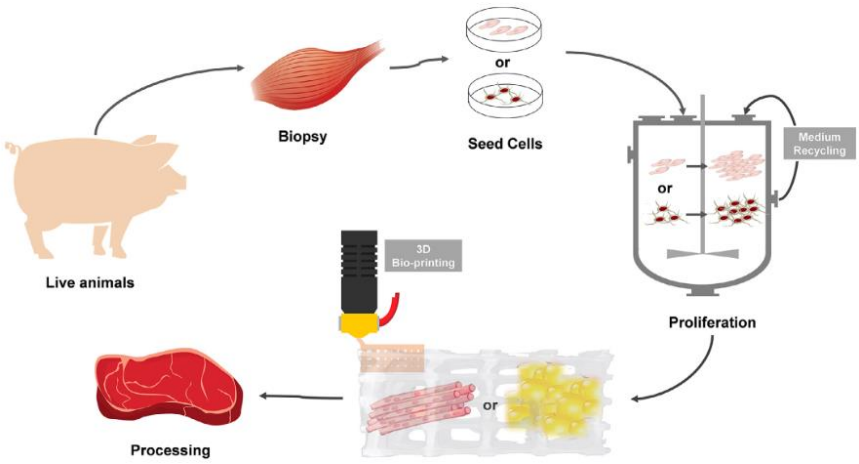
In 2013 a pioneer within the field, Professor Mark Post from the University of Maastricht made a public appearance on an English TV show where the first cultured meat burger was made with bovine stem cells (Kadim et al., 2015; Painter et al., 2020). The burger alone took Google's Co-founder Sergey Brin an investment of 250,000 USD which allowed for production of one single burger patty of 142 grams (Painter et al., 2020). Two years after the introduction of the first cultured meat burger, the first four companies were founded. Since then, the industry has grown to include approximately 60 companies globally (Painter et al., 2020).

2.3 Production Technology for Cultured Meat

There are different production technologies and resources used for producing cultured meat. Despite the technological variation, the overlying process starts with acquiring and banking cells from animals, commonly by taking biopsies. These cells are placed on scaffolds or petri dishes which provide structural support for the cells to cultivate on, this is then put into bioreactors accompanied by suitable growth mediums (Cohen et al., 2022). Growth mediums are the source of nutrients and oxygen, inorganic salts and other growth factors that enhance growth (Cohen et al., 2022). Changes in both the medium and scaffold trigger the starter cells to differentiate into muscle, fat or connective tissue, which together results in meat. Depending on what specific process technology, resources being used and end product complexity, this process normally takes between 2-8 weeks (GFI, n.d). Figure 2 illustrates a general overview of the production process.

Figure 2

Illustration of cultured meat production process



Note. Figure taken from Guan et al. (2021)

2.3.1 Cell Lines

Different categories of cells are feasible for the production of cultured meat such as embryonic stem cells, pluripotent stem cells and myogenic satellite cells (Hong et al., 2021). What characterizes stem cells is their ability to develop into several different cell types (Alison et al., 2002). For cultivating meat, such cells are of great importance, predominantly myoblast or satellite cells, see Appendix D for an in-depth explanation of cell characteristics (Post, 2012; Kadim et al., 2015).

2.3.2 Cell Culture Medium

Once the cell line has been selected, these will be placed on petri dishes where a growth medium is added to support the culture setting (GFI, n.d). To be able to grow cells in vitro settings, the same essential nutrients and inputs that are found in vivo settings must be included. This includes glucose, amino acids, salts, vitamins, water and other vital components (GFI, n.d). The set of these substances is also known as growth medium and is one of the most vital elements of cell culture technology (GFI, n.d).

Kadim et al. (2015) elaborates on a few critical criteria that needs to be met in order for cell culture medium to be commercially viable as production input. First is the cost of culture medium, which could be argued to be specifically important as Sprecht (2020) claims it is the main cost driver for producing cultured meat. Further, the medium should contain exclusively food-grade components that could be accessed in large quantities. Lastly, it should be efficient in terms of driving proliferation and differentiation of cells which ultimately allows for skeletal muscle growth (Kadim et al., 2015).

Drawing on earlier discussion of variation within production processes, culture cell medium is an example of such variation. Moreover, cells could be kept alive with quite simple basal mediums, however the growth and proliferation of cells is swifter when using some sort of animal serum (Van der Valk et al., 2018; GFI, n.d). Such serums are not only expensive but also concerning with regards to animal welfare. The most common source of serum is fetal bovine serum (FBS) (Van der Valk et al., 2018), which in essence is a blood serum extracted from the fetus of a bovine. This can be achieved through different methods, such as collecting blood from the fetus through deceased pregnant cows, drawing blood via cardiac puncture from the expired fetus, or as a byproduct of the meatpacking industry (Thermofisher, n.d). It is estimated by Van der Valk et al. (2018) that approximately 800.000 liters of FBS is produced annually, collected from 2.000.000 bovine fetuses. Further, Van der Valk et al. (2018) claim that the collection of FBS per fetus is maximized by collecting blood by using a syringe straight from the beating heart of the fetus. It is also estimated that the fetus could experience pain and discomfort associated with such processes despite the unfinished process of gestation. It is also assumed that the fetus senses pain and discomfort during the process of being taken out of the mother's corpse.

There are other concerns with regards to the production and usage of FBS, the production of FBS is at risk for safety for laboratory workers due to the potential for endotoxins, mycoplasma and viral contaminants (van der Valk et al., 2018). Another disadvantage associated with the usage of FBS is its variability of composition, which might result in difficulties with regards to conducting scientific experiments (van der Valk et al., 2018). Lastly, such serums are expensive and estimated to contribute up to 80% of the total production cost of cultured meat (Choudhury et al., 2020). The aforementioned concerns connected with the usage and production of FBS is largely acknowledged by the industry. There is an industry wide ambition to move away from animal serum in cell mediums to minimize such concerns (Choudhury et al., 2020). The transition to alternatives to serum-based media is on the horizon due to the development of alternatives such as microbial fermentation to produce recombinant growth proteins or non-animal extracts (Choudhury et al., 2020). It is further argued by Sprecht (2020) that animal free cell culture mediums are not only possible, but also promising with regards to ramping up production quantity and reducing production costs.

2.3.3 Bioreactors

The primary task for bioreactors is to provide housing for cells by regulating and monitoring temperature, oxygen and other vital parameters (GFI, n.d). A bioreactor aims to increase the level of nutrients in the medium and there are currently many different designs available (GFI, n.d). According to Post et al. (2020), the most common bioreactor within cultured meat industry is stirred tanks. The advantage of stirred tanks is its ability to provide large capacity, which allows for scalability. However, the involvement of mechanical rotation of the cells to efficiently homogenize is causing severe stress on the cells which inhibit cells from proliferating adequately (Post et al., 2020).

2.3.4 Scaffolding

Cultured meat products vary in both production technology and end-product characteristics. An important aspect in this regard is the scaffolding of cultured meat products, where more simplistic products such as meatballs, hotdogs or surimi are less sophisticated hence easier to produce, whereas products such as steaks and filets requires specific scaffolds in order to recreate complex multicellular architecture of meat (GFI, n.d). To this background, scaffolds could be seen as a building template for tissue formation which provides a foundation for cells to adhere and grow onto (Seah et al., 2022). Such scaffolds are predominantly built using collagen and gelatin (Seah et al., 2022).

Similar to animal-based serums, both collagen and gelatin are animal-based scaffolds which align poorly with the ambition to eliminate animal involvement in the overall production of cultured meat. To this background, several plant-based biomaterials are being explored (Seah et al., 2022). Young and Skrivergaard (2020) propose that soy protein is a suitable scaffold product which has a promising ability to not only remove animal dependence, but also to reduce cost and allow for scalability with regards to production volumes. These findings were attained by the research of Arye et al. (2020) who ran experiments on two different soy protein scaffolds: TSP-1 and TSP-2 with promising results.

2.4 Externalities of Traditional- and Cultured Meat Production

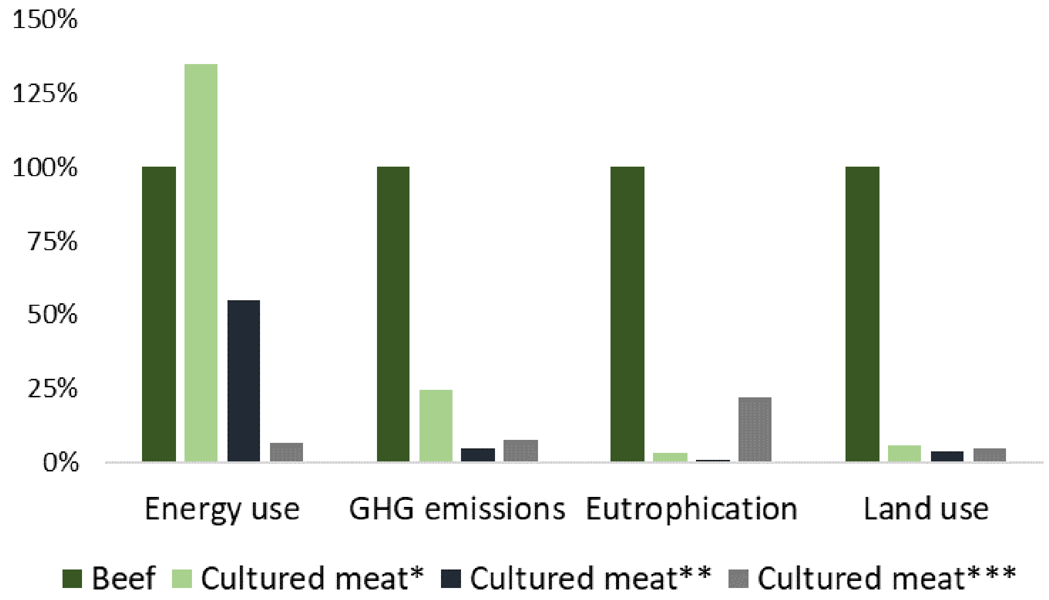
The potential benefits derived from shifting from traditional- to cultured meat are mainly threefold, including potential solutions to environmental issues, animal welfare issues, and human health issues. However, culturing meat is not a perfect fix to any of the problems associated with traditionally produced meat. To provide nuance in this regard, the following sub-chapters compare the externalities of the production between in-vivo and in-vitro meat.

2.4.1 Environmental Effects

As earlier stated, the technology of culturing cells for food production is quite novel. Therefore, there are discrepancies regarding reported numbers depending on what sources are used and when the report was released. Here, it is clear that there is a lack of consensus regarding the comparison of cultured meat and traditionally produced meat, mostly with regards to total GHG emissions and energy usage. To this background, a synthesis of three separate calculations have been conducted which is illustrated in Figure 3. These articles also partially include other meat categories such as chicken and pork but for illustrative purposes, these are excluded from the figure. However, it is important to communicate that beef is associated with larger externalities in comparison to all other meat categories in these studies, which in the extension means that cultured meat is less beneficial in relation to such meat categories than it is in comparison to beef production. However, the comparison between other meat categories such as poultry, sheep and pork are presented in Appendix E.

Figure 3

Synthesis of studies on externalities of cultured meat in comparison to beef



Note: Figure 3 has been constructed by drawing from *Rubio et al. (2020) with Mattick et al. (2015); **Tuomisto & Teixeria de Mattos (2011); ***Schwartz (2021)

When discussing environmental effects from food production, the standard is to base calculations on a life cycle analysis. Rubio et al. (2020) who is using data from Mattick et al. (2015) finds that the energy consumption for cultured meat is 34,9% higher than traditional beef production, whereas the GHG emissions are 75,4% lower but exceeds the GHG emissions of both pork and chicken. However, the difference in both eutrophication and land use is speaking where cultivated meat sees stark advantages across all studies. This is interesting when recalling how 50% of habitable land is devoted to agriculture in combination with the fact that cultured meat is expected to be vastly less land consuming (Ritchie & Roser, 2020). This could allow for a redistribution of current livestock area to be used for other purposes, which begs the topic of carbon storage opportunity costs (Searchinger et al., 2018). Hypothetically, current livestock areal could be transformed into vegetation that allow for carbon storing (Searchinger et al., 2018). Further, 85% of the deforestation of the Amazon is estimated to be derived from animal farming, which has a major effect leading to reduced biodiversity among other consequences (Godfray et al., 2018). In addition, Treich (2021) claims that there are additional benefits in reduced transportation and refrigeration costs as well as it removes the need for carcass waste management. Hayek et al. (2021) claims that the opportunity cost of land area is likely to be the most environmentally beneficial effect.

The most recent scientific research of Schwartz (2021) suggests even lower externalities in the total energy usage for cultured meat in comparison to traditionally produced beef, while the GHG emission is quite similar to the study conducted by Tuomisto and Teixeria de Mattos (2011). When discussing GHG emissions of cultured meat and traditional beef production specifically, it is important to underpin the differences between carbon dioxide (CO_2), nitrous oxide (N_2O), and methane (CH_4). While these three categories of GHG are associated with beef production, cultured meat production is predominately emitting CO_2 due to fossil energy use to warm cultured cells (Chriki & Hocquette, 2020). This is mainly derived from the manufacturing processes and equipment, which varies by bioreactor design, growth medium and stem cells cleaning methods (Tuomisto, 2018). This is important as these GHG have different implications regarding accumulation in the atmosphere. The article by Lynch and Pierrehumbert (2019), who draws upon research from Myhre et al. (2014) claims that CO_4 has a lifespan in the atmosphere of 12 years, which is dramatically lower than the approximately thousand years in which CO_2 accumulates (Archer & Brovkin, 2008). In summary, the short-lived duration of CO_4 is therefore not as severe as the warming impact of CO_2. Lastly, the article of Rubio et al. (2020) claims that the cultured meat category is expected to emit less waste and require fewer resources once the production technology is optimized, which could be an argument for why earlier research overshoots the negative externalities of cultured meat production.

2.4.2 Human Health Effects

There are two main areas in which cultured meat consumption could have implications on human health, these are diseases and antibiotic resistance. With regards to diseases, there are both direct and indirect effects. Firstly, the current production of meat is contributing to a risk of animal diseases (Bhat & Hina, 2011). Diseases such as bovine spongiform encephalopathy (mad cow disease), swine flu, salmonella, E. coli and campylobacter are consequences of intensive farming conditions in combination with poor animal welfare conditions (Bhat et al., 2015; Chriki & Hocquette, 2020; Post, 2012). In contrast, cultured meat is grown in a laboratory setting which lowers the risk of bacterial contamination (Bhat & Hina, 2011; Chriki & Hocquette, 2020).

The indirect effects are of more long-term character, this category includes public health problems such as diabetes, cardiovascular disease and colorectal cancer (Post, 2012; Larsson & Wolk, 2006; Song et al., 2004). Such diseases have been proven to be associated with the consumption of red meat, where saturated fatty acids are of specific importance (Chriki & Hocquette, 2020). This is important for several reasons. Firstly, regarding the more direct effects of diseases derived from animal production. Cultured meat is produced in a more controlled environment where no living animals are used within the facilities. According to Chriki and Hocquette (2020), this removes the risk of a potential outbreak of aforementioned- or other diseases as well as the need for vaccinations. Secondly, with regards to the more indirect effects and public health concerns, cultured meat production is anticipated to be able to control the nutritional content of the produced meat (Chriki & Hocquette, 2020). As earlier described by drawing from research of Larsson and Wolk (2006) and Song et al. (2014) who claim that saturated fats have a negative effect on the diseases mentioned. In cultured meat production, saturated fats could potentially be exchanged for omega-3 fatty acids and other important nutrients such as vitamin B12 simultaneously as iron levels could be increased (Chriki & Hocquette, 2020). However, the viability of this is yet to be determined due to technological barriers, specifically with regards to rancidity by changing the balance of fatty acids (Chriki & Hocquette, 2020).

The second larger category is concerned with the widespread use of antibiotics which is problematic due to the risk of antibiotic resistance. According to Oliver et al. (2011), the usage of antibiotics within meat production has resulted in the progression of antimicrobial resistance which is a great danger for public health. Antibiotics are used for different purposes in different phases of production such as treatment of diseases, prevention of diseases and as growth promotion (Roth et al., 2019). However, antibiotic use as growth promotion has been banned in the EU in 2006 and in the US in 2017 but is continued to be allowed in both China and Brazil (European Commission, 2020; AccessScience, 2017). This is of importance due to the fact that production of cultured meat is made within a controlled environment with close monitoring which reduces the need for antibiotics.

2.4.3 Animal Welfare

Drawing from the projections of an increased production of meat, this suggests an increase of livestock numbers and slaughter. By shifting to cultured meat, this will reduce the need for livestock of larger numbers, as well as slaughter. This is specifically yielding due to the intensive farming conditions in which a large majority of animals are raised. Such environments lack outdoor access where animals are placed in cages or confined environments (Treich, 2021). For instance, 99% of pigs in American pig farms are restricted from basic movement such as walking or turning around due to the fact that they are captivated in small crates (Norwood & Lusk, 2011). In addition, the EU is considered to be the most advanced region with regards to animal welfare standards (Treich, 2021). Despite this, several cruel methods are being used, such as “castration without anesthesia, dehorning, tail docking, teeth clipping, beak trimming and slaughter without stunning” (Treich, 2021, p.36).

However, animals are not completely excluded from cultivating meat in vitro settings as cells are derived from animal biopsies. With this production method, a single biopsy would allow for proliferation of cells, ultimately allowing for a dramatically larger output than one animal. How much meat can be produced from one biopsy is dependent on the cells used and their proliferative capacity which combined determines a multiplicity factor. Further, Melzener et al. (2021) claims that a single biopsy of 500mg of tissue could result in meat production of 5000kg or 20 bovine cattle. This is further contextualized by claiming that 50 biopsies would be able to cover the total meat consumption of Maastricht for two years, which approximately populates 120 000 inhabitants (Melzener et al., 2021).

2.5 Intellectual Property in the Cultured Meat Industry

The majority of investments within the cultured meat industry are allocated within R&D to improve the technology to further increase price performance ratio. Further, one method to ensure that IP is protected is through securing intellectual property (IP) rights with patents. According to Theng et al. (2021), there are 142 patent filings within the cultured meat industry in 2021. The scope of patents largely concerns the development of scaffolds-, cell lines, growth mediums or other process related technologies (Theng et al., 2021). However, there is a patent that has had a central role in the cultured meat industry and is what Bessen and Maskin (2009) refer to as a broad patent. A patent is broad when it covers a wider area, often due to a low specification of what is included. This patent is set to expire during 2022 and is named “Method for producing tissue engineered meat for consumption” (Google Patents, 2000). The patent was initially filed by Jon Vein in 2001 and granted in 2004 and has since then been assigned and used by several different companies through licensing (Google Patents, 2000).

3. Theoretical Foundation

The main purpose for this thesis is to provide insights regarding how the viability of innovation- and imitation-oriented strategies is dependent on the maturity of the industry and subsequently how this might influence the development pace of an industry. In order to attain such insights, the chapter will first elaborate on the topic of strategy orientation (innovative or imitative) and conclude with literature regarding industrial transformation and path dependence.

3.1 Incentives to Innovate or Imitate

Innovation is a term of nuance, a term that is not universally defined. Kahn (2018) claims that the foundation of innovation is threefold, it can be an outcome, a mindset and a process, which further adds to its complexity. In addition, Damanpour and Schneider (2006) claims that innovation has to be put in context depending on in what discipline it is being discussed, which partially explains its diverging definitions. Schumpeter, who was largely concerned with industry transformation, specifically connects innovation to entrepreneurship, claiming that innovation is a recombination of existing knowledge which was argued to be at the core of economic development (Śledzik, 2013). Schumpeter (1942) goes as far as to claim that every firm that seeks profit must innovate. Drawing on the words of Schumpeter (1942), there is a myriad of literature supporting the argument that firms have everything to win on bringing new and innovative products to the market (Zhou, 2006). Supposedly, this allows firms to enjoy benefits in economies of scale, preemption of resources and technological or behavioral factors (Zhou, 2006; Lieberman & Montgomery 1988). In contrast, others claim that such benefits are excessively exaggerated and circumstantial (Zhou, 2006, Shankar et al., 1998; Zhang & Markman, 1988; Lieberman & Montgomery, 1988). This perspective is largely built on the standpoint that there are circumstances where imitative firms are able to exploit innovator's investments in R&D and market development. During such circumstances, it is argued that it might be more beneficial for firms to hold back on innovation. In fact, the study by Golder and Tellis (1993) concluded that it is rare to witness markets where the pioneers are still market leaders, the empirical findings of that study concluded that this was the case in 4 out of 50 product categories examined.

Disregarding the choice of market entry order, there is literature underpinning a relationship between innovative activity and technological advancement (Barra & Sala-i-Martin, 1995). Therefore, the viability of both strategies is argued to have implications on the industry development pace, the former standpoint claims that the fear of imitation will reduce incentives for firms to innovate due the difficulty to reap profits from R&D spendings (Mukoyama, 2003; Barro & Sala-i-Martin, 1995; Zhou, 2006). This is what Mukoyama refers to as "the negative-incentive prediction from imitation-induced competition to growth" (Mukoyama, 2003, p.362). In contrast, the latter claims that imitative behavior might actually increase incentives to innovate due to the need of diversifying from competitors, hence achieving a competitive edge (Bessen & Maskin, 2009; Raustiala and Springman, 2006; Schumpeter, 1942).

Moreover, innovation- and imitation-oriented strategies could be seen as opposites on a continuum of innovativeness, where the former could also be regarded as being a first-mover or pioneer, whereas imitation-oriented firms could be regarded as being imitators, late-movers or followers. Subsequently, this means that an advantage for first-mover's is a dis-advantage for imitators and vice versa ceteris paribus, due to the reason that the strategies are flipsides of sides of the same coin. To this background, the following chapters will indulge in literature regarding innovation- and imitation-orientation.

3.1.1 Innovation-oriented Strategy

There are some discrepancies regarding the definition of first-movers, innovators and pioneering firms. Some scholars such as Zhou (2006) claim that there can only be one pioneering firm in an industry, where all other entrants are followers and imitators. However, this synergizes somewhat poorly with other literature. For instance, Ulhøi (2012) claims that the order of market entry is subject to nuances where pioneers or first-movers could also be more relaxed in its definition by including the first swarm of firms in the market. Whereas Teece (1986) claims that an innovator is a firm who is first to commercialize a new product or process in the market. This study uses the more relaxed definition provided by Ulhøi (2012) as this includes the first pioneering swarm of cultured meat firms.

Nevertheless, firms who adopt an innovation-oriented strategy are characterized by heavy investments in R&D in order to be the first to bring new innovative products and services to the market (Zhou, 2006). When done successfully, this could give rise to first-mover advantages (FMA). Such advantages have been thoroughly theoreticized in several articles, among them are Suaréz and Lanzolla (2005) who defines first-mover advantage as: “a firm's ability to be better off than its competitors as a result of being first to market in a new product category” (Suaréz & Lanzolla, 2005, p. 122). In addition, Lieberman and Montgomery (1988) emphasize that first-mover advantages come to light through three different sources: *technological leadership*, *preemption of scarce assets* and *buyer switching costs*. The aforementioned sources of first-mover advantages consist of several specific mechanisms which are elaborated in Table 1.

Table 1
Sources of first-mover advantages, mechanisms and characteristics

Source of first-mover advantage	**Specific Mechanism**	**Characteristics**
Technological Leadership	*Advantages in learning or experience curve*	Unit production costs fall with cumulative output, which creates competitive advantages for early entrants if learning can be kept proprietary.
	Success in patent and R&D	When technological edge is a function of R&D expenditures, entrepreneurs will gain advantages if the technology can be protected through patents or trade secrets.

Preemption of scarce assets	*Preemption of input factors*	First-movers can gain advantages by acquisition of scarce assets such as physical or process inputs. Superior information can be exploited, i.e., purchasing assets below the up-coming market price such as natural resources and tier one retailing or manufacturing locations.
	Preemption of locations in geographics and characteristics space	In some industries, there is only room for a limited number of profitable firms; first-movers can then select the most attractive niches. This does not only include geographical space, but also shelf space and other related fields.
	Preemptive investments in plant and equipment	First-movers can gain an edge by investing in plants and equipment first. The reason being that it will serve as a commitment and require the firm to streamline production and reduce costs, thereby discouraging other firms from entering the industry.
Switching costs and buyer choice under uncertainty	*Switching costs*	Buyer switching costs are a consequence of a first-mover advantage, firms entering the industry at later stages must make additional investments to attract customers. Switching costs can be either financial, i.e., initial investment or learning (time investment), i.e., adapting to the product.
	Buyer choice	Consumers have limited time and resources to investigate the quality of the product or service, in this context, some consumers may select the first brand they encounter. First-mover advantages can be obtained by increasing brand- recognition and loyalty.

Note: Table 1 has been constructed using information from Lieberman and Montgomery (1988)

However, the seminal article of Lieberman and Montgomery (1988) has received criticism from several angles (VanderWerf & Mahon, 1997; Lieberman & Montgomery 2013). An area of specific interest is what metrics are being used in order to assess FMAs, where more contemporary literature concludes empirical evidence of FMAs in market share but not as frequent in profitability or firm survival. In addition, most scholars within this field, such as the seminal article of Lieberman and Montgomery (1988) have put their efforts into understanding how first-mover advantages arise, but not enough effort has been put into investigating in what circumstances each force is best suited for (Suaréz & Lanzolla, 2005). Suaréz and Lanzolla (2005) distinguish between two natures of first-mover advantages: *short-lived first-mover advantages* and *durable first-mover advantages*. Firms that have achieved first-mover advantages that are of durable nature tend to dominate within their product-class for a long period of time, whereas firms managing to secure short-lived first-mover advantages will not secure prolonged advantages. Furthermore, the likelihood of attaining such advantages is dependent on two factors: *the pace of market evolution* and *the pace of technological evolution* (Suaréz & Lanzolla, 2005). Firstly, the pace of market evolution is concerned with the speed of consumer adoption, i.e., how long time will it take for a product or service to reach the mass market. In contrast, the pace of technological evolution is concerned with the rate of technological- or innovative advancement. For context, the first glass manufacturer originated 3500 BC and it took 3000 years for the next major technological breakthrough to occur within the industry (Suaréz & Lanzolla, 2005). Unlike how computers only ten years ago are not at all similar to those available today, which indicates that technological evolution is faster.

Table 2

Pace of market- and technology's effect on the of first-mover advantages

	First-Mover Advantage		
Paces of (market; technology)	Short-lived	Durable	Key resources required
Calm waters (Slow; Slow)	Unlikely Even if attainable, advantage is not large	Very likely Moving first will almost certainly pay off	• Brand awareness helpful, but resources are less crucial
The market leads (Fast; Slow)	Very likely Even if you can't dominate the category, you should be able to hold onto your customer base	Likely Make sure you have the resources to address all market segments as they emerge	• Large-scale marketing, distribution, and production capacity
The technology leads (Slow; Fast)	Very unlikely A fast-changing technology in a slow-growing market is the enemy of short-term gains	Unlikely Fast technological change will give later entrants lots of weapons to attacking you	• Strong R&D and new product development, deep pockets
Rough waters (Fast; Fast)	Likely A quick-in, quick-out strategy may make good sense here, unless your resources are awesome	Very unlikely There is little chance of long-term success, even if you are a good swimmer. These conditions are the worst.	• Large-scale marketing, distribution, production, and strong R&D

Note: Table taken from Suaréz and Lanzolla (2005)

As illustrated in Table 2, firms can face various external environments where the forces of market- and technological evolution have different paces. Suaréz and Lanzolla (2005) further argue that organizations will experience difficulties in maintaining their first-mover advantage when these forces are evolving at a faster pace as they have a more disruptive nature under such circumstances. Moreover, industries characterized by high technological development will most likely correspond to short-lived first-mover advantages and require strong R&D development, marketing, distribution and continuous improvement of products. First-mover advantages are more likely to be durable in industries that have lower pace of technological- and market evolution, where brand awareness plays a major role and R&D development is of less importance (Suaréz & Lanzolla, 2005).

3.1.2 Imitation-oriented Strategy

Until now, the theoretical section has elaborated on the topic of innovation-oriented strategy, where firms become pioneers in their industry by reaching the market with novel products through innovation. However, as Zhou claims, “Innovation, however, is not the only choice for a product introduction. Because there can be only one pioneer in any product market, imitation remains a viable and more common strategy than innovation” (Zhou, 2006, p.395).
Furthermore, imitation is a concept with many nuances without much consensus regarding its definition. According to Ulhøi (2012, p. 40), “imitation is learning to do something from seeing it executed”. Whereas Zhou, (2006) claims that imitation is subject to different degrees, ranging from pure clones to creative imitation, which synergizes well with the view imitation modes shared by Ulhøi (2012) which are found in Appendix F, and further contextualized further in the theoretical section. Nevertheless, the variability adds to the complexity of the topic and will be further elaborated in subsequent paragraphs.

It is implied by Zhou (2006) that industries characterized by large viability of imitation-oriented strategies tend to develop at a slower pace. Lieberman and Asaba (2006, p. 367) nuances this further by claiming that “In highly uncertain environments, however, imitative behavior can be dysfunctional or even pathological. Herd behavior can lead to speculative bubbles and the waste of resources in duplicative investments”. In contrast to this, the authors also claim that imitation can be beneficial in industries where change is more incremental as it has the ability to defuse rivalry and reduce risk for firms. Lastly, Lieberman and Asaba (2006) also confers to the idea of Zhou (2006) and Barra & Sala-i-Martin (1996), in the sense that fear for imitative competition reduces the incentives for firms to act aggressively and innovatively, claiming that imitation therefore could fill an “anticompetitive role”.

The presence of first-mover advantages and its durability is dependent on follower firms’ ability to imitate the pioneering firm (Lieberman & Montgomery, 1988). As earlier mentioned, Suaréz and Lanzolla (2005) emphasize that first-mover advantages will become short-lived in environments characterized by high pace of technological- and market evolution. The pace of technological evolution, deregulation and decrease in trade barriers has changed the competitive landscape, thus paving the way for imitation strategies to occur (Ulhøi, 2012). With this in mind, there are some drawbacks associated with being a first-mover and the effects will instead aid imitation-oriented firms. According to Lieberman and Montgomery (1988), there are four different categories of first-mover disadvantages (FMDA), hereafter also referred to as imitation-oriented advantages:

- Free-rider effects
- Resolution of technological or market uncertainty
- Shifts in technology or customer needs
- Incumbent inertia

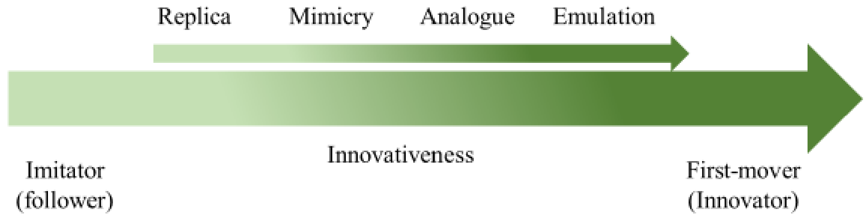
Firms entering the industry at later stages can exploit initial investments made by first-movers, including, R&D, buyer education and infrastructure development. Lieberman and Montgomery (1988) emphasize that innovation costs are generally higher than imitation costs, hence making it more profitable for late-movers to “free-ride” on the success of a first-mover if their technology and related processes is not protected. Technological- and market uncertainty can benefit organizations that enter the industry in mature phases, the reason being that these factors have stabilized to a higher degree, hence lowering the investment risk. Shifts in technology are a result of technological breakthroughs which can be exploited by entrepreneurial firms by threatening established technologies and processes provided by incumbents, which ultimately can result in creative destruction (Anderson & Tushman, 1990). If the industry is witnessing a shift in consumer needs, late-movers have an opportunity to align their offerings with the current needs, thus creating beneficial opportunities for entering the market (Lieberman & Montgomery, 1988). This is in contrast with Schumpeter (1942) who claims that consumer preferences are given and do not undergo spontaneously, ultimately concluding that it therefore cannot lay the foundation for economic change (Śledzik, 2013).

Moreover, an advantage intertwined in the imitation-oriented strategy is the fact that first-movers can experience inertia due to lock-in effects in specific investments or assets, which will be specifically elaborated in 3.3 (Sydow et al. 2009). Within this scope, there are also risks associated with cannibalizing the current businesses which can contribute to the organization being inflexible for future changes (Christensen, 2013). Further, this also affects the viability of different modes of imitation strategies. Both Lieberman and Asaba (2006) and Ordanini et al. (2008) argue that differences between mimetic behaviors need to be understood in order to understand its potential consequences.

To this background, there is not just one way in which firms can pursue an imitation-oriented strategy. Conversely, imitation could be argued to not only require innovative capacity, but also to require different levels of thereof, where emulation imitation requires the most innovative capacity as it strives to outperform the product or service it seeks to imitate (Ulhøi, 2012). In contrast, a replica strategy requires little to none innovative capacity (Ulhøi, 2012). Figure 4 illustrates the different modes of imitation and their relation to innovative capacity. A more detailed description of the different modes of imitation is found in Appendix F.

Figure 4

Imitation modes in relation to innovation strategies



Note: Self-constructed

Therefore, emulation mode of imitation could be argued to be both innovation- and imitation-oriented. In addition to this, Ulhøi (2012) states that firms are not locked into the imitation mode first pursued. In fact, Ulhøi (2012) stresses that organizations can start with a less creative form of imitation (e.g., replica/mimicry) and progress through the ladder of imitation, thus reaching the creative imitation-oriented strategies, i.e., "starting out as a non-creative 'replicating sheep' does not necessarily prevent the agent(s) from later turning into a 'creative, emulating or innovating wolf'" (Ulhøi, 2012, p. 39). With that said, firms that seek to evolve their imitative oriented strategy must have advanced R&D and manufacturing in place, whereas the less creative modes demand less high-skilled and specialized labor.

Further, Ulhøi (2012) emphasizes that the viability of the different modes of imitation depends on external factors. For instance, industries characterized by short product life cycles, i.e., a rapid rate of new product launches, which is argued to benefit firms that have higher degree of innovation within their imitation-oriented strategy and vice versa. Furthermore, Ulhøi (2012) highlights those industries with low barriers to entry are more likely to be exposed by imitation. In contrast, industries with higher barriers to entry, characterized by scientific, technological or tacit knowledge are more difficult to imitate. However, Mansfield et al. (1985) discovered that 60 % of patented innovations in their research were imitated within 4 years, the reason being that it was possible to invent around these patents. This is largely in accordance with Teece (1986) who claims that there are two main reasons as to why patents might provide poor protection. Firstly, in line with Mansfield et al. (1985), patents can be invented around, but also due to legal requirements, where the upholding of validity and infringement are costly.

Furthermore, the viability of aforementioned imitation modes is dependent not only on the product or service it seems to imitate, but also on more general patterns. Ordanini et al. (2008) distinguishes between three categories regarding what type of behavior that gets imitated: frequency-based, trait-based and outcome-based imitations. Frequency-based imitation is achieved when the most widespread behavior is imitated, whereas the trait-based imitation is dependent on specific characteristics or traits of a certain group of firms. Such traits are often related to specific strategies. Lastly, outcome-based imitation is pursued when a certain behavior is believed to be the driver of performance. In addition, specific organizations that are generally larger, successful and profitable that have many connections to firms and that are central in their respective network have a higher probability of being imitated (Lieberman & Asaba, 2006).

3.2 Industry Transformation

Until now, the thesis has taken the perspective on innovation- and imitation-orientation and elaborated on some factors that are deemed to be important when analyzing the viability of such strategies. However, innovation- and imitation-oriented strategies are dependent on circumstantial conditions, hence what strategy is most viable is dependent on external factors such as the market and technology, as well as more internal factors such as knowledge and other firm resources (Kerin et al., 1992; Lieberman & Montgomery, 1998; Szymanski, Troy, & Bharadwaj, 1995). This subchapter is therefore devoted to the coverage of theories explaining industry life cycles and its implication on the firm-specific- and market external elements.

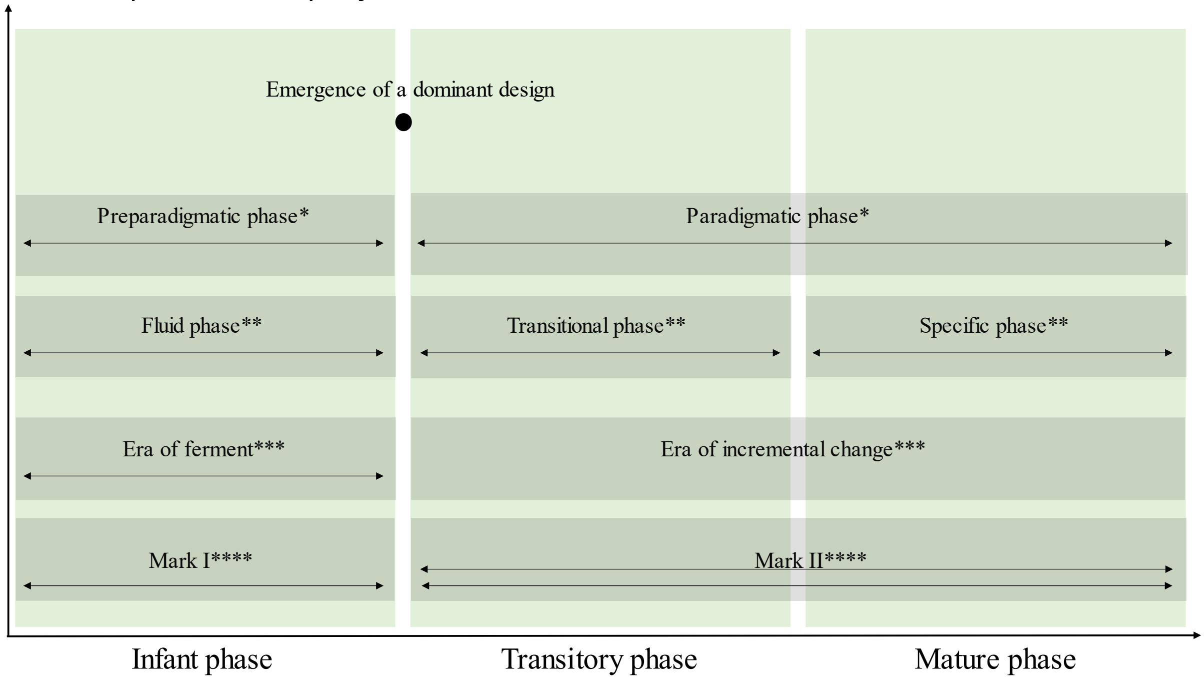
How firms and markets act during times of technological change is a widely debated area. In the wake of the seminal contribution from scholars such as Marx, Smith, Schumpeter and Arrow, many scholars agree that technological change and industry transformation stems from both exogenous and endogenous factors (Dosi, 1984). Furthermore, the evolutionary theory provided by Nelson and Winter (1973) shines light on different factors and aspects of economic change, such as “(...) response of firms and the industry to changed market conditions, economic growth, and competition through innovation” (Nelson & Winter, 1982, p. 3). In contrast to aforementioned scholars such as Marx and Schumpeter; Nelson and Winter (1982) suggest a more dynamic model as opposed to the neo-classical orthodox model, where firms are also constrained by historical decisions. The authors bring forward the idea that firms search for either innovative or imitative solutions in order to increase competitiveness and profits (Nelson & Winter, 1982). As earlier described, the viability of innovation- and imitation-oriented strategies are dependent on circumstantial conditions, such conditions, hereafter referred to as elements, tend to fluctuate over time in a rather predictable pattern. Such patterns have been described by several prominent papers which are further elaborated in depth in the subsequent sections.

3.2.1 Industry Life Cycles

As stated, industries tend to change in a cyclical manner, where an overarching pattern can be observed across industries, which is often driven by technological advancements or discontinuities. There are several frameworks that aim to make sense of how markets and industries evolve from infant to mature stages over time (Teece, 1986; Abernathy & Utterback, 1978; Anderson & Tushman, 1990; Suaréz & Utterback, 1993; Malerba & Orsenigo, 1997). Such theories tend to distinguish evolution into different phases. Furthermore, the different frameworks are largely interrelated but analyze different elements with deviant definitions. Figure 5 therefore aims to integrate the aforementioned frameworks into a new framework proposed by the authors, as well as to illustrate how patterns of industrial transformation in different literature are coherent and differentiated. The following sections will further explain the presented frameworks more in depth.

Figure 5

Patterns of Industrial Life Cycles



Note: Self-constructed using information from *Teece (1986); **Abernathy & Utterback (1978); ***Anderson & Tushman (1990); **** Malerba & Orsenigo (1997)

Each phase has implications on the various industry elements illustrated in Table 3. Furthermore, the positioning in the industry's maturity cycle reveals information regarding the viability of innovation strategies. To this background, there will be an integrated review of such literature in order to provide a theoretical backbone to the thesis that will aid in understanding industrial innovation patterns. Table 3 integrates findings from seminal articles on the topic of industrial innovation patterns. The table aims to give an overview of how the characteristics of the elements change as the industry matures. These elements will be further elaborated in depth in the subsequent section.

Table 3
Industry maturities' effect on industrial and technological elements

Elements	Infant Phase	Transitory Phase	Mature Phase
Technology	Uncertain and diverse	Reduced variety, focused development and performance improvement	Normally only incremental product and process changes. Standardized, low ability to introduce major changes in products or processes
Equipment & Knowledge	General purpose, requiring highly skilled labor	Some subprocesses are automated, creating islands of automatization.	Special purpose, mostly automatic with labor tasks mainly monitoring and control, highly efficient production
Plant	Small-scale, located near users or source of technology, manufacturing is loosely and adaptively organized	General purpose with specialized sections	Large-scale, highly specific to particular products, largely automated
Competition	Uncertain, high risk, failures and competition, no dominant design established, fight within and between technical regimes	Dominant design emerging, decreased uncertainty and competition shifts to product variations	High rivalry over market shares
Innovation	Radical product innovation, mostly from smaller firms, low stability in list of key innovators	Major process changes due to higher demand	Incremental focus for products and processes, with cumulative improvement in productivity and quality
Number of Firms	Many firms, frequent influx and exits, low barriers to entry	Shakeouts, late entry by larger firms mainly through acquisition	Few firms, high barriers to entry
Size of firms	Small and infant, coming from outside the industry and not related to firm size	Mix of small and large firms	Large and mature

Product	Ambiguous requirements with distinctive advantages in comparison to other technologies, high product variety i.e., no dominant design	Improved price performance ratio, emergence of a dominant design	Strong price performance ratio, mostly undifferentiated standard products, possible segmentation
Markets	Niche markets, low demand and small sales figures	Rapid growth and expansion, bridging markets for mass diffusion, high demand	Late and repeated buyers, small growth (stagnating sales figures)

Note: Table 3 has been constructed using information from Teece (1986); Abernathy and Utterback (1978); Anderson and Tushman (1990); Suaréz and Utterback (1993) and Malerba and Orsenigo (1997)

3.2.2 Infant Phase

Moreover, Anderson and Tushman (1990) introduce the concept of *Technology cycle*. This cycle starts off with a technological discontinuity and then enters an era of ferment. The era of ferment is largely comparable to the patterns of Schumpeter Mark I industries as defined by Malerba and Orsenigo (1997), which is characterized by Schumpeter (1942) definition of creative destruction, with a large influx of new entrepreneurial firms who serve as the main source of innovative activity. In such patterns, innovative activities are spread among an array of smaller entrepreneurial firms challenging incumbents with new ideas and innovations (Malerba & Orsenigo, 1997). Such innovations could be what Tushman & Anderson (1990) refers to as technological discontinuities which are defined as “an order-of-magnitude improvement in the maximum achievable price vs. performance frontier of an industry” (Anderson & Tushman, 1990, p. 607). Further elaborated to be an innovation “that does not strike at the margins of incumbents, but at their very lives” (Schumpeter, 1942, p.42). Such discontinuities are further divided into two characteristics: competence enhancing and competence destroying. Competence enhancing discontinuities build on competencies and know-how embodied in the technology it replaces. In contrast, competence destroying discontinuities renders previous competencies and know-how obsolete, i.e., that previous know-how is of low importance for mastering the new technology (Anderson & Tushman, 1990). Consequences of such discontinuities are much in line with the Schumpeterian concept of creative destruction. To this background, competence-enhancing discontinuities tend to be favorable and driven by incumbents whereas competence-destroying shows the opposite relation.

According to Anderson and Tushman (1990), the era of ferment is portrayed by two main processes: competition between technical regimes and competition within the new technical regime. Technologies provided by incumbents will not dematerialize easily, thus fierce competition between old- and new technologies is likely to occur. Furthermore, new innovative technologies are usually devalued at their introduction stage, mainly due to the fact that these have not been tested on the market and that the technology rarely works as expected during infantile stages (Anderson & Tushman, 1990). Additionally, incumbents tend to increase innovation advancement within existing technologies in order to compete against novel innovations from the new technological regime. Moreover, Abernathy and Utterback (1978) refers to this emerging stage as *fluid phase*, which is characterized by major uncertainties, where different technological designs compete against one another. Where the innovation efforts are mainly targeting users' needs and their feedback to further develop technologies to meet market demands, i.e., that this phase is more of an experimental nature (Abernathy & Utterback, 1978). Further, the production plants are small-scale located near the users or the source of technology and the production processes are relying on skilled labor (Abernathy & Utterback, 1978). Similarly to Anderson & Tushman (1990) and Abernathy & Utterback (1978), Teece (1986) refers to this emerging phase as *preparadigmic phase* and emphasizes that in such phases, it is important for firms to remain flexible until an industry standard has been set. Teece (1986) exemplifies the importance of flexibility by highlighting the automobile industry, where the pioneering firms that chose the design of steam cars had to leave the industry as the closed combustion engine became the industry standard. Teece (1986) claims that the model proposed by Abernathy & Utterback provides good explanatory power in mass market industries where manufacturing and economies of scale are important, while consumer taste is rather homogenous, but that it lacks explanatory power when addressing other emerging industries. However, both Teece (1986), Abernathy and Utterback (1978) and Anderson & Tushman (1990) claim that there is a high level of technological uncertainty and experimental character in the industry when radical innovations are introduced. This is partially due to the newness of the innovation and the low understanding of consumer needs and reactions.

Furthermore, Malerba and Orsenigo (1997) separates industry development into two distinguishable patterns; *Schumpeter Mark I*, and *Schumpeter Mark II* industries. Mark I industries are characterized by low barriers to entry, due to the technological uncertainties and rapid shifts in technological development, which makes it possible for new firms to constantly enter the market. Both Abernathy and Utterback (1978) and Anderson and Tushman (1990) bring up firm size as an element that changes over time, where infant industries tend to be made out of smaller firms whereas the specific phase and era of incremental change consists of a relatively smaller number of larger firms. This is challenged by Utterback and Suaréz (1993) who claims that it is not firm size that is the decisive factor per se and states that innovative firms tend to come from outside the industry, i.e., that innovative firms in infant industries could be of different sizes, and that the common denominator is the fact that they enter from outside the industry (Utterback & Suaréz, 1993). Anderson and Tushman (1990) further nuance this phenomenon, pointing out that competence-destroying discontinuities are often driven by firms outside of the industry, whereas competence-enhancing is often driven by incumbents.

An important aspect in the literature of industry transformation is the notion of *dominant design*, which is defined as "(...) a single architecture that establishes dominance in a product class" (Anderson & Tushman, p. 613). Abernathy and Utterback (1978) further highlights that the dominant design is the accumulated result from a number of innovations, thus resulting in standardization which will help to streamline the production process. However, breakthrough innovations have the possibility to achieve stability as the industry applies the technology to a higher extent. However, this does not mean that the design is of dominant characteristics. According to Anderson and Tushman (1990), the strictest selection criteria is when one particular design accounts for more than 50 percent of the market, meaning that only one design can accomplish this criterion, ultimately resulting in a dominant design. The emergence of a dominant design could emerge by different drivers. Anderson and Tushman (1990) discuss the following categories which are:

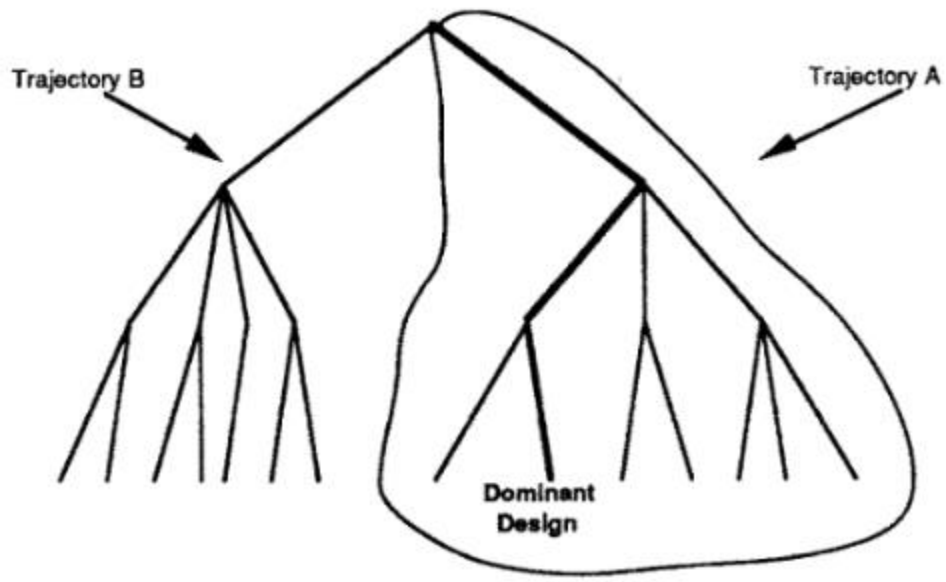
- Powerful user
- A dominant producer
- Industry committee

- Government regulation

Dominant designs are argued to be behind the technological performance frontier, the reason being that the design reflects the set of social, technical and political forces. As dominant design emerges when it covers more than 50% of the market, it needs to cater to a large array of needs. Usually, the designs that are located at the performance frontier have some drawbacks, not uncommonly with regards to price or social concerns. Therefore, there are other factors that influence what product or process becomes a dominant design other than pure technological performance (Anderson & Tushman, 1990). In addition, the authors argue that a technological discontinuity cannot become a dominant design. This is due to the fact that first versions or technological discontinuities fail to become standards due the technical variation present during the era of ferment, and that those versions improve along with the era of ferment (Anderson & Tushman, 1990). To this background, it should be noted that technological discontinuities can evolve into a dominant design but can never become one in itself. Furthermore, Utterback and Suaréz (1993) nuances the notion of technological trajectories, which in the extension might, or might not lead to a dominant design. Utterback and Suaréz (1993, p. 6) defines a technological trajectory as "(...) a path of technical progress established by the choice of a core technical concept at the outset". Figure 6 illustrates the aforementioned technological trajectories and how one of these emerges into a dominant design.

Figure 6

Technological trajectories and emergence of a dominant design



Note: Figure taken from Utterback and Suaréz (1993)

Technological trajectories are depicted as trajectory A or B illustrated in Figure 6, which subsequently diverges into additional paths, where only one leads to a dominant design. More contemporary literature conveys critique in this regard by proving that some industries are characterized by a development pattern where several designs continue to have large market shares, a pattern where the industry fails to adopt a dominant design, such as the lightbulb industry with three vastly different technologies who coexist according to Bergek and Onufrey (2014). However, the authors also convey that such development patterns are unlikely and exist only in a few industries.

Considering the fact dominant design is not portrayed as a radical change, instead it is about a creative set of existing technologies and knowledge about the end-users (Utterback & Suaréz, 1993). An example of this is the well-known QWERTY keyboard. There are currently better technological solutions available which allows for more rapid typing due to a superior design than the design of QWERTY. Despite such outperforming designs, the QWERTY keyboard has strong-, or almost total dominance in the market (Suaréz & Utterback, 1993). The emergence of dominant design will contribute to a shift in competition towards process oriented innovative activities and standardization (Suaréz & Utterback, 1993). Furthermore, organizations that struggle with this transition will experience difficulties in competing in the industry and will eventually be forced to leave the industry, thus causing a shake-out period during the transitory phase.

3.2.3 Transitory Phase

The transitory phase of industrial innovation patterns shows significant differences in comparison to the infant phase. In contrast to Mark I industries, which are defined as widening, meaning innovation focus is dispersed in many different directions as they mainly are derived from a wide range of smaller firms. On the contrary, Mark II industries reveals a deepening pattern, where innovative capacity is more concentrated and distributed across a smaller number of relatively larger size firms, where stability of ranking of innovators is greater (Malerba & Orsenigo, 1996). Further, the widening pattern is characterized by a lower variety of innovation, where firms are more homogenous in regard to their innovative efforts, this synergizes well with the idea of the emergence of a dominant design. Hence, the Schumpeter Mark 1 terminates when both the fluid phase and era of ferment terminates.

In Schumpeter Mark II industries, incumbent firms are dominant in terms of innovative capabilities since the accumulation of knowledge is a decisive factor for the future innovative capacity (Malerba & Orsenigo, 1995). Furthermore, Mark II industries display similarity to the era of incremental change as described by Anderson and Tushman (1990). The era of incremental change emerges as a consequence of the emergence of a dominant design. This era shifts both the innovatory characteristics, as well as its drivers. Meaning that innovations tend to be of incremental or continuous character and are mostly a result of the innovatory capacity of a smaller number of firms of larger economic value (Anderson & Tushman, 1990). Much similar to the characteristics of the definition of Mark II industries, it is also found that such continuous innovations are targeted towards refining the dominant design rather than challenging the industry standard (Anderson & Tushman, 1990). Similarly to how the era of ferment and fluid phase terminates as a dominant design emerges, Teece (1986) claims that the end of the pre paradigmatic phase terminates as the competition shifts from trying to identifying what will emerge as the dominant design to instead center around to economies of scale and price as volume increases.

In connection to Abernathy and Utterback (1978), it could be argued that both the transitional phase and the specific phase are describing similar industry patterns as Anderson and Tushman (1990)'s era of incremental change. Similar to how the emergence of a dominant design terminates the era of ferment, it could be argued to also terminate the fluid phase and hence give ground to the transitional phase as described by Abernathy and Utterback (1978). The transitional phase is less devoted to giving ground to new radical innovations, and more devoted towards increasing the price performance ratio by a focused development. This often entails a shift from product innovation to process innovation. Further, the transitional phase is characterized by developing a family of products based on the dominant design (Abernathy & Utterback, 1978).

A key characteristic for the industry dynamics within the transitory phase revolves around the shakeout of firms. Factors that decide which firms manage to survive the shakeout are elaborated in several articles such as Suaréz & Utterback (1993); Klepper (1996) and Jovanovic & MacDonald (1994). As the dominant design has emerged, there will be a natural shakeout of the firms who decided to pursue other designs (Suaréz & Utterback, 1993).

3.2.4 Mature Phase

Both the paradigmatic phase (Teece, 1986), the era of incremental change (Anderson & Tushman, 1990), the specific phase (Abernathy & Utterback, 1978) and Schumpeter Mark II (Malerba & Orsenigo, 1997) are the ending stages before the cycle repeats itself, hereby collectively categorized under "mature phase". This is a phase where many of the patterns incepted during the transitory phase are further built upon. Competition tends to revolve more around cost reduction than increasing performance of the product or service, and if the design of the product is changed, it is rather in the forms of elaborating the current dominating design rather than competing against it (Tushman & Anderson, 1990). This is often achieved due to automatization of processes which reduces the need for highly specialized competencies, which are present during the infant phase, in contrast to mature industries where the competencies needed lie more within monitoring and controlling (Abernathy & Utterback, 1978). The downside of such automatization is the decreased degree of flexibility which impacts the cost of introducing new changes, both in processes and the products themselves, this is one of the reasons for the shift from more radical types of innovation to incremental innovations. Despite the shift of innovation characteristics, it is argued that most of the innovation process is achieved during the mature phases rather than infant or transitory stages (Myers & Marquis, 1969; Rosenberg, 1976; Anderson & Tushman, 1990).

Malerba & Orsenigo (1997) claims that the innovative activity is highly concentrated among a small number of larger firms where the importance of contribution of smaller firms is relatively low in comparison to earlier phases. This is partially due to the difficulty entering the industry in such phases in combination to the shakeout period during the transitory phase. As earlier stressed, barriers to entry are also high due to increased process innovations (Anderson & Tushman, 1990), which establishes conditions for incumbents to produce goods at competitive prices, thus discouraging new firms to enter the industry. The competition between the active firms is fierce and largely centered around rivalry regarding market shares due to the limited market growth (Suaréz & Utterback, 1993).

3.2.5 Conditions of Technological Regimes

Similar to the concept of industry life cycles, Malerba and Orsenigo (1990, 1993) lay out four conditions that combined determine the technological environment in which firms operate, which is known as the technological regime of an industry (Malerba & Orsenigo, 1997). The literature presented in Table 4 immerse into the concepts of opportunity, knowledge cumulativeness, appropriability and knowledge base which subsequently have implications on the viability of innovation- and imitation-strategies.

Table 4
Conditions of technological regimes throughout industry maturity phases

Condition	Infant phase	Mature phase
Opportunity	High	High
Knowledge cumulativeness	Low	High
Appropriability	Low	High
Knowledge base	Low/High	Low/High

Note: Table 4 has been constructed by building on the foundation of Malerba and Orsenigo (1990, 1993, 1997)

Opportunity conditions refer to the easiness of innovating which is further consisting of four basic dimensions (Malerba & Orsenigo, 1997):

- Level - The level of opportunity is a decisive factor for the degree of incentives to undertake innovative activities. Where a high level of opportunity allows for a high probability of innovating in relation to the number of resources used.
- Variety - High opportunity qualifications are often correlated with a wide range of technological solutions, approaches and activities which is most common in the beginning of an industry life cycle.
- Pervasiveness - High pervasiveness refers to new technology and knowledge being applicable to several different industries. In contrast, low pervasiveness will only be applied in few or in some cases only one industry.
- Source - Various sources lay ground to the main driver for innovations among different industries. In some cases, Universities are the source for contributing to radical innovations, while in other cases, innovations are the results from advancements in R&D and related activities. In addition, end-users and suppliers can be an essential source for innovations for certain industries.

The condition of cumulativeness reveals information regarding how today's innovative activities will affect the innovative activities tomorrow. In essence, the innovators of today are due to cumulative conditions more likely to be the innovators of tomorrow if there are cumulative conditions in the industry. This is further derived from three basic dimensions;

- Learning processes and dynamic increasing returns at the technology level - New technological knowledge is built upon prior experience and expertise which has been done historically.
- Organizational sources - Cumulativeness can contribute to developments through R&D facilities and provide a relatively stable flow of innovations. The sources of cumulativeness are most likely firm-specific, meaning that the firm's internal capabilities will determine the scope of innovations obtained.
- Success breeds success - Prior success and market response can be related to cumulativeness from R&D, investments, technical performance and profitability. It can

be argued that past innovative successes enable organizations to reinvest in these activities to increase the likelihood of creating new innovations.

The appropriability conditions are largely concerned with agents' possibility to protect its innovative activities from imitations, ultimately allowing firms to reap the benefits for its innovations. This is further divided into two basic dimensions;

- Level - The level of appropriability is determined by the ability for firms to protect their innovations. Conversely, a low level of appropriability is evident in industries with high knowledge spillovers.
- Means of appropriability - Means of appropriability is concerned with the different ways of protecting said innovations. Such ways include patents, secrecy or the existence and control of complementary assets.

The knowledge base is crucial for innovative activities as it is upon such knowledge that innovations are built. This is further divided into the nature of the knowledge itself, and the means of knowledge transmission. The nature of knowledge is further divided into four basic dimensions;

- Generic or specific - the knowledge could either be generic or specifically connected which reduces its applicability for other innovative activities.
- Tacit or codified - the knowledge could be either tacit or codified which determines the level of documentation, codification and transmission.
- Complex or simple - the knowledge could be more or less complex or simple regarding both integration and the competencies needed for innovation.
- Independent or systemic - the knowledge could be specifically delimited to a certain function or dispersed throughout an organization or a larger system.

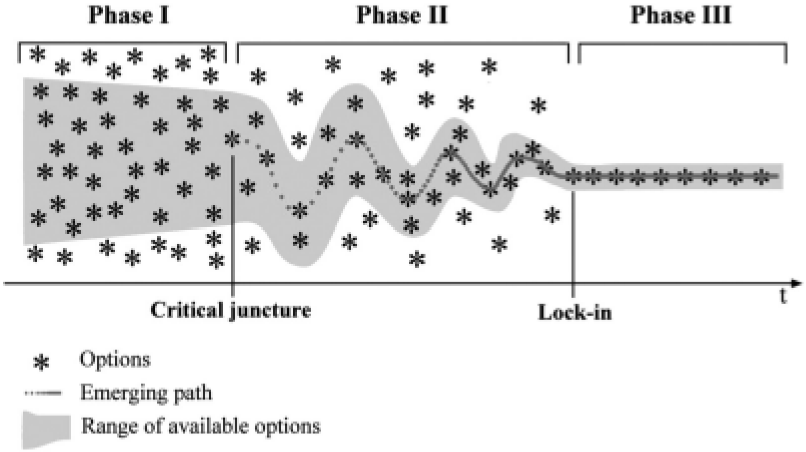
Further, the means of knowledge transmission is largely dependent on the basic dimensions of the nature of the knowledge base. Knowledge that is generic, tacit, complex and systemic, the better fit is knowledge transmission of more informal character. The opposite connection is observed when knowledge is more specified, codified, simple and independent. Such knowledge bases fit better with more formal ways of transmission such as license, publications and publications (Malerba & Orsenigo, 1993).

3.3 Path Dependence and Self-reinforcing Mechanisms

As elaborated in the theory of industry life cycles, it is evident that there is competitive turmoil during the infant phase where there is rivalry between technological regimes. During such rivalries, the theory claims that incumbent firms tend to defend their outdated products or processes. This pattern has been witnessed in an abundance of industries and technologies such as when Netflix challenged Blockbuster (Teece, 2010) or when Kodak failed to become digital (Lucas & Goh, 2009).

The former theoretical sections put a large emphasis on how market- and technological dynamics differ throughout an industry’s life cycle. However, it shares little insights into the difficulty for firms to achieve flexibility and adaptability needed to withstand the challenges embedded in new discontinuities. This begs the topic of *path dependence* and its constituting factors. Path dependence is sometimes falsely used to signal that history matters for the future. While this is naturally true, the concept of path dependence is far more specific. Originated by David (1985), the terminology of path dependence is exemplified by the QWERTY keyboard setup, that was carried over from its predecessor, the typewriter. This design has been dominating the markets for long, despite other more effective designs such as the Dvorak keyboard. In this setting, the theory of path dependence aids in understanding why both organizations and consumers make certain choices due to historical events. Schreyögg et al. (2011) further nuanced the notion of path dependence by driving on earlier work of Arthur (1989, 1984) as well as Beyer (2010) and gives prominence to four effects or self-reinforcing mechanisms. Combined, these self-reinforcing mechanisms have implications on a firm's flexibility of options.

Figure 7
The constitution of an organizational path



Note: Figure taken from (Sydow et al. 2009, p. 692)

As illustrated in Figure 7, the options available for any given firm is dependent on its positioning in its organizational path, where the options decrease along the phases. The initial phase is characterized by a wide range of actions and the decisions taken in this phase cannot be foreseen by prior events (Schreyögg et al. 2011). However, the gray shade in Figure 7 illustrates that the range of available options are not completely open, as all choices are dependent on the past. Along the path, the firm eventually reaches what the authors refer to as a *critical juncture.* The critical juncture is the point where the self-reinforcing mechanisms described below sets in, which is also the inception of the second phase. This is the point of development where a firm builds its path, where building a path also means excluding other paths as illustrated by the options (*) outside of the gray shaded area. Eventually, firms might find themselves in a scenario where the options are dramatically limited, often due to some effects, also referred to as self-reinforcing mechanisms which are elaborated below. In the long term, this can create difficulties for organizations that compete in environments that require flexibility. This is further underpinned by many authors. For instance, Lieberman and Montgomery (1998) claims that this a common problem for first-movers as uncertain markets and technologies could be subject to swift changes which poses tremendous challenges for firms positioned in phases of lock-in.

3.3.1 Coordination Effects

Coordination effects emphasize the benefits of rule-based behavior, as more organizations apply and adapt to a specific rule or routine, the more well-organized and effective the interaction will become among these (Sydow et al., 2009). The authors further highlight that this effect will be more powerful as the adoption increases, the reason being that rule guided behavior contributes to anticipate reactions in advance and mitigate risks associated with it. An example of coordination effects related to organizations is working-time regimes which will provide efficient cooperation, both internally and externally (Schreyögg & Sydow, 2011).

3.3.2 Complementarity Effects

Complementarity effects originate from economies of scope, which signifies that the costs of producing and selling goods or services are lower when these are provided jointly rather than producing and selling them separately (Sydow et al., 2009). In a broader sense, this effect can be utilized when synergies can be exploited by combining two or more interrelated resources, rules or practices (Sydow et al., 2009). In addition, Teece (1986) emphasizes that complementarity assets are part of a system, and successful innovations need to take advantage of these, such as how software is interlinked with hardware, i.e., in the computer industry. Further claiming "Since the core technology is easy to imitate, by assumption, commercial success swings upon the terms and conditions upon which the required complementary assets can be accessed." (Teece, 1986, p. 291).

3.3.3 Learning Effects

Learning effects explains how the frequency of an operation is connected to efficiency in the very same operation (Sydow et al., 2009). Ultimately, this has implications on the marginal cost for production due to enabling an operation or process that is more reliable and faster (Sydow et al., 2009). In extension, the presence of learning effects further increases incentives of utilizing a certain way of working due to efficiencies obtained from previous learning effects. Conversely, this reduces incentives to change to other operations due to the switching costs. It is argued by Sydow et al. (2009) that the presence of such effects tends to lead organizations to put attention towards incremental improvements as it is more likely to gain acceptance in comparison to alternative options, ultimately making firms more inclined to be engaged in local search, i.e., meaning that firms look for opportunities that are positioned within the shaded area in figure 6.

3.3.4 Adaptive Expectation Effects

The theory of expectation effects states that agents' expectations about the future choices of other agents could affect the adoption of a certain technology (Arthur, 1989). This sort of effect is not too far-fetched from the theory of coordination effect. The difference lies in that expectation effects as opposed to coordination effects seek a more implicit type of advantage that is referred to as being on the winning side of technology battles. This in turn provides a feeling of social belonging (Sydow et al., 2009).

Combined, the presence of aforementioned mechanisms affects organizations' number of alternative choices. Ultimately, this suggests that both organizations and industries tend to gravitate towards one technology, or in relation to earlier theoretic sections; a dominant design (Onufrey & Bergek, 2013).

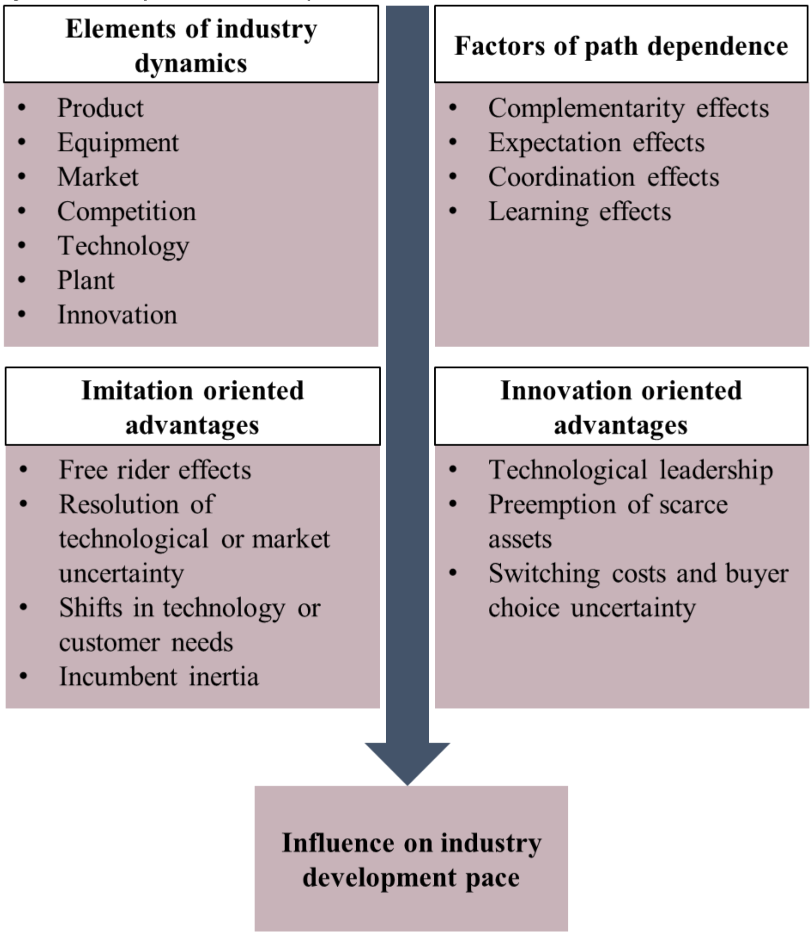
3.4 Synthesis of Theoretical Foundation

The ambition for this thesis is to explore how the viability of innovation- and imitation-oriented strategies are influenced by industry maturity. Specifically, in industries of emerging character where technology is embedded in the product or process. Then, the thesis also partly aims to assess how this might influence the development pace of an industry of such emerging character. In order to attain such insights, the thesis draws from theory of industry transformation and industry life cycles in order to address what elements change as an industry matures, and how such elements transform. It also draws from theory of both first-mover advantages and imitation advantages in order to address what factors are important in assessing the viability of such strategies.

Regarding the framework of path dependence, our expectation is that the factors constituting the framework presented by this thesis also have an effect on the viability of both innovation- and imitation-oriented strategies. For instance, if there are a high degree of learning and investment effects in combination with a high degree of knowledge cumulativeness, this implies that there could be first-mover advantages. Reason being that a first-mover would have more time to accumulate learning effects. Such learning effects could for instance be related to production efficiency or market knowledge, stemming from incremental innovations in production or consumer knowledge. However, this is also largely dependent on the presence of appropriability conditions and knowledge spillovers. Therefore, another point of view is that investment and learning effects affect the viability of first-mover- and imitation strategies, which subsequently are dependent on the presence of appropriability conditions. To this background, a theoretical synthesis has been conducted, where the insights from the theoretical condition has been illustrated in Figure 8.

Figure 8

Synthesis of theoretical frameworks



Note: self-constructed

Drawing on the previously stated fact that industrial elements tend to evolve as an industry matures. This thesis is specifically concerned on how these elements in emerging industries influence the viability of innovation- and imitation-oriented strategies. This is illustrated in the quadrants of elements of industry dynamics and factors of path dependence in Figure 8, which has an influence on the two other quadrants of innovation- and imitation oriented strategies. Combined, all four quadrants are expected to have an influence on the industry development pace as illustrated by the gray arrow. This relationship is estimated due to the literature of Barro and Sala-i-Martin (1995), Mukoyama (2003) and Zhou (2006) who claim that the incentive for firms to innovate lessens when there is opportunity for imitators to imitate. In contrast, Schumpeter (1942); Bessen and Maskin (2009) and Raustiala & Springman (2006) claim that imitation might actually spur innovation.

4. Methodology

This chapter includes detailed information regarding the research strategy, research design, research methods, data collection, research quality and its following subsections. It is tied together by an integrative discussion of the following topics, as they combined lay the foundation for the methodology of the thesis.

4.1 Research Strategy

The thesis is concerned with the development of an emerging industry and the effects thereof. According to Bryman and Bell (2015), a quantitative approach emphasizes quantification in the collection and analysis of the data, whereas the qualitative approach emphasizes words to further develop findings and form theory. Furthermore, the authors argue that a qualitative research strategy most commonly uses an inductive approach, which allows the researcher to generate new theories derived from the findings. In contrast, a deductive approach allows the researchers to generate hypotheses from theory and then gather data to validate the hypothesis (Bryman & Bell, 2015).

To this background, a qualitative research strategy was chosen as it would best fit the more complex nature of the research and to get a deeper understanding on the viability of innovation- and imitation-oriented strategies in emerging industries, in this case, the cultured meat industry. Adding to this, the uncertainty derived from investigating futuristic scenarios further adds to the complexity and uncertainty of the topic. An additional motivation for using a qualitative approach is that it allowed the respondents to contribute with insights as the respondents brought up information that the researcher did not know prior to the interview (Bryman & Bell, 2015). The qualitative research strategy was accomplished through interviews, which allowed the respondents to share their honest opinions and reasoning. In addition, this allowed for different perspectives as the respondents could speak openly and touch upon sidetracks that were perceived to be of importance.

Due to the complex nature of the research, the limited literature of innovation strategy in emerging industries and the newness of cultured meat industry, the research approach chosen was abductive, which is a combination of an inductive- and deductive approach (Saunders et al., 2016). This approach allowed the researchers to move back and forth between the two aforementioned modes, which was essential in this exploratory nature of research. Firstly, a deductive approach was used to start the process by gathering existing literature within the topic of innovation- and imitation strategy, as well as industry transformation and path dependence. Lastly, the chosen approach allowed the researcher to continuously improve the theoretical framework as new empirical data was collected, in order to confirm that the theoretical framework is relevant to the data.

4.2 Research Design

The function of a research design is to serve as a framework for the data collection and the data analysis. In addition, the chosen framework should provide an understanding of the prioritization of elements the research seeks to analyze, i.e., causal connections, understanding behaviors within a social context or generalizing within a specific group (Bryman & Bell, 2015). Moreover, the research design for this thesis is of *cross-sectional* character as it corresponds to the data collection from more than one single case, while still being at one single point in time (Bryman & Bell, 2015). The motivation behind the chosen research design was to collect data from more than one case, this contributed to a fuller picture with more diversity, stemming from the different perspectives which allows for variation.

The cross-sectional design enabled the thesis to attain insights from executives, as well as independent experts within the industry of cultured meat. Furthermore, due to the nature of the research, there are drawbacks related to the fact that causal connections cannot be made with certainty, meaning that it is difficult to say with certainty how one event is caused by another, thus manipulating variables is not an option (Bryman & Bell, 2015). However, the aim of this study is not to illustrate causal relationships, rather the objective is to contribute with insights on the viability of innovation- and imitation-oriented strategies in emerging industries, which ultimately is estimated to affect the development pace of the industry.

4.3 Data Collection

Considering the fact that cultured meat is a relatively new industry, there is limited research available. Hence, the strategy for primary data collection was to conduct qualitative interviews, more specifically semi-structured interviews with executives from cultured meat firms as well as experts within academia. In addition, this approach enabled the researchers to ask follow-up questions to get richer answers with more depth as well as it allowed for a high degree of flexibility (Bryman & Bell, 2015). Ultimately, this led to a more holistic approach which laid the foundation for both a wider, and a deeper analysis of the cultured meat industry and its influence on innovation- and imitation-oriented strategies. In addition to the primary data, a literature review was conducted to build a theoretical framework that would form the basis for the analysis.

4.3.1 Semi-structured Interviews

The rationale for conducting semi-structured interviews is that it allowed the researchers to ask questions from a preconceived list of questions, however the order of questions varied depending on the respondents, which allowed the participants to have a more natural conversation (Bryman & Bell, 2015). The authors further argue that the semi-structured interview approach was appropriate for this thesis as it allowed the interviewer to ask follow-up questions or ask for more detailed information in cases when a given respondent took an alternative course in the conversation that was not predetermined by the interviewers (Bryman & Bell, 2015).

One can argue that an unstructured interview approach would add more value since it provides for even more flexibility than the chosen semi-structured interview style. However, the researchers claim that such a strategy could lead to a conversation rather than an interview which could jeopardize the outcome (Bryman & Bell, 2015). Furthermore, semi-structured interviews allowed for better comparability, hence an analysis of higher quality. The approach also allowed for cross-case comparisons which enabled the thesis to make comparisons between respondents' answers and to present relationships between variables (Bryman & Bell, 2015).

Two separate interview guides (Appendix A & B) were conducted to form the basis for the interviews, attention was put to keep the language at a comprehensible level to the target audience and questions were constructed to reduce the likelihood of being of a leading nature (Bryman & Bell, 2015). One guide focused on the academic experts whereas one guide was targeted towards the cultured meat executives. The reasoning behind this is twofold; firstly, the questions to experts was more oriented to understand industry development with regards to the production technique from an unbiased perspective, whereas the questions towards the cultured meat executives was more oriented towards understanding their strategies and the future of the industry from their point of view, specifically in connection to innovation- and imitation-oriented strategies.

4.3.2 Selection of Respondents

The selection of respondents for the data collection was carried out through *purposive sampling*, meaning that respondents were not targeted by random selection, thus participants were selected by strategic choices that correspond to the relevance for the research questions (Bryman & Bell, 2015). Furthermore, the selected respondents had different roles, areas of expertise, geographical locations and organizations in order to ensure that the primary data included a high variety. However, one should pay attention to the fact that generalizations cannot be made for the population since this is a non-probability sampling (Bryman & Bell, 2015). Lastly, the aim was to interview individuals far up in the hierarchical level within the chosen industry. Since there is reason to believe that scientists, managers and other high-ranked executives have more knowledge within this complex field. This might however limit the availability of data collection as these respondents were difficult to reach. By including both executives within cultured meat firms as well as experts within the field, a wider perspective of insights was obtained. Due to the scarcity of cultured meat producers, a global scope was taken in order to maximize the potential to conduct valuable interviews.

To this background, a screening of companies was performed which listed a total of 39 firms all over the world. All 39 firms were contacted firstly through mail. In the event of no response at first point of contact, desired stakeholders were identified on LinkedIn and approached specifically. This field proved to be immensely difficult to attain interview respondents within. In total, 4 out of our 39 high-ranked executives within cultured meat firms accepted the interview request. In addition, a screening of scientists was also performed through the researcher directory of GFI which lists many of the most well-known alternative protein scientists. In total, 10 scientists were approached due to their field of expertise and 4 accepted the interview request. Both the executives and experts are listed in Table 5 and 6 below, the experts approved to not be anonymous whereas all executives except Dr. Serene Chng and Shiok Meats did not.

Table 5
Overview of cultured meat executives

Referred to as	Role	Date	Duration (min)
R1	Chief Scientific Officer	25/2	63
R2	Chief Executive Officer and Co-founder	3/3	76
R3	Strategy & Marketing Executive	16/3	59
Serene Chng	Head Of Research	8/3	65

Table 6
Overview of cultured meat experts

Name	Area of research	Citations	Date	Duration (min)
Christopher Bryant (PhD)	Main research area within consumer behavior, consumer psychology and food technology.	983	11/3	65
Jean-François Hocquette (PhD)	President of the French association for animal science. Main research area within muscle biology, muscle growth and beef eating quality.	13 296	11/3	70
Tom-Ben Arye (PhD)	Senior Scientist (GFI), main research area within cellular agriculture, tissue engineering, cultured meat and alternative proteins.	375	17/3	46
Andrew J. Stout (PhD Candidate)	Main research area within cellular agriculture, cultured meat, synthetic biology and metabolic engineering.	2316	23/4	64

4.3.3 Interview Setup

All interviews were held digitally due to geographical constraints. The software Zoom was used during all interviews, and all respondents received an email prior to the interview with a brief description and purpose of the study. When the respondents agreed to participate, an invitation was sent, and the different time zones were taken into consideration. Seven interviews were conducted in English, and one was held in Swedish. Furthermore, all interviews incepted with two mandatory questions, the first is whether the interview could be recorded or not, and if the respondent would like to be anonymous or not. Regarding the first questions of recording, 7/8 respondents accepted to be recorded under the condition that the recording's sole purpose was to perform accurate transcriptions and that the recording file was deleted without being shared to external parties when the transcriptions were finished.

4.3.4 Transcription of Semi-structured Interviews

Bryman and Bell (2015) claims that the process of transcription is extensively time consuming. In this case, it was argued that the value of transcribing the interviews was of high importance. To this background, a transcription software was used which allowed for a less time-consuming process. However, the disadvantage of such an approach was the time-consuming process of revising the transcripts in order to attain adequate transcriptions; this was achieved by comparing the video recording with the transcription. Nevertheless, the advantages of transcribing the interviews post the interview itself was that the interviewers were more focused and present, which further enabled the interviewers to pick up on reactions, which occasionally led to deviations from the interview guide which is part of the strength of semi-structured interviews. As explained, one respondent declined to be recorded which forced one of the interviewers to transcribe manually as the interview was ongoing. This was prepared for by always having both authors present during all interviews. In order to mitigate the risk of losing valuable information from this interview, the researchers summarized the insights directly in connection to the interview.

4.4 Data Analysis

The qualitative data has been used as the primary source of data and a thematic analysis has been used for analyzing the data. According to Bryman and Bell (2015), qualitative data is often unstructured and difficult to grasp, hence thematic analysis provides flexibility to analyze the findings. Furthermore, the high level of flexibility also allowed for interpretation by the researchers, which has the potential to influence the results of the thesis, hence thematic analysis is rather subjective. With this in mind, the codes were both predetermined based on existing theoretical frameworks as well as emerging through the empirical insights. The usage of emerging codes is specifically important when pursuing a semi-structured approach, as this increases the possibility of obtaining perspectives that were unexpected by the researchers.

The thematic analysis was conducted with the help of qualitative data analysis tool NVivo, where each theme had its own label and the data got tagged under each relevant category which can be accessed in Appendix G. NVivo, as recommended by Bryman and Bell (2015) proved to be of tremendous value when conducting the data analysis, not only does it allow for rapid thematic coding, it also allows for creation of word clouds which is an effective tool in identifying frequent themes in accordance with Bryman and Bell (2015). However, one should not disregard the fact that a computer assisted qualitative data analysis software (CAQDAS) such as NVivo cannot help in decisions regarding the creation of codes. Another risk of using CAQDAS is associated with research projects with several researchers, as coordinating the coding might become a difficult task when several people are involved. Therefore, all coding in NVivo was done in unison. Lastly, Bryman and Bell (2015) argue that CAQDAS such as NVivo pushes the researchers to develop codes that are interrelated, which can be beneficial in the progress as possible connections have been identified. In addition, some of the predetermined codes were less frequently used and some emerging codes were used to a higher extent, which resulted in some codes getting excluded from the thematic analysis.

4.5 Literature Review

A literature review serves as the foundation to complement the primary data for this thesis. This is primarily made out of articles with the following inclusion and exclusion criteria:

Table 7
Inclusion criteria for secondary data for the theoretical foundation

Inclusion criteria	**Exclusion criteria**
Relevant for the research question and overall purpose.	Research that includes the keywords but deemed as poor fit for the research or the overall purpose.
Written in Swedish or English.	Other languages than Swedish or English.

Mainly journal articles that are peer-reviewed, but also gray literature such as technical reports and web-based guidelines that are relevant and important to the research question.	Non-peer reviewed articles with questionable credibility. This could include studies sponsored by subjective parties such as meat-producers or other.
Mainly articles that are well-cited.	Poorly cited articles that reduce credibility.

The literature included consists of articles published in academic journals. However, literature published in business journals will also be included in order to attain insights of a more practical character. The ambition is to mainly include articles that are both peer-reviewed and well-cited as this increases credibility of the thesis which will be instrumental for the results and conclusion. However, this can in some instances favor articles with less recency which is why exceptions were made if needed. This is specifically important considering that the subject of cultured meat is a rather new phenomenon where most of the literature is more contemporary in its nature. Regarding the innovation literature, this research is both consisting of more historical articles upon which more contemporary literature are built upon. This allows for articles that are cited and peer-reviewed to a larger extent. Access to literature review will be channeled through several databases; Google Scholar, University of Gothenburg Library and Chalmers Library.

Keywords: Innovation strategies, Innovation-oriented, imitation-oriented, first-mover advantages, first-mover disadvantages, industry life cycles, industry transformation, industrial patterns, path dependence, cultured meat industry, order of market entry, cultured meat, cultivated meat, lab-grown meat

The keywords were included both in stand-alone as well as in combination during the searches. Several of the articles found through the keywords were later used for what is referred to as *snowball sampling* according to Bryman and Bell (2015), i.e., the references used in included articles were screened in order to find further literature of relevance. Exclusion criteria were used in order to attain a high quality of literature. This includes literature that fits the keywords but deemed irrelevant and articles that lack the high credibility needed to fit for inclusion. Lack of credibility could be derived both from a low number of citations, a lack of peer-review or studies that received sponsoring from subjective parties. Further, literature written in other languages than Swedish, or English were excluded due to the risk of misinterpretation and time consumption of translation. This was viewed as a non-significant challenge considering that the vast amount of literature on the subject is written in English.

4.6 Ethical Considerations

It is essential to keep an ethical perspective in consideration when conducting business research. Bryman and Bell (2015) argue that researchers can only make informed decisions if they are aware of issues of ethical concerns that can arise in business research. Bryman and Bell (2015) also highlight four main areas of ethical principles which will be further discussed below.

Harm to the participant is an important topic which can be both of physical and psychological characteristics. The latter can occur by putting the respondent's reputation and career on the line, for instance by including sensitive or confidential information in public reports which the respondents has not given approval to (Bryman & Bell, 2015). To avoid this, all respondents have had the opportunity to remain anonymous, both regarding their personal information, but also the organizations. To ensure this at an even greater level, all respondents have received emails with quotes included in the report with the possibility of both approving or disapproving the quotes added. In cases of disapproving, the quote is removed completely. This information was shared with the respondent at the start of the interview.

Lack of informed consent can arise when respondents have insufficient information regarding the objectives and purpose of the report, which can therefore result in making an uninformed decision whether or not they want to participate (Bryman & Bell, 2015). Risks associated with this have been considered by thoroughly communicating the purpose and objectives of the report. This was done when the invitation was sent and also at the time of the interview. The interview request is visible and attached in Appendix C.

Invasion of privacy is considered to be an ethical breach if the respondents' privacy in the form of values are disrespected (Bryman & Bell, 2015). However, the nature of this study is largely academic and professional which reduces risk for privacy intrusion. In order to further minimize the risk, each interview is set off by clearly stating that it is always the respondents right to refuse to answer any question.

Deception can take place when researchers describe and represent their research as something other than what it actually is (Bryman & Bell, 2015). This is similar to lack of informed consent, but the difference is that deception occurs when the researchers falsely describe their objectives and want to limit participants' understanding of the research. This is partially mitigated by including the interview request guide in the appendices. In addition, at the start of each interview, the objective and purpose of the report was discussed to make sure that the respondents understood these.

4.7 Research Quality

The following section will discuss potential risks associated with a qualitative research method. According to Bryman and Bell (2015), qualitative research has often been criticized for being too subjective and evocative. However, two criteria will be further analyzed to mitigate potential drawbacks of the thesis which are; *reliability* and *validity* as these are deemed to be specifically important for business research (Bryman & Bell, 2015).

4.7.1 Reliability

External reliability takes into consideration whether the research findings are repeatable or not (Bryman & Bell, 2015). As previously mentioned, the high degree of interpretations of the researchers and semi-structured interview style make it difficult to replicate the findings of the thesis in contrast to a structured interview style. However, an unstructured interview style is considered to be the most difficult one to replicate due to the high degree of interpretation and flexibility together with a low degree of comparability. To this background, the chosen strategy will enable further research to be conducted simultaneously as it creates an opportunity to allow the thesis to provide valuable insights for such research. In addition, the follow-up questions resulted in even more difficulties for replication of the study. However, to increase reliability of the thesis, the researchers conducted an interview guide, which is illustrated in Appendix A and B.

According to Bryman and Bell (2015), when there is more than one researcher or member of the research team, problems can arise between the researchers to reach agreement upon findings. In order to mitigate such risks, the researchers have continuously held transparent discussions to make sure that they were on the same page. In addition, transcriptions have been analyzed by both researchers and coding in thematic analysis was done as a team, hence working in silos during coding and analyzing was not permitted.

4.7.2 Validity

Internal validity is concerned with how well the model measures the observations and if the research process is free of error (Bryman and Bell, 2015). Regarding the part of implementation of the research process, the researchers deem it to meet the criteria of validity as both researchers conducted all interviews in unison, with an emphasis on carrying out the interviews in a similar fashion. However, the interviews are semi-structured which might add some variability in the interviews which is part of the semi-structured approach's strength.

External validity is regarding the degree of generalizability across other social settings than the one chosen (Bryman & Bell, 2015). In this regard, one should underpin the fact that the thesis uses a non-random sampling approach, meaning that the external validity of the thesis is sub-optimal, this has been partially mitigated by transparent inclusion criteria and delimitations found in previous sections. However, by both including executives and independent researchers on a global scale, with different competencies and positions and multicase study, one can argue that these choices have increased the external validity.

Similar to how there are overarching maturity patterns between industries, there are still differences between industries of similar maturity. Such differences will affect the generalizability of the research. For instance, the cultured meat industry is a highly technological process industry with a product that is largely similar to the product it aims to replace. This is likely to have an implication on the generalizability of the research. This synergizes largely with what Bryman and Bell (2015) refers to as transferability. Transferability is concerned with the applicability of the findings in the study to other studies. Further, Bryman and Bell (2015) emphasize that studies of qualitative character are likely to fail in regard to transferability, as such studies tend to study smaller samples. In addition, this suggests that qualitative research should be transparent regarding methodological approaches, specifically regarding amount and characterization of respondents, methods for data collection, date and time for the interviews. As previously elaborated, this study has followed all recommendations regarding the transparency of methodological approaches and qualitative studies. In conclusion, this increases transferability to other contexts or settings.

5. Empirical Findings

This section presents the empirical findings from the semi-structured interviews with anonymous executives as well as experts in the field. The data shared by the respondents has been divided into the main theoretical themes of the thesis; innovation- and imitation-oriented strategies, industry transformation, technological regimes and path dependence.

5.1 Innovation-oriented Strategy

Several respondents claim that they foresee advantages from being early in the industry of cultured meat (R1, R2, Dr. Chng and Dr. Bryant). R2 further stresses the importance of being first in an industry which have a high degree of technological involvement and further states that:

> "There are advantages in being early in technology-based industries, such as the one of cultured meat" - R2

This industry has shown some distinctive characteristics regarding the incentives to innovate. Dr. Bryant explains that many pioneers in this field are mission driven and incentivized from two overarching perspectives. Firstly, many people in this industry entered due to environmental concerns, where the main ambition is to reduce the externalities stemming from traditional meat production. Secondly, many people ended up in the industry due to their concern for animal welfare, which is largely what drove Dr. Bryant himself. This combined, is argued by Dr. Bryant to increase the incentives for firms to develop the industry as a whole, not just the profitability of the specific cultured meat firm. This is exemplified by drawing comparisons to the industry of electric vehicles.

> "I think that maybe there is a higher propensity for companies to do as Tesla did a few years ago, making their intellectual property open source. Because, the idea is, we do not just want to be the ones making money off electric cars. We want electric cars to be a thing. And in this instance, it is beneficial to that happening overall. If the IP is more widely available such that the infrastructure can be built." - Dr. Bryant

5.1.1 Technological Leadership

The importance of patents has been communicated in several interviews. This is a method for firms to keep the knowledge proprietary. The existence of patents is also closely related to first-mover advantages in the sense that it reduces knowledge spillovers from R&D and innovation. Dr. Bryant further states that:

> "(...) so I think that from an individual firm's perspective, there must be economic advantages to being first in the sense of having IP, like patents." - Dr. Bryant

Dr. Chng mentions that their organization is applying for patents and quotes that:

> "We have patents when it comes to isolation technology and specifically related to the species we are covering, so other companies tend to innovate within other species" - Dr. Chng

Furthermore, R2 mentions that technological edge can either be gained through patenting or by incorporating trade secrets to a higher degree. R1 has a similar approach to this topic and further highlights that:

> "There is high security within biotech firms, the plants usually have 12-foot-high fences, a lot of cameras, guard houses and securities." - R1

Similarly, Mr. Stout shares a similar perspective, namely that cultured meat firms are closed off and do not share any information.

> "It may be a self-perpetuating cycle because none of the companies are talking, and so there's no disincentive to be quiet because all of your peers are quiet." - Mr. Stout

Even though it is evident that protecting knowledge is a key component of managing to obtain technological leadership, it is also evident that the tools used for this endeavor have associated drawbacks. For instance, Dr. Bryant mentions that there is a divide between the interest of individual firms to deliver value for its stakeholders, and the industry advancements as a whole. This is specifically important in relation to patents, where Dr. Bryant argues that patents could be used in a way to protect against knowledge spillovers, simultaneously, that might also hamper industry advancement on an aggregated level. In addition, Dr. Bryant adds that the key actors within the cultured meat industry are often mission driven, he exemplifies this by claiming that Dr. Mark Post is mainly motivated from an environmental point of view whereas himself and many of his colleagues are concerned about animal welfare.

> "(...) it seems that a lot of the company's value is in intellectual property and the ability for developing advantages at this stage. But as I see, there are more forces in this industry than you might see in other industries. Pushing towards getting funding for open access research and making the industry be kind of beneficial overall. Of course, it's still going to be subject to concerns for shareholders." - Dr. Bryant

Even though several respondents have given power to patents as an important tool in knowledge protection, opposite standpoints have also been shared. For instance, Dr. Bryant mentioned that one of the key patents within cultured meat technology will expire during 2022. The patent has been licensed for over 20 years by first-movers within the industry.

> "Basically, when it comes to intellectual property. There can often be a very broad first patent for the concept of cultured meat overall, right? And this, I think, has now expired (...) But the very broad patent of the concept goes quite some way to making the technology more accessible to others." - Dr. Bryant

5.1.2 Preemption of Scarce Assets

The interviews shine light on a few key assets that are deemed to be the foundation of future success within the industry. These key assets include competences within the cultured meat technology and traditional meat industry as well as marketing and business competences. Dr. Hocquette states that the main scarcity of key assets is talented personnel, whereas capital seems to be of less importance.

> “According to the proponents of cultured meat themselves, they don't need more money; they need skills and expertise due to the huge technical challenges of cultured meat.” - Dr. Hocquette

Similarly, Dr. Arye also underlines the rapid increase in funding, while also acknowledging the lack of qualified talent in researchers and scientists. Dr. Arye, Dr. Hocquette, R2 and Dr. Chng stress the importance of highly skilled researchers within the field of cultured meat. The majority of people working within these organizations are working with activities related to R&D and technologies. R2 mentions that around 80% of the employees are working with R&D, whereas Dr. Chng mentions that around 50% of the personnel are in R&D. Furthermore, it seems to be a challenge to acquire the right competencies in the industry, Dr. Arye further highlights that:

> “The main bottleneck in the Israeli cultivated meat ecosystem is the availability of researchers.” - Dr. Arye

This view is also shared by Mr. Stout who discusses the lack of qualified personnel and further claims that the non-compete clauses of California allows personnel an increased mobility to sign employment at other firms. Which is in contrast to the other suggested hotspots for the cultured meat industry of The Netherlands, Israel, Singapore and the U.S that were brought up by R1 and R3.

> “California has no non-compete clauses, so it is illegal for a company to prohibit you from moving to your competitor and that is part of the reason that California has become this really big cluster point for tech- and biotech companies.” - Mr. Stout

R2 mentioned that cultured meat firms generally are talented at R&D related activities but lack the knowledge when it comes to consumer goods and how to launch products in the market. R2 emphasizes the fact that this is a fast-moving consumer goods (FMCG) that requires specific branding and marketing competences in addition to the R&D intensive and innovative competences. Further, this is achieved by introducing partnerships with traditional meat producers with strong brand recognition, suggesting a strategy of private labeling.

> “In our case, we will go with an established brand (...) we should keep our efforts on the technology, and they can bring it into the market directly.” - R2

The view that cooperation with traditional meat incumbents is of great value is shared by other respondents. Dr. Chng claims that the anticipated go to market strategy will be through private labeling or co-branding with major food companies that have experience in producing end products within the food industry. Dr. Chng claims that this is a way of tapping into the competences that have been built up during an extensive amount of time in these companies. When asked about the motivation for pursuing crustacean products, Dr. Chng claims that this decision was taken due to absence of such development from other firms.

> “So, this was our CTO and our CEO's decision. It made much sense at the time because there were no crustacean cultivator companies and few seafood firms at the time. I mean, because there are a lot of red- and white meat companies. So that is why they wanted to move to an area that's a bit more niche.” - Dr. Chng

5.2 Imitation-oriented Strategy

Most respondents claim that trade secrets and patents are an important tool in protecting against imitation. However, several respondents also acknowledge the risk of potential imitation. R1 claims that similar patterns have been played out in history and further exemplifies this by telling the story of Tyson Foods and Beyond Meat. Where Tyson bought a 6,5% stake of Beyond Meat and sold off the investment with a high return.. Since then, Tyson Foods has launched their own brand of both plant-based and hybrid foods. In this regard, hybrid foods refer to a product which uses both traditionally produced meat as well as vegetarian inputs.

> "Tyson Foods exploited their investment in Beyond to gain knowledge, sold their shares with profit and then started a new brand of vegetarian and hybrid meat substitutes, this is what all large meat producers are doing, look at JBS and Cargill for instance." - R1

> "The transition between traditional meat production and cultured meat is quite reminiscent of the downfall of Nokia and Kodak, but the biggest companies are investing in this and trying not to end up on the sidelines. Tyson and Cargill are trying to develop their own plant-based products, which they did not see coming so quickly." -R3

R1 also mentioned that traditional meat companies are conservative when it comes to innovation and will generally only invest in new companies or technologies when they have to. In addition, these giant firms have tech-scouts which constantly seek for new innovative solutions or firms to invest in. Furthermore, it seems to be common for incumbents to create incubators whose sole purpose is to invest in disruptive innovations such as cultured meat startups.

> "Firms send out tech-scouts, because there is less risk and commitment, specifically since they cannot develop cultured meat by themselves. The traditional meat industry generally put low emphasis on innovation, we invest when we have to." - R1

However, respondents claim that the risk of innovation is dependent on what kind of product is being developed. Dr. Chng underpins this by stating that the choice of species is of importance when it comes to the risk of being imitated. Reason being that the majority of available research is within land species, specifically cattle and chicken, and not within seafood and niche markets like crustaceans.

Another aspect that is brought up regarding the risk of imitation is that several respondents see this as a disjointed market in the sense that it will be very unlikely to witness a development to a "winner takes it all industry". The reason for this is three-fold, firstly both Dr. Chng and R2 bring up the topic of geographical or cultural preferences, claiming that there are speaking differences between regions when it comes to food habits and more specifically food preferences. For instance, there are differences among the Muslim and Jewish community, in the same way that there are differences in food preferences between the population of Singapore and Israel. The second argument for the dis-jointed market structure is concerned with the externalities of transportation, as this is contradictory to one of the main ambitions of the cultured meat sphere.

> "The world is vast (..) there will be certain countries or markets which certain firms will dominate due to consumer demands, dietary preferences and habits. In addition, we have

to be aware of carbon footprints, and not transport from Singapore to countries where we can and have the opportunities to collaborate with local partners." - Dr. Chng

"There are also large differences between populations, for example the population in China has a much lower confidence in domestic production and there we see that they are better disposed to lab-produced meat." - R3

Lastly, there are differences when it comes to regulation in different regions, meaning that different technologies can be applicable depending on where the organization is located. One example of this is brought up by R3 who speaks in depth of the importance of regulation and genetically modified organisms (GMO).

"It is important to be aware of your market, for instance, in the U.S the customers are more willing to consume GMO-products, whereas in the EU, consumers are more conservative." - R3

5.3 Industry Transformation

The following subchapters will elaborate the findings in connection to the ILC and its elements, as well as technological regimes. Furthermore, Mr. Stout states that there have been solid technological advancements in recent years. For instance, Mr. Stout claims that the cost of production has reduced by an order of magnitude and nuances this by stating that historical advancements largely create high expectations going forward. Where people expect similar cost reductions as those who have been taking place, which might or might not be unreasonable expectations.

"I think people see the fact that 10 years ago we were at $300,000 and now that we are at $100 as proof that we will soon reach $3, and I don't think that is guaranteed." - Mr. Stout

5.3.1 The Market

Dr. Bryant, Dr. Hocquette, Dr. Arye, Dr. Mr. Stout, R1, R2 and Dr. Chng emphasize that the industry is witnessing a massive increase in investments, which has resulted in more organizations entering the industry. According to Dr. Bryant, Mr. Stout, R1 and Dr. Chng the industry has grown massively over the recent years, this includes both financing and number of firms. R2 explained that the massive growth in the industry must be critically analyzed and further stated that:

"There is market data stating that there are around 50 companies who are active in the cultivated meat field. I think this refers to companies operating in different areas of the value chain but when it comes to cultivated meat producers, I think that there are maybe around 10-15 companies that are taking the production to industrial scale." - R2

This statement synergizes well with Dr. Bryant who claims that there are many small firms who are basically spin-offs from universities who start a firm due to a scientific breakthrough of various magnitude. These firms often aim to be acquired by other cultured meat companies. Furthermore, both R1 and Dr. Bryant add that it is not uncommon for traditional meat companies to tap into the competences and knowledge of cultured meat firms. The respondents exemplify this by claiming that large meat producers such as Cargill, JBS Foods, Hormel Foods and Tyson Foods have made such investments. R1 further explains that traditional meat companies in general are conservative when it comes to innovation and their spendings. The interviewee states that:

> "The traditional meat industry will only invest when they have to as they cannot develop cultured meat competences internally. These large firms primarily invest to gain knowledge and know-how, when this is done, they usually sell their shares with profit and start their own division in-house. All such firms have started disruptive innovation units in order to get a foot in the space." - R1

Several respondents shine light on similar industrial development patterns; that larger firms acquire smaller cultured meat firms and that we are starting to see a consolidation of the market. In addition, R1 claims that the near future will reveal what firms will survive this transition period where the respondent expects to see some firms dropping out.

> "Only the strong ones will survive, the firms with innovative capacity and pilot plants."- R1

There is a clear discrepancy regarding the knowledge needed for cultured meat and the traditional meat industry. However, this knowledge discrepancy is also visible within the cultured meat industry. Dr. Chng underpins this by stating that their firm has made a recent acquisition of a cultured meat firm pursuing production of land-based species whereas their own competences lay within sea-based food. This in turn further underpins the ongoing consolidation of the industry.

5.3.2 Technological Characteristics

When discussing technological aspects with regards to production, it is evident that there is great variation, partly due to the uncertainty, and partly due to the different goals among the firms. When Dr. Hocquette is asked to share his perspective of the cultured meat industry in 2022, this is what he says:

> "I will have only one word, it's uncertain. Both from a technical point of view, but also from the consumer point of view." - Dr. Hocquette

The idea that there is a high degree of technological uncertainty is a theme permeated in several interviews (Dr. Hocquette, Mr. Stout, Dr. Arye, R1, R2, R3).. However, both R1 and R2 emphasize that the technology used in production of cultured meat is not new, rather, the technology originated from the field of regenerative medicine. With this said, there is a great challenge in applying the existing technologies and knowledge within the regenerative medicine field in the production of cultured meat.

> "The main objective here is to use the technology that normally has been used for production of very low volumes at very high prices to be used at very large volumes to very low prices, i.e., to do the opposite. This is crucial if we really want to make a difference in the way that the world is fed." - R2

The aforementioned technological variation can be categorized at different levels. From a broader perspective, it is clear that there are both firms pursuing 3D printing technology and more traditional means of scaffolding in order to attain a 3D like structure. Due to the scarcity of firms within the field, specifically within 3D printing, it has been decided to not disclose respondents in this regard. Another main technological challenge that the respondents mentioned is regarding the choice of cell lines. This choice will influence both the downstream variables, as well as its implication on the end product (Dr. Chng, R2, Dr. Hocquette and Dr. Arye). This is specifically important with regards to the chosen species pursued. Dr. Chng underpins that there is great difference in cell lines between production of land-based animals and sea-based animals in general, but specifically also within crustacean species. Crustacean species genetics is more similar to the ones of insects. This in turn requires vastly different production factors and variables as the cells do not grow the same. This means that there are differences in the cell culture media, temperature and other factors (Dr. Chng). Furthermore, it is not only variation in species that is a determining factor of production technology. Also, product variation within the same species is important to consider. The respondent firms are pursuing different products ranging from products that are less structured, hence demands less tissue engineering and scaffolding, such products include mince, sausages, meatballs and nuggets or hybrid products. Whereas other interviewee firms are pursuing structured products such as shellfish, steaks or charcuterie. The latter category requires a more complex production technology in order to attain the correct 3D structure and fat marbling which is both a difficult process at the same time as it is deemed decisively important for both palatability and appearance. In order to provide full anonymity, specific respondents are not disclosed in this regard.

Another aspect which shows variation among the firms is the choice of cell culture medium. Several respondents mentioned that major innovation investments are being made within this area (Dr. Arye, Mr. Stout, Dr. Bryant, Dr. Chng and R2). This is important as it is shown that the cell culture medium is the most dominant cost driver in production.

> "I think about 90 percent of the cost of cultured meat is going in the growth medium category. And then I think about 99 percent of that is like a very small fraction of the overall medium, which is called growth factors." - Dr. Bryant

However, it is recognized and emphasized by Dr. Bryant, Dr. Hocquette, R2 and Dr. Chng that there is a high priority ambition to move away from FBS due to the animal welfare concerns, as well as the high cost. However, Dr. Bryant touches on the first cultured meat commercial product; the cultured chicken nuggets sold at a restaurant in Singapore by Eat Just.

> "It uses fetal bovine serum, which the industry needs to not do, basically in order to get any of the environmental and animal welfare benefits, which is the point of cultured meat, right?" - Dr. Bryant

5.4 Technological Regimes

Dr. Arye, R1 and R3 mentioned that the source of innovation within the field of cultured meat is predominantly coming from the start-up space and to some extent from academia. R1 further emphasizes that universities' role is to generate knowledge, however, the technology that is being developed in the cultured meat industry is already available.

> "The role of universities is to generate knowledge, in the cultured meat industry, all knowledge needed is already out there - it just has to be applied to the specific industry. Also, universities do not operate with the urgent mindset as start-ups do, because of VC-funding. The real innovation that actually will make a difference is coming from the start-up space." - R1

Another important driver of innovation within cultured meat is the nervousness of states to be able to be self-sustaining which is emphasized by both Dr. Chng and R3. Today, there are several countries that are highly dependent on food imports, specifically protein imports. Such countries include parts of Asia and The Middle East.

> "Singapore Food Agency is revising its regulatory system, and hopefully we will see more innovations and applications as a result of that. (...) Singapore has put out an initiative that they want to hit 30 percent of food consumption to be grown in Singapore by 2030."
> - Dr. Chng

Dr. Chng goes on by informing that there are substantial advantages for alternative protein companies in Singapore, Enterprise Singapore, which is a government agency, plays a large part in this development by helping start-ups, for instance by giving grants.

Further, Dr. Chng claims that there are different ways to look at knowledge cumulativeness in this industry. Firstly, there is a lot of open knowledge in this field that mainly stems from academic research such as GFI and New Harvest, who share information that is important in order for firms to be innovative. However, Dr. Chng also says that there is a lot of value in key patents and trade secrecy among the firms which might lead to some difficulty in innovating as a new firm. Furthermore, Dr. Chng goes on by claiming that it is definitely possible for newly entered firms to be innovative within the industry under the condition that the firm has a key patent such as a high growing density molecule or another key technology. During such circumstances, the rest of the knowledge needed can be derived from other open sources of information. When asked more specifically about the concern about the ability for new firms to enter the industry and take advantage of knowledge spillovers by cultured meat pioneer firms, Dr. Chng says that:

> "To some extent yes, but they will likely have to build on it because just using that alone is not really innovation because you just repackage it. But in order to make products and technology more valuable, then those companies need to come to you to license your knowledge. This is also what we see today with a specialization of firms focusing on small parts of the value chain such as scaffolds or cell mediums. - Dr. Chng

Dr. Chng goes on by claiming that the modularization of the industry where individual firms increasingly are focusing on niche aspects of the value chain such as scaffolds or growth mediums is probable to develop into a future scenario where firms have to license patents or knowledge from such specified firms.

5.5 Path Dependence

R2 discusses the choice of cell medium, and its supplier. Further claiming that it is common for cultured meat producers to source from the same suppliers. R2 further states that the most common suppliers for cell mediums are Merck, CellGenix and Thermo Scientific. In addition, R2 claims that aforementioned supplier companies are not at all interested in these emerging technologies as of now. This is due to the fact that cultured meat producing firms are small, with a low production volume which in the extension requires small amounts of cell medium, ultimately resulting in a small market. And historically, cell mediums have not been used in production of food. According to R2, one can choose the same technology for various mammals' cells, thus producing a wide range of different products. Furthermore, different technologies contribute to various end products, hence one must know in advance what type of end products that are desired before investing in technologies. R2 further emphasizes that:

> "You can use the same technology for different land species, but the main difference I think of why companies choose different technologies is because of the final product, in terms of texture, replicability of in-vitro meat or pricing reasons." - R2

R3 stresses the importance of being aware of path dependence, especially in the infant phase of the industry. In addition, if an organization is developing technologies and related processes to a certain cell type, it will become difficult to completely change direction after several years. The reason being that large investments have been made, both in the form of capital, but also knowledge building in the specific area. R3 further expresses this through:

> "There are strong incentives to be aware of path dependence, specifically related when choosing which product you want to access, your choices that you have made will probably be your prison." - R3

On the contrary, Dr. Chng stresses the importance of different technologies and how well these are suited for different cell lines. More importantly, there are immense differences among land- and crustacean species, therefore investing in one of these technologies will most likely give rise to the other one being neglected. As earlier mentioned, crustacean species are more similar to insects, which in turn requires completely different factors for enabling growth. These further stresses the importance of path dependence, investments in knowledge and technologies in early stages give rise to lock-in effects. However, Dr. Chng mentions that:

> "If we switch from seafood to red meat, the bioreactors are different, so we must consider different equipment and requirements. Shiok Meats has recently acquired Gaia Foods, Southeast Asia's first cultivated red meat start-up. This acquisition is consistent with our growth strategy and adds value for the cultivated meat industry." - Dr. Chng

Path dependence affects organizations in various ways and R3 further emphasizes that most companies are implementing some sort of diversification strategy in order to not be fully committed to one path. R3 explains that one way of doing this is by incorporating and investing in different cell lines, various end products and related technologies. R3 further mentions that:

> "The later in an industry you are, the more complicated path dependence becomes and the more difficult it becomes to incorporate diversification strategy." - R3

R3 claims that this is something that is specifically important within the industry of cultured meat. R3 is aware of the tradeoff between flexibility, cost, and time to market. Where increased flexibility is achieved by having parallel development initiatives such as exploration of different cell lines, production methods or end products. Furthermore, this also means that the company is focusing R&D efforts in several fields rather than centralizing all development efforts into one technology. This is argued to prolong the time to market for cultured meat products. One such example is given by the following quote by R3:

> "Should we start with cells that are more flexible (e.g., stem cells) or should we work with myoblasts that are easier to work with, they multiply faster, it may take 10 days instead of three weeks for stem cells. But if you want to keep the possibilities open, stem

> cells can be a way to work with more sophisticated products in the future and it can increase flexibility." - R3

In connection to production technology, the production facility is of great importance. This is largely due to the fact that the chosen technology has to be accompanied by a facility aligned for that specific technology. R1 claims that there are differences in regard to how cultured meat producers go about decisions with regards to pilot plants, specifically how flexibility is built in the plants in order to mitigate the risks of uncertainties, further arguing that it is likely that the companies with pilot plants will be the companies turning out to be successful in the long term.

> "(...) all startups will come, some will progress, some not, only the strong ones will survive, these are the firms with innovative capacity and pilot plants." - R1

Furthermore, the design of the pilot plants seems to have high importance during the inception of emerging technology industries. More specifically, the flexibility of future development of the plant is deemed to be valuable in uncertain and infant industries. In addition, pilot plants indicate that the organization has strong assets, which in turn both attracts new investors, but at the same time incentivizes investors to remain invested. R2 further mentions that the cultured meat industry is shifting from the current pilot plants to larger commercial scale plants. R2 highlights that:

> "...companies are moving to commercial scale, working with industrial types of equipment and they are starting to see challenges that they will face in order to bring this to a larger scale." - R2

According to the theoretical findings, it is argued that firms who are early in an industry have the possibility to influence the expectation of potential customers and upcoming firms. This is emphasized in the empirical findings where Dr. Chng argues that:

> "(...) new companies will look to other cultivated companies for direction, especially to the more established as they probably have more experience with what is expected for the industry (...)." - Dr. Chng

For context, one thing that has been revealed through the interviews is the diverging views of what cultured meat actually is. In one corner, there are advocates who aim to produce a product that resembles meat as much as possible. In the other corner, there are advocates claiming that there is intrinsic value in only trying to mimic traditional meat. This viewpoint is emphasized by R3 who highlights that cultured meat may be something completely different. For instance, it is perceived to be possible to produce a cultivated meat product with superior nutritional value, reduced content of triglycerides and other adaptations which allows the product to surpass the traditional counterpart in several aspects. Another aspect that R3 stresses are hybrid products, cultured meat could have an essential role in enhancing vegetarian meat substitutes. For instance, a huge part of palatability is connected to the fat levels and characteristics, leading to the fact that cultured meat fat can be used to further enhance the taste experience of vegetarian meat substitutes. R3 further argues that it is uncertain what cultured meat actually will be in the future and explains that:

> "One might accept that the taste is not similar to traditional meat, but on the other hand, you consume a product with better nutritional value, free from antibiotics and completely without triglycerides." - R3

Hocquette has a similar view on this topic, further explaining that there is a discrepancy whether or not cultured meat should be classified as meat or an entirely different branding. This is specifically important depending on the motives of the consumer, where it is argued by Dr. Hocquette that some consumers are driven by an ethical concern for animal welfare:

> "Some people argue that "cultured meat" should be called something else, without the word meat because it is not meat. Some argue that cultured meat does not fulfill the requirements to be known as meat due to the absence of rigor mortis and due to major differences in terms of composition and nutritional value with conventional meat." Even for marketing purposes, for ethical or moral reasons, it should not be called meat because this might discourage some consumers who want to make a difference between cultured meat and meat - Dr. Hocquette

A slightly similar perspective is also acknowledged by Mr. Stout who sees three broad product categories that are being researched within: cultured meat, vegetarian meat substitutes and hybrid products combining parts cultured meat or fat with vegetarian substitutes such as soy or pea products.

6. Analysis and Discussion

The following chapter analyzes the empirical findings along with the theoretical framework. The first section analyzes the level of maturity within the cultured meat industry. Whereas the following sections will further indulge in the topic of path dependence, first-mover advantages and the influence of such findings on the viability of innovation- and imitation-oriented strategies and the development pace of the industry.

6.1 Assessment of Cultured Meat Industry’s Degree of Maturity

In order to assess the maturity of the cultured meat industry, the empirical findings have been analyzed against the literature of industry life cycles, mainly derived from Teece (1986); Abernathy and Utterback (1978); Anderson and Tushman (1990); Utterback and Suaréz (1993) and Malerba and Orsenigo (1997). The maturity analysis illustrated in Table 8, which is derived from the proposed integrated theoretical framework illustrated in Table 3. The elements have been revised slightly due to the nature of the empirical findings which is further elaborated below. The analysis strongly indicates that the cultured meat industry is currently positioned in the infancy phase with partial evidence of transitional characteristics, specifically connected to the element of market dynamics. The subsequent sections will elaborate how this, along with other factors can influence the viability of innovation- and imitation strategies respectively.

Table 8
Analysis of Cultured Meat Industry´s Level of Maturity

Elements	Analysis of the empirical findings in relation to industry maturity elements	Assessment of degree of maturity
Technology	Uncertain, high variety (i.e., cell lines, growth medium), lack of best practice (dominant process design), such as 3D printing or traditional production, originated from other industries (regenerative medicine). Separate technologies needed depending on end-product characteristics and species.	Infant
Plant & Equipment and spatial positioning	Emergence of pilot plants with small scale production, variety in equipment such as bioreactors and scaffolds, which needs to be specifically adapted to the end product pursued. Concentrated spatial clusters of cultured meat firms.	Infant
Knowledge	Highly specialized and skilled labor (mostly scientists and ~80% of staff in R&D), which is a bottleneck for cultured meat firms. Knowledge characteristics are complex and largely codified in intellectual property. Knowledge stemming from both start-up space and academia.	Infant

The Market (Competition, nr and size of firms)	High risk, competition is based on who can achieve a low-cost product first i.e., technical competition within upstream production. Large influx of small cultured meat firms, as well as acquisitions/large investments by incumbents. As well as acquisitions between cultured meat firms. Low barriers to entry.	Infant/ Transitory
Innovation	Innovation is argued to be the key to success. Many small firms innovating separately, in different directions (3D, scaffolds, growth mediums, cell lines etc.).	Infant
Product	High product variety and lack of dominant design (complex products such as steak and uncomplex such as mince and nuggets, as well as different species such as poultry, pork, beef, crustaceans or input goods such as fat). Very low (but improved) price/performance ratio driven from high production costs. Additional uncertainty due to the lack of consensus regarding what a cultured meat product is expected to be.	Infant

The following sub-chapters shine light on the analysis that led to the categorization and analytical results depicted in Table 8.

6.1.1 Technology

A pattern that is shown throughout a majority of the interviews is the uncertainty within the industry, not only with regards to technology, but also regarding consumer response and preferences. This synergizes well with Anderson and Tushman's (1990) definition of an industry within the era of ferment, where technology is uncertain, and each pioneering firm is devoted to developing and differentiating its variant from other pioneering firms. This is in accordance with most of the ILC literature where Abernathy and Utterback (1978) also stresses the uncertainty in fluid stages with low understanding of consumer needs and reaction. Similarly, it is also in accordance with the pre paradigmatic phase of Teece (1986) and Mark I pattern by Malerba and Orsenigo (1997) where technology is said to be uncertain with rapid shifts in technological development. It is difficult to specifically assess the technological variation due to the high secrecy and low willingness to share details regarding the chosen technology. To this background, it is difficult to pinpoint what specific technological choices the different pioneering firms have made with regards to the choice of cell lines, bioreactors, scaffolds and growth mediums. Despite the high secrecy, all respondents claimed that the industry is uncertain in one way or another, not the least in regard to technology.

6.1.2 Plant, Equipment and Spatial Positioning

The empirical data highlights that not all cultured meat firms have production plants, but in the cases they do, they are of pilot character i.e., small scale production. This synergizes well with Abernathy and Utterback's (1978) definition of fluid phase, where plants are small-scale and reliant on skilled labor. This suggests that the element of the plant is in an infant phase. With regards to geographical location in infant phases, the same article underlines that the plants are located near the users or source of the technology. Within the cultured meat industry, four main clusters of firm locations have been identified through the empirical data; Tel Aviv, Silicon Valley, Singapore and The Netherlands. There are different reasons for this spatial positioning.

Tel Aviv has one of the most prominent universities with regards to cell culture. The cluster of cultured meat firms in Tel Aviv are located within a block or two from each other surrounding the aforementioned Weizmann Institute of Science. In similarity with Tel Aviv, the firms in Silicon Valley are also located closely to each other, but partially also for another reason. The abundance of venture capital and funding possibilities for Silicon Valley based firms as well as the possibility for knowledge spillovers through acquiring personnel from other firms is seen as a magnet for these firms. California is argued to be rather unique in this aspect where personnel are allowed to sign employment contracts for competitor firms, due to the lack of enforcement of non-compete clauses. Moreover, Silicon Valley is also an area characterized by strong entrepreneurial activities, which further attracts skilled labor. Singapore, however, is largely driven by governmental incentives, there is a nationwide ambition to be self-sustaining to 30% by 2030; the so called “30 by 30 plan”. Lastly, The Netherlands is also a spatial cluster for cultured meat firms. Reason being the strong academic advancements within the field, likely derived from the large proportion of the GDP which is sprung from the agriculture sector.

6.1.3 Knowledge

Knowledge is acknowledged as one of the most important resources for the cultured meat industry in its current stage. This is likely due to the high uncertainness of technology, markets and the complexity surrounding it. To this background, firms put large emphasis on both technological knowledge in order to improve the scalability and reduce the production costs but also knowledge regarding consumer preferences and market behavior. The knowledge base for cultured meat firms is arguably more codified than it is tacit in accordance with the definition by Malerba and Orsenigo (1997). This is largely due to the scientific nature of the research, where much of the knowledge base is derived from the universities. In addition, firms want to protect their intellectual property with patents and trade secrets which arguably could indicate that the knowledge is of codified character. Specifically due to the fact that patenting is a method of codifying knowledge in accordance with Malerba and Orsenigo (1993). According to Teece (1986), the classification of knowledge will lay the foundation of easiness to imitate, where it is argued that codified knowledge is easier to imitate than tacit. Even though the knowledge is more inclined towards a codified nature, the knowledge required in the cultured meat industry is also what Malerba and Orsenigo (1997) define as complex knowledge. An argument further suggesting this is the previously stated fact that approximately 80% of the personnel in the cultured meat industry are working in R&D related activities.

The presence of knowledge cumulativeness partially dictates if a firm could be innovative in the future or not. According to the theory of Malerba and Orsenigo (1997), there is a low degree of knowledge cumulativeness in infant industries due to the novelty of the technology. This novelty means that there has been a short period of time for firms to achieve cumulative knowledge. However, one should not disregard the fact that the cultured meat technology is not entirely new as stressed in the empirical findings. Rather, the challenge is to adapt previously existing technology to a new industry and product. This is also what is seen during our empirical findings, namely that much of the competences are coming from adjacent industries. Which suggests a technology pervasiveness in accordance with Malerba and Orsenigo (1993). In contrast to the suggested low knowledge cumulativeness in infant industries, the empirical insights show signs of knowledge cumulativeness due to the high perceived importance of IP. Where the ownership of patents could influence what firm will be innovative or not in the future. However, Mansfield et al. (1985) and the empirical findings claim that not only might it be possible to circumvent patents, which in the study is achieved within 4 years in 60% of the cases. There is also a broad patent which will expire 2022, which broadly contains the technology needed to produce cultured meat. In addition, it is also stated that universities and scientific research such as Weitzman Institute, GFI and New Harvest provides a large part of the knowledge base within cultured meat. This knowledge is open and available for all firms which potentially allows new firms to become innovative and build on the previous knowledge even though they have not been part of previous innovative activities.

6.1.4 The Market

Regarding the element of market dynamics, it is clear that the market is relatively newly founded, where the oldest firms in the industry were formed around 2015. Since then, there has been a large influx of new firms. Where the empirics argue that many of the newly entered companies are small, sometimes only consisting of a few university students. This is largely in accordance with the definition by Malerba and Orsenigo (1997) who claim that Mark 1 industries are often witnessing a high influx of entrepreneurial firms challenging incumbents with new ideas and innovations. However, as Utterback and Suaréz (1993) states, the firm size is not of importance when addressing the maturity of the industry, rather it is the fact that entrepreneurial firms come from outside the industry, which often results in innovations of competence-destroying character. This is witnessed in the cultured meat industry, where the pioneering firms are both newly found, and entering from outside the traditional meat industry, largely in synergy with Schumpeter’s (1942) definition of creative destruction.

6.1.5 Innovation

Anderson and Tushman (1990) claims that the era of ferment is characterized by a low stability on the list of key innovators and that the source of innovation is a larger number of smaller firms. This synergizes well with the empirical data, where it is claimed that innovation stems from a large number of small entrepreneurial firms who recently entered the industry.

On the topic of innovation, it is clear that the production technology of cultured meat is distinctly different with regards to traditional production of meat. While traditional meat is produced by raising and slaughtering animals, cultured meat is produced in laboratories or pilot plants by the usage of cell culture technology. This agrees with the definition of technological discontinuity and radical innovation by Anderson and Tushman (1990) due to the fact that it has the possibility of rendering the current competences obsolete while simultaneously changing the state-of-the-art technology of the industry. Despite the knowledge-destroying characteristic of the discontinuity, the empirical data suggests that the traditional meat producers possess essential competencies for cultured meat industry. Such competences are mainly argued to be within distribution, marketing and meat knowledge. This synergizes well with Suaréz and Lanzolla (2005) who emphasizes the importance of key resources in both marketing and distribution when the technological pace is rapidly advancing. As the infant industry is characterized by an influx of small firms coming from outside the industry, it is likely that such firms are generally poorly skilled with regards to marketing and distribution as such knowledge and competences have not had the time to be accumulated. One can argue that this is of specific importance when the end product is similar to the end product that it aims to replace, as the consumer knowledge is likely to be more pervasive between technological regimes in such occurrences.

6.1.6 Product

The product of cultured meat shows great variation in both end product characteristics as well as choice of species. Such variation is also found in the empirical data where firms pursue complex products such as cultured meat steaks or crustaceans, more simple products such as mince or nuggets, as well hybrid products combining both cultured meat and vegetarian substitutes. Another aspect of variation is regarding what a cultured meat product is supposed to fulfill, specifically that cultured meat has the potential to be more healthy than traditional meat, but that this might incur a different palatability.

Several similarities are identified when put in relation to the fluid phase of Abernathy and Utterback (1978), which is characterized by diverse products, which in more mature stages converge into a single product line. However, it is possible that the theory is lacking in explanatory power for explaining the future development of cultured meat products. This viewpoint is largely derived from the current meat market where an array of animal products are being sold, both with regards species, but also different breeds and cuts of meat. It is likely that future development will follow the same pattern. However, it could be argued that a reduced variety of product characteristics could be identified in other product characteristics, specifically in regard to technologic involvement, such as nutritional content, choice of GMO or other production processes.

6.2 Incentives to Innovate or Imitate

The following three subchapters will analyze the possibilities to attain the three sources of first-mover advantages stemming from Lieberman and Montgomery (1988), by contrasting the empirical data with the theoretical foundation. In connection to the theory of the durability of FMAs by Suaréz and Lanzolla (2005), it is difficult to assess the pace of the market due to the infancy of the industry, which is a drawback associated with analyzing emerging industries as explained by Forbes and Kirsch (2011). With this said, the industry maturity assessment signals that the industry is witnessing rapid advancements in R&D and innovation, which is underlined by the achievements in improving the price performance ratio for cultured meat. Furthermore, the high variety in both production technology and lack of dominant design, as well as the variety in end product considerations further speaks to a rapid technology pace where firms are putting large emphasis on innovation and doing so in many different directions. With regards to the pace of market evolution, this is difficult to assess due to the lack of products in the market. Although there is uncertainty, there are elements that provide insights of where cultured meat industry is heading. The current price levels are high which might result in the launching of cultured meat as a premium product with high margins and small quantities, which gradually transitions into the ambition of selling high quantity at low prices. Furthermore, the empirical material shows some concern with regard to consumer adoption and the fact that consumers in some geographic areas are conservatively approached to this kind of product which might correspond to a relatively slow adoption rate. Another element that was brought up in the ILC assessment is the number, size and entries of firms. The assessment shows that this industry is witnessing a rapid influx of new firms. However, it is not certain that this large influx of new firms will be correlated with a rapid growing market with regards to sales. The empirical material suggests that the rate of diffusion of cultured meat is largely influenced by regulations which further complicates the topic of market pace. A likely scenario is that some regions will, due to regulatory constraints fall behind with regards to diffusion, whereas areas such as Singapore with a more well-developed regulatory regime combined with both financial and strategic aid for cultured meat firms are likely to develop more rapidly. Which further underpins that first-movers should be careful when selecting their spatial positioning.

6.2.1 Technological Leadership

The possibility of attaining first-mover advantages due to technological leadership is as explained by Lieberman and Montgomery (1988) dependent on two factors; advantages from learning- or experience curve, and success in patents or R&D. The empirical insights show that the learning and experience curve is steep. As explained, the first burger 2013 cost 250.000-300.000 USD to produce depending on sources, which according to the empirical findings can now be produced for approximately 100 USD due to technological advancement.

As previously stated, the empirical evidence indicates that the pioneering firms are applying for patents to protect IP. Lieberman and Montgomery (1988) emphasize that when technological success is a function from R&D spendings, pioneering firms can attain first-mover advantages by protecting R&D and innovative efforts through patents. In addition, Mansfield et al. (1985) states that it is more difficult to imitate process innovations than it is to imitate end products. This is largely due to the fact that process innovations cannot be reverse engineered. In the field of cultured meat, the product itself is a rather non-complex FMCG, where the ambition for several firms is to produce a product as similar to traditional meat as possible, which from a comparison perspective makes it difficult for firms to assess the difference by simply looking at, and reverse engineering the products. However, the production technology behind is both entirely different and complex which reduces the potential for firms to imitate, this is largely in line with Mansfield et al. (1985) claim that process innovations are more difficult to imitate than product innovations.

In addition, Lieberman and Montgomery (1988) claims that the pharmaceutical industry is one of the few examples of industries which are subject to patent races. Where success in patenting is a large decider for FMAs. This is due to the regulatory scheme, where pharmaceutical companies need regulatory approval in order to enter the market. In similarity with the market for drugs, the cultured meat industry is also heavily regulated which is emphasized in a majority of the interviews.

6.2.2 Preemption of Scarce Assets

By entering the industry in infant stages, firms might have the ability to preempt competitors access to certain scarce assets. The empirical insights show scarcity in the current industry, as well as it suggests what might become scarce in the future as the industry matures.

6.2.2.1 Personnel as a Scarce Asset

As emphasized, the industry of cultured meat is R&D intensive with a considerable dependency on qualified personnel. The access to such expertise is scarce, hence posing as a challenge for many firms, a challenge of a greater magnitude than obtaining financing. Part of the reason for the scarcity of qualified personnel is largely due to the infancy of the industry. Abernathy and Utterback (1978) highlights that emerging industries are reliant on highly skilled labor, whereas the demand for highly skilled and specialized labor decreases as industries mature. In accordance with Lieberman and Montgomery (1988) definition of scarce assets, expertise in the cultured meat industry can be regarded as an asset of scarcity. Therefore, an important aspect to consider is the firm's ability to both recruit and retain desired personnel. Where the retaining of personnel is specifically important when assessing the viability of innovation- and imitation-oriented strategies. In this aspect, it seems to be industry standard to attempt to retain personnel with stock options, which would increase incentives to stay at a given firm. Another aspect in regard to personnel retention is non-compete clauses which restrain personnel from switching between firms. However, there are regional disparities in this regard, which according to the empirical data is one of the reasons as to why Silicon Valley is a hotspot for the biotech sector at large, but also for the cultured meat sector specifically. Therefore, pioneering firms might experience difficulties securing a high personnel retention rate in this area due to a high employee mobility. Which in the extension influences the possibility of attaining first-mover advantages in the forms of personnel. Further suggesting that such advantages are dependent on spatial positioning as this determines the employee mobility, not only the possibility to retain personnel, but also the supply of personnel. In this regard, the empirical data suggests spatial clustering of cultured meat firms, primarily located in close proximity to sources of qualified personnel, such as The Weizmann Institute.

The fact that the viability of attaining preemption of qualified personnel seems to be dependent on the ability to prohibit personnel from moving between cultured meat firms needs to be analyzed in relation to an understanding of the characterization of knowledge. The knowledge in the cultured meat industry is both complex and largely codified. Considering the fact that knowledge is codified through patents, it might reduce the risk of knowledge transfer between firms if employees were to be hired by imitator firms as the knowledge and competences are largely embedded in the organization and not the personnel per se. However, preempting personnel and retaining them through different lock-in effects such as stock-options might not be a viable long-term strategy recalling how Abernathy and Utterback (1978) claims that the need for highly skilled labor wanes as an industry matures. Reason being that processes are established simultaneously as automatization increases, where controlling and maintenance becomes of larger importance than highly specialized R&D.

6.2.2.2 Partnerships as a Scarce Asset

In addition to personnel, another scarce asset identified is the importance of securing partnerships. The empirical data underlines that cultured meat firms value partnerships for two main reasons; access to established distribution channels and supplier networks as well as brand recognition and knowledge in marketing. Furthermore, a majority of the interviewee firms explained that their organizations should focus exclusively on the technology and cell culture. With regards to the go to market strategy, they will establish a business-to-business relationship and go to market with an established partner. Generally speaking, cultured meat firms lack knowledge when it comes to the business of FMCG, which requires completely different knowledge such as marketing and branding. In line with Lieberman and Montgomery (1988), securing partnerships with established incumbents which have superior marketing expertise and strong brand awareness can allow pioneering firms to get hold of such scarce assets, which could result in first mover advantages.

This synergizes well with the idea of complementarity assets as described in both Onufrey and Bergek (2015) and Teece (1986). Namely that there are strong complementarity effects in securing partnerships and distribution channels. This is likely to give rise to both innovation- and imitation advantages. The advantages for an innovation-oriented strategy are located within the possibility of preempting followers from securing high value partnerships. This is dependent on the assumption that there is a scarcity of desired partnerships. In this line of thought, it is argued that this is no winner takes it all industry, partially due to the fact that cultured meat firms have to alter their products to different markets. Therefore, the partnership's regional characteristics should be analyzed. In this setting, the regional characteristics are largely concerned with where the partner has an established distribution network, where its customers reside and where the brand recognition is most valuable. When such parameters are included, it is likely that several partnerships are filtered out, hence increasing the scarcity of available partnerships. This is specifically interesting recalling the importance of regulatory approval as this narrows the options for spatial positioning even further.

6.2.3 Buyer Switching Cost

Due to the nature of cultured meat products, which is quite non-complex FMCG without technology embedded in the end-product, buyer switching costs are difficult to attain in line with arguments from Lieberman and Montgomery (1988). Reason being that FMCG usually requires little learning and expertise from a consumer perspective, while simultaneously being quite homogenous. Whereas high technological products often require learning to use the products efficiently, they are generally more interlinked with other infrastructure which enables coupling with complementarity assets, while more technically advanced products allow for a higher degree of product differentiation. Combined, this reduces the possibility for pioneers in FMCG markets to use buyer switching costs as source of FMA in accordance with Lieberman and Montgomery (1988). That being said, buyer choice under uncertainty can still be attained by first-movers as consumers and producers have yet to agree upon what cultured meat should be. By assumption, indicating that consumers will associate cultured meat with the first products they encounter and when uncertain, choose the products or brands they are familiar with. This is largely in line with the literature of path dependence and expectation effects, as well as with Teece (1986) who see potential advantages for first-movers to influence what will emerge as a dominant design.

6.3 Path Dependence

The empirical data clearly shows that the cultured meat industry is characterized by uncertainties, not only within the technological aspect, but also in regard to end product considerations of what cultured meat really is and how it is best produced. In connection with Abernathy and Utterback (1978) and Anderson and Tushman (1990), there is no dominant design in the cultured meat industry concerning the production processes or end product. There is also evidence suggesting that the cultured meat industry is subject to path dependence. Specifically, in regard to technological trajectories. As Schreyögg et al. (2011) highlights, firms have a wider range of options available in the early stages and as time progresses, the range of options will become narrower. This was recognized and brought up during a few interviews. For instance, R3 claimed that the chosen trajectory will most likely become your prison, suggesting that the firm is plausible to reach the lock-in stage as defined by Schreyögg et al. (2011). This is interesting in combination with the fact that the industry is yet to establish a dominant design, as this poses a risk for pioneering firms to follow the wrong trajectory. This is specifically concerning as regulation and policies might interfere with the selection of a dominant design. For instance, the choice of pursuing GMO related technology might be completely detrimental to a firm if there is low technologic pervasiveness between such production techniques and non-GMO choices, and only GMO-free cultured meat is accepted by regulatory parties. In such cases, the factors of path dependence might inhibit firms from transitioning from their initial choice of production design to the dominant design due to what Sydow et al. (2009) refers to as technological lock-in, which, according to Utterback and Suaréz (1993) is a major factor for firm shakeout during the transitional phase

However, the empirical data suggest that cultured meat firms are aware of such risks, and a minority of the firms are deliberately pursuing parallel technological trajectories simultaneously in an ambition to hedge against the risk of traveling along the wrong path. This strategy chosen by the pioneering firms is in line with arguments mentioned by Teece (1986), mainly that firms operating in an emerging industry must remain fluent and flexible, in order to adapt to external changes, such as emergence of dominant design. With this said, it is not only costly to pursue simultaneous technological trajectories, but it also reduces the technological advancement in investment and learning effects according to Onufrey and Bergek (2015). Which ultimately might result in a scenario where firms who pursue simultaneous technological trajectories end up as late-movers due to slow development in relation to those who focused their R&D efforts into what eventually emerges as the dominant design. Such trajectories could for instance be cell lines or production methods such as 3D printing versus traditional culturing. Furthermore, this way of working also increases costs of research as the firm ceteris paribus has to employ more personnel in R&D. Ultimately concluding that such flexibility is a trade-off with regards to technological advancement and cost. Therefore, there might be stronger incentives to hold back market entry until the industry reaches a transitory phase due to the emergence of a dominant design. This eliminates the risk of pursuing the wrong technological trajectory while simultaneously reducing the cost of R&D. Which according to Lieberman and Montgomery (1988) is referred to as “free-riding” on first-movers investment

6.3.1 Coordination Effects

According to Schreyögg et al. (2011) coordination effects are frequently occurring in industries where the product or service is interlinked with infrastructure, such as how automobiles are interlinked with roads, or software with hardware. In general, such dependencies are mostly observed within technological end products. Regarding coordination effects of cultured meat, it is rather difficult to foresee any such effects due to the fact that the end product of cultured meat is not of technological character, hence is less dependent on external infrastructure. With regards to technology adoption, coordination effects are concerned with the presence of network effects, where the utility of the network increases with the number of users. In this specific case, no such network effects can be identified.

6.3.2 Complementarity Effects

As earlier mentioned, the lack of external infrastructure as well as complementary products provides no evidence of reinforcing mechanisms with regards to complementarity effects on the adoption side. However, it is stated in Onufrey and Bergek (2013) that technology adoption might yield companies’ benefits in complementarity effects through vertically related products, resource complementarities or distribution channels, where distribution channels are specifically interesting. Teece (1986) claims that the ownership of complementarity assets is influencing the viability of imitation, claiming that when firms control complementary assets, they are likely to reap the profits in the market, despite not controlling the most valuable IP, as it protects pioneers from followers. However, Teece (1986) also claims that there are generally no complementary assets in the pre paradigmatic phase, due to the novelty of the product. Instead, rivalry centers around competition for a dominant design. Furthermore, it is not until the paradigmatic phase, and the establishment of a dominant design that competition revolves around price and scalability. When industries reach such stages, the control of complementary assets might yield firms a competitive edge through specialized manufacturing tools or distributions. This is along the lines with what has been communicated in a majority of the interviews, namely that cultured meat firms will cooperate with established meat firms as it will yield them access to existing distribution channels. In this setting, a partnership with a traditional meat firm could preempt another cultured meat firm to establish similar partnerships with the same firm. This will be further discussed when indulging in the topic of preemption of scarce assets in section 6.3.2.

6.3.3 Expectation Effects

In line with Sydow et al. (2009), firms seek to be on the winning side of technology and to gain legitimacy. A concern in the cultured meat industry is the usage of FBS. In accordance with R2, Dr. Chng and Dr. Bryant, it is contradictory to involve FBS in the production as a large part of the ultimate purpose of cultured meat is to contribute to a more sustainable environment by improving animal welfare. In this sense, there might be a possibility for pioneering firms to dictate the expectations. The expectation is not only revolving around the production technology, but also regarding end product considerations. The empirical data shows that there is no consensus regarding what a cultured meat product is supposed to be, if it is supposed to mimic traditional meat as much as possible, or to be a completely new product with higher nutritional value and different palatability than what the consumers are used to. To this background, the firms that manage to launch cultured meat first might have the possibility to set the expectations in what Teece (1986) and Onufrey and Bergek (2015) define as expectation effects. This might allow pioneering firms to create certain expectations with regards to what a cultured meat product is and align its technological development in that very direction. For instance, the first firm to reach the market with a product could market it as GMO or FBS free, which might reduce competitiveness for cultured meat products that utilize GMO or FBS in the production. This could allow firms to dictate the direction of technological development and render other technological trajectories obsolete. Which could be argued to be of specific importance in industries characterized by a great variety in production technology, end product consideration and production inputs.

6.3.4 Investment and Learning Effects

With regards to technology adoption, the nature of the product of cultured meat is an uncomplex food product. A product that requires no other knowledge or learning in order to be consumed. Which is largely in accordance with Onufrey and Bergek (2013) who claims that such effects are most likely to accrue in high technological products, where users have to invest in both training and competence building, in such scenarios, consumers face switching costs and sunk costs in regard to switching to alternative technologies or products. This also synergizes well with Lieberman and Montgomery (1988) who claims that that first-mover advantage can rise through buyer switching costs, where consumers have made investments in learning these technologies both with regards to time and financial spendings.

However, there are self-reinforcing mechanisms observed with regards to technology development, specifically in connection to investment costs. R2 claims that a pilot plant for cultured meat could require firms several hundred million dollars to build in upfront costs. Costs that in turn could turn out to be sunk costs if the production technology chosen lacks flexibility with regards to other paths as described in the theory of path dependence. This in turn would force cultured meat companies to engage in local search, i.e., that firms look for opportunities that are positioned in accordance with their current resources and knowledge, despite the fact that other alternatives could prove to be superior and emerge as a dominant design.

6.4 Implication on Industry Development Pace

All executive respondents were asked if they were concerned about imitation, and the answer was rather unified. The market potential is tremendous, and that this is not a winner takes it all industry. Therefore, there were few concerns with regards to imitation from followers. While there is no argument to distrust this statement, the truth is that only 4% of pioneers remain market leaders in their industries according to the study of Golder and Tellis (1993). Furthermore, it is not as simple as to say that a strong viability of first-mover advantages will incentivize firms to innovate hence increase the overall development in the industry in accordance with Zhou (2006) and Barro & Sala-i-Martin (1995). Similarly, it is not as simple as to say that increased competition from imitation increases firms' incentives to innovate in order to launch competitive products and services, much like the Schumpeterian analysis and the literature of Bessen and Maskin (2009).

An aspect revealed by the empirical data is the high level of secrecy between cultured meat firms. This was communicated both directly and indirectly. R2 claimed that the main method for understanding what competitors are up to is through communication with their suppliers, as the cultured meat firms often procure from the same sources, while it is considerably rare that cultured meat firms communicate directly to one another. Likely, the high secrecy is a symptom from the fear of knowledge spillover and imitation. With this said, it is not unlikely that cooperation and knowledge spillovers between these firms might actually advance the industry as a whole more efficiently as firms can share technological breakthroughs. To this background, there is a slight discrepancy between how firms directly channel how they perceive the threat of imitation, and their practical actions. In the extension, this suggests that the fear of imitation might hamper the development pace of the industry of cultured meat.

Regarding the codification of knowledge and possibility of protecting R&D with patents, there are contradictory conclusions to be drawn from the findings. Firstly, all firms claim that patenting is important in their ambition to protect IP. Consequently, this incentivizes firms to undertake R&D costs as the potential benefit of such spendings can be kept proprietary. In essence, this spurs innovation in this industry hence increasing the development pace. However, there are also drawbacks with regards to patents' influence on an industry’s development pace. Bessen and Maskin (2009) claims that patents of broad nature might prohibit other firms without such patents from contributing towards innovative development. However, this thesis concludes that this is further dependent on the success of licensing. In the cultured meat industry, the broad patent that was granted in 2004 is licensed to several parties which might reduce the negative effect of patenting, or even increase the development pace as the patent is a codification of knowledge in accordance with Malerba and Orsenigo (1993) which further enables other firms to absorb such knowledge. Moreover, it is argued that when such broad patents expire, the possibility to innovate increases with magnitude which might lead to long run benefits for the industry development pace.

An interesting aspect identified in regard to the empirical material is the fact that many pioneers in this field are mission driven, and hence largely concerned with the industry development as a whole, and not only the profitability of the specific firm. It is therefore argued that technological breakthroughs through patents are more likely to be shared and licensed than in other industries. This is in stark contrast to the theory of Barro and Sala-i-Martin (1995); Zhou (2006) and Mukoyama (2006) who claim that the propensity for firms to imitate reduces incentives for pioneering firms to innovate. This viewpoint is likely to have explanatory power in many industries, but the industry of cultured meat is an anomaly in regard to its potential to solve paramount concerns regarding animal welfare and environmental effects. It is therefore argued that such industries are less concerned with imitation, and the scientists themselves actually incentivize it. The conclusion from this statement is that the implication on industry development pace is likely to be influenced by what firm contributes to the technological breakthrough, as motives to license or publicly disclose such knowledge is likely to differ among firms, and between the corporate world of cultured meat firms and academia.

Another interesting aspect that the empirical data revealed is the fact that there are regional disparities when it comes to incentives for different countries to develop the technology of cultured meat. More specifically, countries such as Singapore are more incentivized to accelerate the development of the cultured meat industry due to the ambition of increasing self-sustainability of food production. In connection to this, the regulatory landscape in Singapore will favor pioneers in this industry due to the country wide ambition to accelerate the domestic production technology of cultured meat. In conclusion, this suggests that the development pace of the industry is spatially dependent, where policymakers influence not only the viability of being a pioneer, but subsequently also the overall development pace of the industry.

6.5 Revised Theoretical Synthesis

The theoretical foundation proved to be fruitful when assessing the viability of innovation- and imitation-oriented strategies in an emerging industry. However, the findings suggest some additional factors that are explanatory in this regard. Therefore, a revised synthesis of the theoretical framework is now proposed. In essence, four factors have been added in the revised synthesis of the theoretical framework, which are (1) regional disparities, (2) product characteristics, (3) co-branding, (4) technological hedging.

6.5.1 Regional Disparities

The literature falls short in explaining the regional disparities revealed by the empirical data. In the case of cultured meat, the regional differences are linked to the different incentives between the countries. The analysis concluded that there are regional disparities when discussing the viability of innovation- and imitation-oriented strategies. Some regions, such as Singapore, are incentivizing firms to undertake R&D initiatives within this emerging industry in order to increase self-sufficiency of food production. This means that first-movers in this field are receiving financial and managerial aid by the government agency Enterprise Singapore. Another aspect in this regard is the regulatory setting, where it is identified that the ability to attain FMAs is also dependent on the spatial positioning, this is deemed to be of specific importance in industries characterized by regulatory control, such as the previously discussed patent races in the pharmaceutical industry or in the industry of cultured meat.

Lieberman and Montgomery (1988) discuss the idea of preemption of scarce assets as one of the main drivers for FMAs. The analysis contributes to this regard by concluding that what is identified as a scarce asset might not be uniform across regional areas. For instance, cultivated meat firms are often clustered in close proximity to scientific institutes due to its source of knowledge. In such spatial areas, the asset of knowledge is likely to be less scarce than other areas, ceteris paribus. Despite the existence of aforementioned scientific institutes, the empirical data underpins a consensus regarding the scarcity of knowledge. However, the literature is deeply concerned with appropriability concerns for products and technology, mainly with regards to patents, but fails to discuss appropriability conditions for assets such as knowledge in personnel. The analysis concludes that the degree of mobility of personnel is an important factor to consider when discussing FMAs, this too is dependent on spatial positioning and the enforcement of non-compete clauses. As a closing note, this is specifically important when the characteristics of knowledge are tacit and complex as this suggests that the knowledge is embodied in the personnel working with it to a higher extent than the organization itself. In a similar vein, the abundance of venture capital activity in Silicon Valley might reduce the scarcity of funding in that area, whilst it is less available in other regions such as Israel or Singapore. Therefore, the revised framework proposes that the preemption of scarce assets has to be further analyzed spatially in order to attain more complete insights.

6.5.2 Product Characteristics

In general, the literature of industry transformation is describing how the element of a product evolves as an industry matures, where it is going from being ambiguous in regard to requirements with a poor price performance ratio, and as the industry matures, the product price performance ratio improves, and the product becomes largely undifferentiated. However, the literature does not nuance the effect of high technological end products versus high technological processes products. Similarly, the theory of path dependence rarely discusses the distinction between a high technological production process and technological end-products.

Further, the literature of path dependence and its self-reinforcing mechanisms has shown to be fruitful when analyzing technological trajectories and its mechanisms. However, the theory is suggested to be better equipped for analyzing industries with technological end-products rather than highly technological processes. In this case, the end-product of cultured meat is a rather non-complex FMCG, and the analysis has revealed that it is difficult to obtain coordination effects in such products. As earlier mentioned, this effect is taking place in industries with products that are interconnected with infrastructure (Schreyögg et al. 2011). FMCG rarely have this effect since they are not dependent on a specific infrastructure of that nature. I.e., that such effects are more frequently to occur within technological end-products to a larger extent, such as smartphones are dependent on external infrastructure in cellular carriers, the supply of applications or the development of applicable headphones.

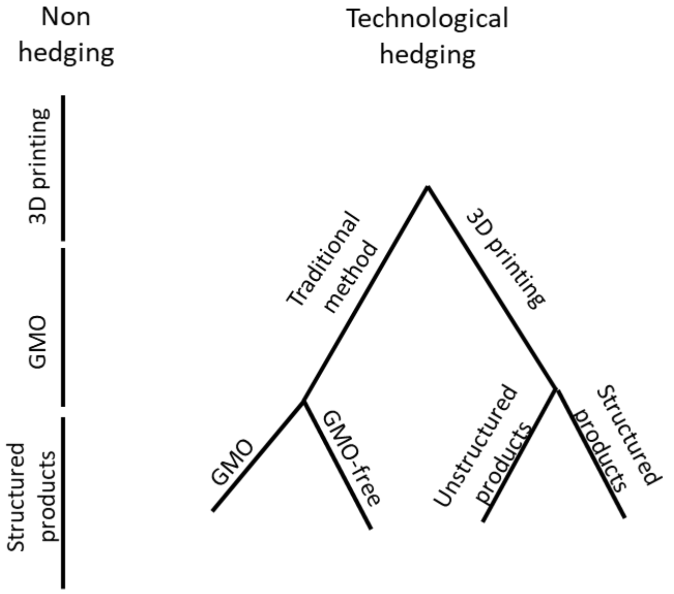
In a similar line of thought, the literature covered regarding incentives to innovate also falls short in distinguishing between product characteristics in any length. Where the analysis concludes that buyer switching costs are difficult to attain in FMCG. It is suggested that buyer switching costs are mostly obtained in products with a high degree of technological involvement, as consumers have to make upfront investments to purchase the product and additional investment in time to learn how to use it efficiently (Lieberman & Montgomery, 1988). This idea is poorly connected to a product who is fast-moving and quickly consumed, which is what characterizes a FMCG, despite its highly technological production process. Where the low complexity of the end products requires little learning for consumers, this in combination with the homogeneity of fast-moving goods allows the consumer to freely switch between products.

6.5.3 Technology Hedging

The literature of industry transformation adds nuance when discussing the technology in different phases of maturity. This is argued to influence the viability of innovation- and imitation-oriented strategies in the different phases. Similarly, the path dependence literature addresses technological lock-in, which also influences the viability to innovate or imitate in different phases. The empirical data shows evidence of firms deliberately pursuing parallel technological trajectories, due to the fact that it is yet to be determined what path will lead to a dominant design. In this regard, the literature regarding FMA and FMDA should be concerned with the technological variety and uncertainty. More specifically, the pervasiveness of knowledge between technological trajectories, as well as the presence of self-reinforcing mechanisms that lead to technology- or organizational lock-in as this influences the viability of adopting an innovation- or imitation-oriented strategy. Figure 9 has been conducted in order to illustrate how technological hedging intervenes with technological trajectories. Figure 9 illustrates how a concentrated non-hedging approach results in specific and non-diversifiable choices, such as 3D printing, GMO and structured products, a path that if proven successful will develop more rapidly. In contrast, firms could pursue simultaneous technological trajectories as a sort of risk mitigation due to uncertainty. Such a strategy is likely to develop at a slower rate as multiple paths are being explored.

Figure 9

Technological trajectories in relation to technological hedging



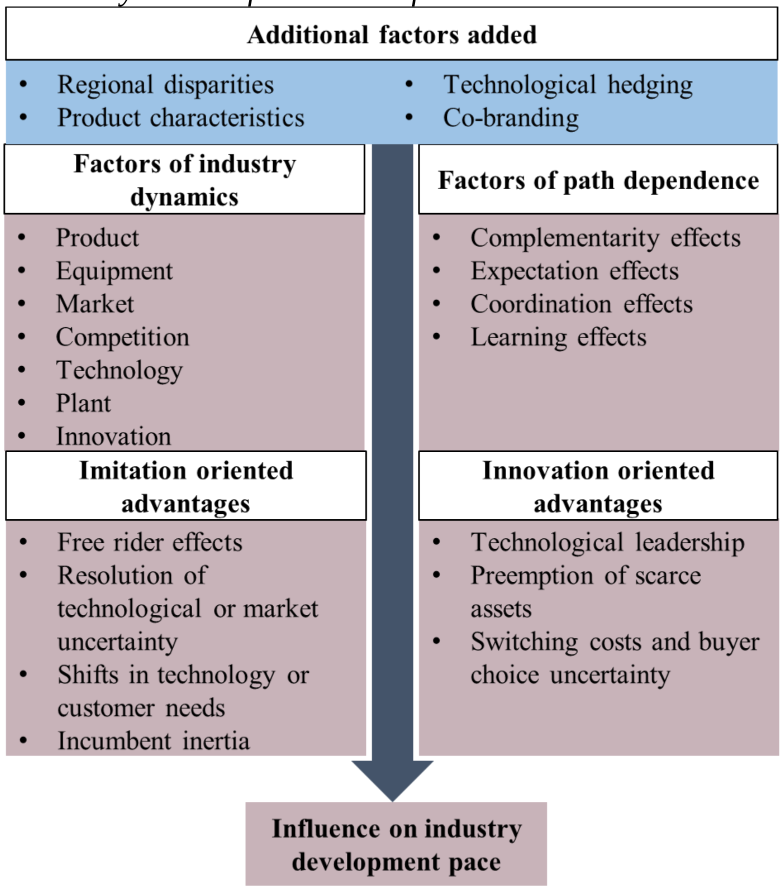
Note: Technology for cultured meat is far more complicated than what is illustrated in this figure, and that specific choices are complexly interdependent.

6.5.4 Co-branding or Private Label

Both Suaréz and Lanzolla (2005) and Lieberman and Montgomery (1988) emphasize the need for strong brands but provide little nuance to practical implications thereof. The analysis concluded that cultured meat firms are likely to pursue a private label go to market strategy, where they partner with traditional meat firms with established networks of suppliers, distributors and marketing knowledge. At least one of the four firms interviewed will go to market with their partner's brand, as brand is important for FMCG, where customers oftentimes tend to buy what they are familiar with. What the literature fails in addressing is the tradeoff between short-term win and long-term risk. As cultured meat firms go to market under a brand outside the organizations immediate control, they are at risk of finding themselves in a position where the brand of their product is a strong source of FMA, which is controlled by an external partner. On the other hand, by using this go to market strategy, cultured meat firms will be able to enter the market quickly, relations with both distributors and suppliers are likely to allow for a faster go to market. In addition, the skepticism found among potential customers of cultured meat might be lessened when the product is marketed by a familiar brand which further incentivizes cultured meat firms to pursue the strategy of co-branding.

Figure 10

Revised synthesis of theoretical framework



Note: The four factors that have been added in the revised synthesis of the theoretical framework are (1) regional disparities, (2) product characteristics, (3) co-branding, (4) technological hedging.

7. Conclusion

This chapter aims to answer the proposed research question and its sub-question by delineating conclusions from the analysis section. Furthermore, the thesis managerial- and theoretical implication will be elaborated along with recommendations for future research.

7.1 Incentives to Innovate or Imitate

The analysis uncovered relationships between the theoretical frameworks and the empirical data. It concluded that many of the elements in infant stages in the ILC framework synergizes well with the findings from the empirical data, ultimately concluding that the industry of cultured meat is positioned in an infant phase. In order to answer the first research question, the following conclusion will compile how such elements and theories might influence the viability of adopting either an innovation- or imitation-oriented strategy. Lastly, as the viability of innovation-oriented strategy is dependent on the viability of an imitation-oriented strategy and vice versa. An advantage for any of the two strategies will pose a disadvantage for the other ceteris paribus. Therefore, the strategies are not collectively exhaustive, which is why they are discussed in unison as opposed to separate chapters. Now, the thesis recalls upon the main research question:

RQ. *What incentives are there for firms to adopt an innovation-oriented-, respectively an imitation-oriented strategy in cultured meat industry?*

A pattern that permeates the viability to adopt an innovation- or imitation-oriented strategy is the factor of spatial positioning, as this in turn influences several of the sources of FMAs and FMDAs, which was elaborated for in the analysis. Further, the analysis of the empirical data suggests that there are several incentives for firms to adopt an innovation- or imitation-oriented strategy. Firstly, it is evident that there are possibilities for pioneering firms to attain FMAs by preemption of scarce assets. This, however, is largely dependent on spatial positioning as it influences the possibility for employee retention as well as the supply of desired personnel. However, the viability of such strategies could be questioned as the need for specialized R&D competences are reduced as the industry matures. Therefore, the strategy of protecting against imitation with personnel lock in might be a poor strategy in the long-term, but essential in the short-term.

Preemption of valuable partnerships have the possibility to yield FMAs as the regulatory landscape might drastically reduce the options regarding spatial positioning in the market. However, the strategy of pursuing partnership or private labeling synergizes poorly with Suaréz and Lanzolla (2005) who claims that brand recognition is one of the most important assets for attaining durable FMAs that last over time. Therefore, there might be a tradeoff between (1) the advantages of short-term accessibility to distribution- and supplier networks, market competences and brand value, and (2) the forfeit of attaining durable FMAs as the cultured meat firms themselves fail to build brand recognition that is within their control. As an ending note, a viable strategy for cultured meat firms in this regard is to pursue co-branding rather than private labeling as this increases the possibility of taking ownership of the brand, while simultaneously giving the firm access to distribution channels, network and marketing expertise.

Considering the fact that the production of cultured meat industry is technologically advanced, this allows for protection of technological advancement by patents which allows innovation-oriented firms to attain a position of technological leadership. This is specifically valuable as the knowledge is both cumulative and codified, which not only suggests that the knowledge is embedded in the organization rather than its personnel, but also that previous innovative advancement is important for future innovation success. However, the viability of attaining a position of technological leadership might lessen as there is a broad patent which is set to release this year, which in combination with the fact that a large source of knowledge for the industry is coming from academia and open institutes. Which in turn makes the information publicly available and accessible to all firms. In addition, the innovation of cultured meat is largely a process innovation, which reduces the possibility for reverse-engineering, hence imitation.

Due to the fact that cost of production seems to be the most important barrier as of now in combination with previous advancements in price performance ratio, this suggests that there might be economies of scale within the industry. Specifically, as the product of cultured meat is a high quantity FMCG. This allows firms to enjoy learning effects with regards to production which is likely to yield FMAs. However, one should not disregard that increased economies of scale also implies that the organization is less flexible to other trajectories, as its competences and resources are refined and developed into one specific trajectory. An interesting aspect which was identified in the empirical data was the strategic choice of pursuing parallel technological trajectories simultaneously as a method of risk mitigation to being locked-in to the wrong path. This might allow pioneers to reduce the risk of uncertainty, specifically if there is pervasiveness between the trajectories chosen, i.e., that knowledge and learnings can be shared between the trajectories. This further increases the viability for firms to innovate if the firm can incur the tradeoff in cost, which is largely driven by the fact that such initiatives require deep pockets and more personnel. However, the industry of cultured meat is receiving great interest from the outside world, specifically from venture capitalists which allow for an abundance of financing. Therefore, the strategy that this thesis refers to as technological hedging is likely to be a good method for risk mitigation in the cultured meat industry. However, this might have poor implications on the development pace of the industry, as the development might be less focused.

Lastly, the literature suggests that the main reason for firm shakeout during the transitory phase is the fact that firms travel down the wrong technological trajectory. The cultured meat industry is not only uncertain with regards to technology, but also with regards to consumer preferences and regulatory regimes. This combined might incentivize firms to apply for regulatory approval first, hence blazing the trail for imitators to follow. Specifically, firms might be able to dictate what cultured meat is supposed to be in the eyes of the consumers, what kind of serum and growth mediums should be used, and what kind of production technology that manages to emerge as a dominant design. The downside, however, is that the very same uncertainty that gives rise to these possibilities, also infer the risk for the pioneering firm to travel down the wrong path, as they wander in the dark considering that no trail has been blazed by any other pioneer.

7.1.1 Implication on The Industry Development Pace

The purpose of the sub-research question is to understand how the aforementioned strategies could affect the development pace of the cultured meat industry. Therefore, the following section will include conclusions drawn from the analysis which might influence the development pace of the industry. The thesis will now answer the sub research question.

- ***Sub RQ.*** *How might the viability of aforementioned strategic orientations affect the development pace of the industry?*

A pattern observed is the excessive secrecy among cultured meat firms, due to concern of imitation through knowledge spillovers. Such secrecy is argued to hamper industry the development pace as the learnings from one technological breakthrough is likely to be beneficial for another cultured meat firm, hence advancing the industry development. However, from a firm level perspective, the high level of secrecy will most likely protect investments in R&D, hence leading to a technological leadership position. With regards to the pace of industry development, patents, specifically of broad nature, can give result in one of two scenarios;

1) It can block competition, by hindering other firms from contributing to further development, which most likely will reduce the development pace.
2) Contrary, if the patent is licensed, other firms within the industry do not have to spend their R&D resources on similar technologies. Instead, firms in the industry can contribute for further development by pursuing unexplored areas, thus accelerating the development of the industry.

However, an interesting empirical insight revealed that several key people in the cultured meat industry are missionaries with deviant incentives, their ambition is not only primarily connected to building a successful and profitable business. Conversely, these missionaries perceive the cultured meat industry as something much greater where the main ambition is to contribute to make the planet a better place. Against this background, one can assume patents in this industry are more likely to be licensed than in industries of less importance with regards to global concerns. This pattern has been proven previously in the industry of cultured meat. By assumption, the advancements made by individual cultured meat firms are more likely to be shared between other cultured meat firms than what is expected in other industries ceteris paribus, due to the high proportion of missionaries within the field. Therefore, who secures patents and technological breakthroughs is expected to influence the pace of industrial development, as it is likely that firms differ in their altruistic agenda.

Another aspect that has been analyzed and discussed throughout the thesis is technological hedging, which could be argued to both spur and hamper industrial development. Firstly, the uncertainty within the industry incentivizes firms to pursue several different technological trajectories simultaneously. which results in a diversity of R&D activities, leading to multiple trajectories. This may inhibit the development of the entire cultured meat industry as less time is devoted to the technological trajectory which will become the dominant design. Whether this will spur or hamper the development pace could be argued to be determined by knowledge pervasiveness and uncertainty. A high uncertainty and an abundance of possible trajectories further incentivizes firms to pursue technological hedging. However, if the industry is less uncertain and there are fewer possible trajectories, this might allow firms to conduct more adequate estimates as to what trajectory will lead to a dominant design. On the contrary, a focused development can aid firms in obtaining superior technology more rapidly. If the findings of such technological advancements are made public, and others are incentivized to further innovate in other unexplored directions, the development pace of the cultured meat industry will most certainly accelerate. In conclusion, if there is less uncertainty within the industry, one might expect that a strategy of technological hedging is likely to result in waste of R&D-related resources, thus hampering the industrial development pace. In connection to what has previously been stated, the industry of cultured meat is specifically uncertain, not only with technology but also with regards to consumer preferences and regulatory regimes, which combined incentivizes firms to pursue a technological hedging strategy ceteris paribus.

7.2 Theoretical- and Managerial Implications

This thesis objective was to analyze what incentives there are for firms to adopt an innovation- or imitation-oriented strategy in an emerging industry, in this case the cultured meat industry. This was achieved by drawing upon the theories of innovation- and imitation-oriented strategies (FMA and FMDA), industry transformations (ILC) and path dependence. Furthermore, the analysis concludes that the theories of industry transformations and path dependence are fruitful when assessing incentives to innovate or imitate. In addition, these theories add important aspects that are not directly included in the theories of FMA and FMDA. In essence, we argue that the maturity of the industry and its elements directly affects the viability to adopt an innovation- or imitation-oriented strategy. Therefore, there are incentives to connect what in theory is treated as quite separate academic fields in order to provide a holistic and nuanced understanding of the viability of innovation- and imitation-oriented strategies.

To this background, the study contributes with the theoretical implication that the theories of industry transformation and path dependence are fruitful and relevant when trying to understand the field innovation- and imitation- oriented strategies in emerging industries, which is a field that is largely overlooked. Despite the fruitful contributions of ILC and path dependence, the empirical data revealed important factors that influence the viability of innovation- and imitation-strategies, factors that are not directly covered in any of the literature. These factors were added in the revised synthesis proposed in section 6.5, which suggested four distinct factors which influence the viability of innovation- and imitation-oriented strategies: (1) regional disparities, (2) product characteristics, (3) co-branding, (4) technological hedging.

The general implication for managers is to be aware of the maturity of the industry as this influences the viability of certain decisions. This is further elaborated below:
(1) The analysis concludes that the maturity of the elements included in the proposed framework has implications on the viability to innovate or imitate. Therefore, it is important for managers to maneuver accordingly. The need for technological hedging decreases as the industry matures, as the variety narrows continually until a dominant design emerges. In this line of thought, it might be valuable for managers to assess not only the maturity of the industry, but also the presence of self-reinforcing mechanisms, flexibility and technological pervasiveness, as this combined influences the potential value of technological hedging. For clarification, managers are recommended to assess:

- How self-reinforcing mechanism might affect the organization's flexibility in decision-making
- Whether there is knowledge pervasiveness between the similar technological trajectories pursued
- What assets are scarce in the industry
- If the firm has an adequate amount of financing which allows to incur the costs of technological hedging

(2) The analysis concludes that the characteristics of knowledge are important to assess when exploring FMAs. Specifically due to the insights revealed by the ILC literature, as emerging industries are characterized by being knowledge intensive.

- Therefore, it is important to assess whether the knowledge is embedded in the organization or its employees. I.e., to what degree is the knowledge codified or tacit, complex or simple. These insights should be analyzed in relation to employee retention and mobility.

(3) The analysis concludes that firms should carefully consider their product characteristics in an emerging industry as this is likely to influence the possibility of securing FMAs. In this line of thought, two aspects have been revealed by the analysis. Firstly, products such as cultured meat, which are produced by highly technological and advanced processes, but remain a rather uncomplicated end product are different from highly technological end products in several regards.

- Managers need to be aware of whether their organization's end product is of high- or low technological nature. High technological end-products are more inclined to be interlinked with infrastructure and managers must in these cases be aware that the infrastructure increases the value of their product. If the infrastructure is not in place, there might be a possibility for the pioneering firm to establish and take ownership of such infrastructure, which in accordance with the literature can give rise to strong sources of FMAs.

7.3 Future Research

The cultured meat industry might not be a perfect representation of an arbitrary emerging industry. It is an industry which distinguishes itself by process innovation as it is introducing a drastically different way of producing a quite similar product. Several firms measure success in how well their product mimics traditional meat, whereas other firms pursue both hybrid products as well as products aiming to surpass palatability and, or nutritional values. Nevertheless, the similarity between the new product and the old product it aims to replace is speaking, which is likely to have implications on the topic of innovation- and imitation-oriented strategies. The highly technological production process combined with the low technologic end product is argued to influence the possibility to attain complementarity effects, buyer learning and switching costs, as well as the possibility for imitators to reverse engineer. Therefore, it would be interesting to spur research of the same sorts, but in emerging industries with products whose external dominant design is different than the external dominant design of the product it aims to replace, such as how the smartphone replaced its predecessor in the landline or basic cell-phones.

In addition, the thesis scratches on the surface of technological hedging and how it might influence the viability of innovation- and imitation-strategies. A hypothesis is that the choice for firms to pursue parallel technological trajectories as a tool for hedging against lock-in and choosing the wrong path is likely to influence the development pace of an industry. Therefore, further research into the effects of technological hedging on industry development might nuance the field of industry transformation and development, specifically within emerging industries who are characterized by a large degree of uncertainties.

Lastly, it is implied that the strategy to co-brand or to become a private label supplier might influence the viability of attaining FMAs. To this background, it would be interesting to retrospectively assess how such choices have affected firms market share, survivability, profitability or other metrics in emerging industries. Specifically, in regard to different time horizons, as the literature claims that strong brands are important sources of durable FMAs, whilst being less important for short-term FMAs.

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9. Appendix

Appendix A - Interview Questionnaire Executives

Starting questions

1. Do you think that you have any advantages from being early in this industry?
    a. And do you think there are any advantages from being first-to-market?
2. Are you concerned about the risk of imitation and protecting investments in R&D?
3. What do you think about the maturity and future development of your industry?

Questions regarding industry maturity

1. What kind of products are you offering and/or researching into and why has this been chosen?
2. Where do you put your main innovation efforts at the moment and why?
3. Do you focus on one specific production technology, or do you experiment with multiple ones?
4. Could you elaborate on your production plant and equipment, (small or large-scaled) and why have you chosen to place it at the current location?
5. What can you tell us about your competitive landscape?
   (Type of firms, production technology, number of firms, products, size of firms)

Questions regarding technological regimes

1. Would you say that new technological knowledge is built upon prior experience and expertise?
2. Do you feel like you are able to protect your innovations, knowledge, if yes how? if not, why?
3. What knowledge and competences are important to your organizations and how would you describe the possibility of sharing such knowledge?

Questions regarding path-dependency

1. Are you dependent on the decisions of stakeholders, if yes - how?
   (Suppliers of growth serums, distribution channels, alliances, competitors etc., complementary products?)
2. Do you think that there is or will be a standard production technology for producing cultured meat?

Questions regarding first-mover advantages and imitation

1. What factors do you think will be deciding when customers choose their cultured meat supplier in the future? (Brand recognition, taste preferences, costs, supply/distribution)
2. How do you think that you will sell to consumers, and do you think that there will be first-mover advantages in securing partnerships with the distribution channels, if yes how?

Ending questions

1. Are there anything you would like to add that you think might be interesting or of value to our research?

Appendix B - Interview Questionnaire Experts

Starting questions

1. How would you describe the cultured meat industry today? What kind of development do you think we will witness in the coming years?
2. Do you think there will be any advantages from being early in this industry?
    a. And do you think there are any advantages from being first-to-market with a product?
3. What do you think about the risk of imitation and protecting investments in R&D?
4. What do you think about the maturity and future development of the industry?

Questions regarding industry maturity

1. Where do you think firms put their main innovation efforts at the moment and why?
2. How would you describe the production technology within the industry - would you say that there is a lot of variation?
3. What do you think about the geographical placements of the firms and plants? Do you think this has any importance?
4. What can you tell us about the competitive landscape?
   (Type of firms, production technology, number of firms, products, size of firms)

Questions regarding technological regimes

1. Would you say that new technological knowledge is built upon prior experience and expertise?
2. What knowledge and competences do you think are important for this industry and how would you describe the possibility of sharing such knowledge?

Questions regarding path-dependency

1. Do you think that companies will be locked into their initial investment made in production technologies chosen today, and hence the products they are developing?
2. What stakeholders do you believe are important for the cultured meat industry? (Suppliers of growth serums, distribution channels, alliances, competitors etc, complementary products?)
3. Do you think that there is or will be a standard production technology for producing cultured meat?
4. What do you think will happen to traditional meat consumption if cultured meat achieves good scalability and market penetration?

Questions regarding first-mover advantages and imitation

1. What factors do you think will be deciding when customers choose their cultured meat supplier in the future? (Brand recognition, taste preferences, costs, supply/distribution)
2. How do you think that cultured meat producers will sell to consumers, and do you think that there will be first-mover advantages in securing partnerships with the distribution channels, if yes how? (I.e., own branding, co-branding or B2B)

Ending questions

1. Are there anything you would like to add that you think might be interesting or of value to our research?
2. Do you think that the firms that are active and leading within the industry today will be the leading firms 5 or 10 years from now?

Appendix C - Interview Request

Hello “*Company name*”,

Our names are Joakim and Ali, and we are currently writing our masters' thesis within the field of cultured meat. To this background, we would be delighted for a possibility to conduct a short digital interview with you.

We are Swedish business students studying Innovation and Industrial Management at the School of Business, Economics and Law in Gothenburg and at Chalmers University of Technology. Our purpose for the thesis is to investigate the level of maturity in the industry and factors regarding path-dependency might influence cultured-meat producers' ability to appropriate returns by attaining first-mover advantages and by protection against imitation.

The interview is expected to last for approximately an hour and requires no preparation from your side. It aims to yield answers regarding industry maturity and different components contributing to path-dependencies. This will be explained more in depth at the start of the interview. Therefore, it would be beneficial if the respondent has some insights into objectives and strategic targets of the organization. If requested, we will grant full anonymity with regards to all information shared and personal details.

Your mission inspires us, and we believe that cultured meat will be part of creating a more sustainable solution for supplying meat in the future. Naturally, we would be glad to share our thesis and its findings with you after the process has been finished. We would be glad to receive your answer by a replying mail or through the contact details attached below.

Sincerely,

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Appendix D - Stem Cells

Characteristics of stem cells used for in vitro production

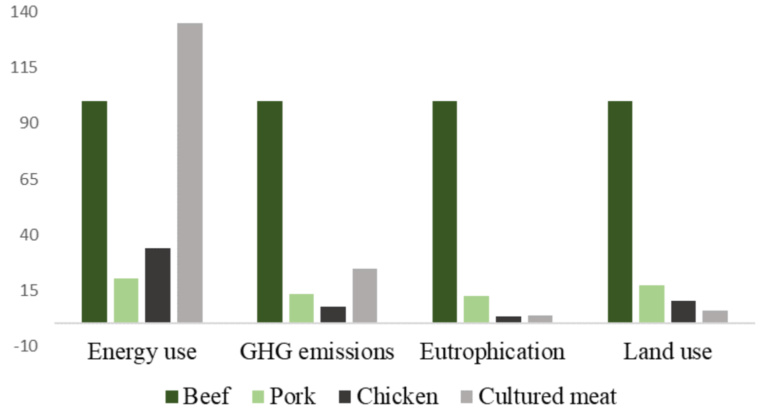
Type of stem cell	Tissues and stem cell can differentiate into	Persistency in terms of number of replications in vitro
Embryonic stem cells	Most tissues of the animal body	Long-term persistency and may be limitless (Zeng and Rao, 2007)
Totipotent stem cells	All cells of the body and the developing fetus. The newly fertilized egg is a good example	Theoretically high
Pluripotent stem cells	Most tissues of the body, but more restricted than totipotent stem cells. The embryonic stem cell is an example of this type	Variable
Induced pluripotent stem cells	Most tissues of the body. Fully differentiated cells can be induced to become pluripotent by appropriate treatments (Holde and Vogel (2008)	Variable and unknown in many cases
Adult stem cells	A broad classification across tissues, with the most being specific to the tissue they originate from	Most adult stem cells are limited to 50–60 divisions. This replicative capacity is termed the "Hayflick limit" (Roobrouck et al., 2008)

Multipotent stem cells	Several tissues depending on the tissue of origin. For example, the mesenchymal stem cells from the mesoderm can differentiate into fibroblasts, adipocytes, osteoblasts, chondrocytes or myocytes (muscle cells)	Variable, depending on animal age
Myosatellite stem cells	Muscle tissue. An example of a unipotent or committed stem cell that is capable of supporting one tissue type only	Decreases with age (Roobrouck et al. 2008), and may be less than 20 divisions in vitro for adults (Mouly et al. 2005)

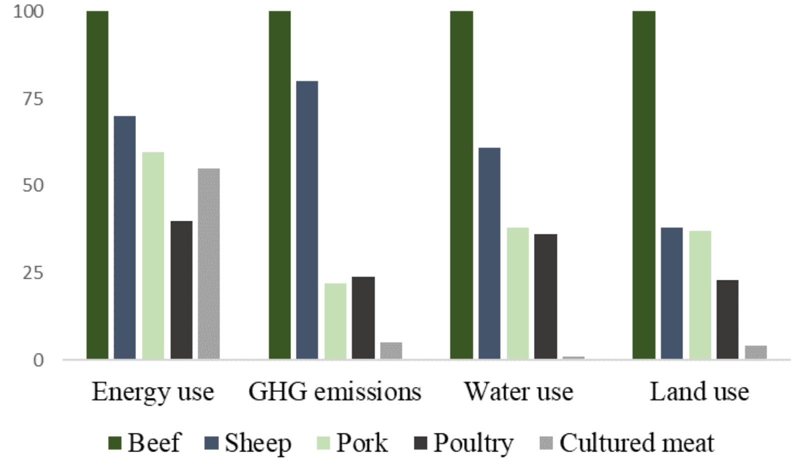
Note: Table taken from Kadim et al. 2015

Appendix E - Externalities between meat categories and cultured meat

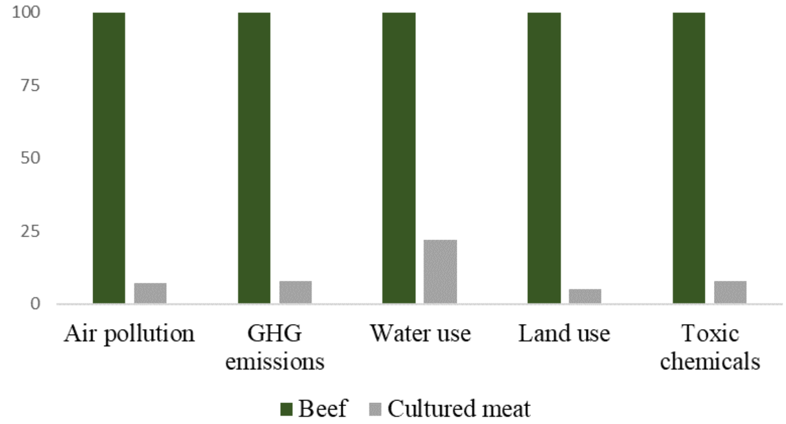
Rubio, N. R., Xiang, N., & Kaplan, D. L. (2020). Plant-based and cell-based approaches to meat production. Nature Communications, 11(1), 1-11



Tuomisto, H. L., & Teixeira de Mattos, M. J. (2011). Environmental impacts of cultured meat production. Environmental science & technology, 45(14), 6117-6123



Schwartz, E. (2021). Anticipatory Life Cycle Assessment and Techno-Economic Assessment of Commercial Cultivated Meat Production. The Good Food Institute.



Appendix F - Modes of imitation and its relation to innovative capacity

Mode of imitation	**Description**
Replica	Replica is the most basic and straightforward imitation mode which requires the least number of resources to understand how the technology or innovation functions, it can be both illegal and legal depending on specific circumstances. Examples of products within this scope are luxury consumer goods.
Mimicry	Mimicry is often rather standardized and routinised solution which are in line with the firm's existing knowledge base. Such imitation is largely enabled through reverse engineering or through purchases of specifications, manuals, blueprints and equipment. A well-known example is when Pepsi mimicked Coca Cola
Analogue	Analogue imitation is largely enabled through reverse engineering in combination with basic inhouse R&D. This requires basic manufacturing capabilities in combination with an evolving absorptive capacity. This would in turn allow firms to alter or modify the product the firm seeks to imitate
Emulation	Emulative imitation aims to exceed the product the firm seeks to imitate which in turn makes it the most complex and R&D intense mode of imitation. It requires advanced R&D and manufacturing capabilities and complementary assets.

Note: Table conducted using information from Ulhøi (2012):

Appendix G - Thematic codes

Type of theme	Overarching theme	Coding	
Predetermined themes	Innovation-oriented advantages	Technological leadership	Advantages in learning or experience curve
			Success in patents and R&D
		Preemption of scarce assets	Preemption of input factors
			Preemption of geographical locations and characteristics space
		Switching costs and buyer choice under uncertainty	Switching costs
			Buyer choice
	Imitation-oriented advantages	Freerider effects	
		Resolution of technological or market uncertainty	
		Shifts in technology or customer needs	
		Incumbent inertia	
	Path dependence	Self-reinforcing mechanisms	Coordination effects
			Complementarity effects
			Learning effects
			Expectation effects
	Industry life cycles	Elements	Technology
			Equipment and knowledge
			Plant

			Competition
			Innovation
			Number and size of firms
			Product
			Market
Emerging themes	Regional disparities		
	Go to market		
	Product characteristics		
	Technological hedging		