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Big Data and the Future of Insurance

How data-centric technologies influence the competitive structure of the European life and health insurance industry

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Abstract

Technology has the power to transform entire industries overnight. The insurance industry will become datafied by the disruptive power of big data analytics, cloud computing, Internet of Things (IoT) and predictive modeling, to name a few. The purpose of this thesis is to understand how developments in data-centric technologies have influenced the collection, processing and use of data in insurance and how these developments have changed the competitive structure of the European life and health insurance industry. This is a case study of the EU life and health insurance industry over three distinct technological paradigms: analogue, digital and data. The analysis of each paradigm shows how technology has the power to transform industry competition, and that the winning technologies, which form the basis of the following technological paradigm, are selected through economic, institutional and social forces operating ex post. Very few studies have examined big data and insurance, yet this thesis shows how big data analytics is able to disrupt a very conservative industry such as insurance, which is critical knowledge for insurance companies and researchers alike. Most notably, it demonstrates how the entire model of risk management, which is essential to insurance, will change with the introduction of individual and dynamic risk assessment.

Keywords: Life and health insurance; technology; big data; analytics; disruption; Internet of Things; cloud computing; predictive modeling; machine learning.

Preface

This thesis started as partnership with another student of CBS, named Han Yong Cho. The partnership was terminated four months before hand-in deadline. All of the written material in this thesis is produced by me, while only the original idea and problem formulation was produced jointly. After the partnership was terminated, I made some alterations to the original problem formulation and was able to keep much of the material I had already written. However, much of the analysis was written with another continuation in mind. I sincerely hope this is unnoticeable.

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1. Introduction

The insurance industry is on the brink of major transformation as technology is transforming every aspect of the industry. This transformation will lead to exciting opportunities for the insurers that are able to embrace them, but significant risks for the laggards. Today, digital is becoming central to the insurance customer experience, especially within the segments of Generation Y and the tech-savvy (Batty et al., 2010), and IoT, cloud computing, big data and analytics are now converging to offer insurers new and valuable competencies. While technology has the power to disrupt entire industries overnight, some challenges are specific to insurance.

To remain competitive, insurers must be ready to collect, process and use data in innovative ways through analytics in order to gain knowledge and improve decision-making. And while advanced data mining techniques have already taken root in auto insurance, the application of such techniques for more objective and optimal decision making in life and health insurance is still at an early stage. Furthermore, these insurance types are relying on very sensitive private data, which is why privacy rights cannot be ignored.

The purpose of this thesis is to examine the technological transformation of life and health insurance at the EU level. The goal is to analyze the technological developments in the industry with a focus on data-centric technologies and their influence on its competitive structure. Insurance is generally considered a very conservative industry in their adoption of new technology, but with the digital transformation it has become an increasingly data-heavy or 'datafied' industry. This thesis will build from a historical narrative to illustrate the power of technological change over time, through three technological paradigms: analogue, digital and data. The reason for this historical approach is that technological progress often seems to maintain a relatively autonomous momentum, and only by understanding the developments over time can one understand the relationship between the economic, institutional and social forces that operate to select the technologies that become basis of competition. The technological paradigm has major impact on the competitive structure, which is why the goal of this thesis is to answer the following research question:

> *How do developments in data-centric technologies influence the collection, processing and use of data in insurance and how does it change the competitive structure of the European life and health insurance industry?*

In order to answer the research question, a set of sub-questions has been designed, which will guide the structure of the thesis:

1. How has the use of data-centric technologies in insurance changed over time since WWII?
2. How will recent developments in data-centric technologies, such as big data analytics, machine learning and predictive modeling, influence the competitive structure of European life and health insurance as the industry enters the data paradigm?
3. How can insurance companies leverage technology in order to remain competitive in the data paradigm?

In order to answer these questions, a combination of two theoretical frameworks has been used. Giovanni Dosi's (1982) theory of technological paradigms and technological trajectories is used to illustrate the determinants and directions of technological change in the insurance industry, while Porter's five forces (1979) is used analyze the competitive forces within each of the three technological paradigms. Together these theories allow us to understand how technological progress can shape and reform the competitive structure of an industry.

The thesis is structured as follows: Section 2 will present some key definitions. Section 3 examines related research and presents the academic- and empirical contributions made by this thesis. Section 4 clarifies the research process and design, including methodology, delimitations and data collection. Section 5 presents the theoretical framework used to answer the research question. Section 6 is the analysis, with a short introduction to modern insurance followed by a deep dive into the three technological paradigms and the evolution of technology and competition in the EU life and health insurance industry. Section 7 provides a discussion on the broader regulatory and social consequences of the increased use of data, including privacy concerns and how to improve EU's health care sector through public private partnerships. This section does not pretend to be a full analysis on these issues. It merely serves as a starting point for future analysis while discussing possible solutions to concerns raised throughout the analysis. The final section, Section 8, presents the conclusion.

2. Definitions of Key Terms

Technology: The practical application of knowledge in a particular area – in this case computer- and data science. It refers to methods, systems and devices, which are the result of scientific knowledge being used for practical purposes.

Disruption and disruptive technology: Disruption creates a new value network by changing how we think, behave, learn and do business, while displacing established market leading firms and products. Disruptive technologies change the bases of competition by changing the performance metrics along which firms compete.

Big Data: Data that have the five characteristics: Volume, variety, velocity, veracity and value.

Big Data Analytics: the solutions, processes and procedures, which allows an organization to produce, process, access and analyze a relatively large amount of data to get information and aid the decision making process, which is the ultimate objective of big data analytics (Nicoletti, 2016). These are the techniques for analyzing big data, which cannot be handled by traditional analytical tools and techniques.

Predictive Modeling: The process of creating, testing and validating a statistical model to best predict the probability of an outcome. It is used to forecast future outcomes from historical data by utilizing a number of modeling methods from machine learning, artificial intelligence and statistics.

Machine Learning: A subfield of computer science. Essentially a system, which is trained to generalize beyond testing data, thus giving computers the ability to learn from new data without being explicitly programmed by humans. Within the field of data science, machine learning is used to formulate complex models and algorithms that are then used in predictive analytics. Machine learning is then the process of automatically discovering patterns in data, which are then used to make predictions.

3. Academic- and Empirical Contributions vs. Related Research

The purpose of this section is to introduce related research as well as this thesis' academic and empirical contributions. As mentioned in the introduction, this thesis will build from an international business point of view during the analysis to a more political discussion

3.1 Related research

Frizzo-Barker (et al., 2016) did a study of the rise of big data in business scholarships during the period 2009-2014, and found that 72% (n = 158) were conceptual in nature, and 28% (n = 61) were empirical. They also measured the proportion of qualitative (50%), quantitative (39%), and mixed-method studies (11%) in the articles with empirical methods. Very few studies in the sample focused on insurance (<1%) and only 15% of studies focused on critical, ethical or socio-economic aspects of big data.

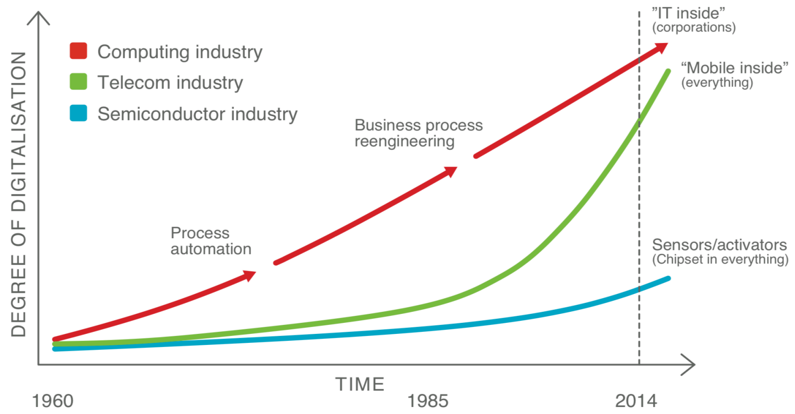
Since this thesis focuses on industry analysis, much of the related research is carried out by management consulting firms (Batty et al., 2010; Chattopadhyay, 2011; Hocking et al., 2014; Hurley, Evans, & Menon, 2015; Taylor, 2016) and industry trade groups (Association of British Insurers, 2015; Bharal & Halfon, 2013; Swinhoe, Merten, Stephan, & Marc, 2016). Research has also been done on the possible implications of digital solutions to insurance, with specific attention to big data analytics (Nicoletti, 2016; Thomas & McSharry, 2015). While some authors have focused on the potentials and societal role of IoT (Atzori, Iera, & Morabito, 2017), others have focused on the consumers' desire to share personal information (Pickard & Swan, 2014). Another field of study related to this thesis is the historical studies of actuarial science and the technological transformation of the insurance industry (D. Cummins & Santomero, 1999; Lewin, 2007; Yates, 2005).

Thus, this thesis relates to studies of technological innovation and transformation (Porter & Heppelmann, 2014), big data analytics and machine learning (Davenport, 2013; Jesse, 2016) and industry competition (Downes, 1997; Grundy, 2006; Porter, 1979). Only limited research has been carried out in any of these fields with focus on insurance in general and life and health insurance in particular. The purpose of this thesis is to provide a coherent analysis of the technological developments in insurance and their impact on the competitive structure within the industry.

3.2 Academic and empirical contribution

This thesis adds to the research of evolutionary theories of economic change, which is discussed more in the following section on the methodology of this thesis. There has been conducted several critical surveys of the field (Andersen, 1994; Hodgson, 1998; Nelson, 1995; Nelson & Winter, 2002), The argument in evolutionary theory of economic change is that the starting point for academic research must be the heterogeneity of economic agents (Castellacci, 2006). Firms are guided by routines, similar to phenotypes in biological evolution, because their decisions are the result of the development of their genetic endowment (individual skills and organizational routines) in a given economic and institutional environment. As a result, this thesis incorporates a historical perspective of the technological changes over time. This is an important part of the argument, as it illustrates the

Figure 1: The evolution of digitalization and datafication



NB: Digitalization + datafication = Disruption of economy, society, everything

Source: Mulligan (2013, p. 5)

way competition and selection transforms the economic world so that heterogeneity is continuously renewed and evolution becomes a never-ending process.

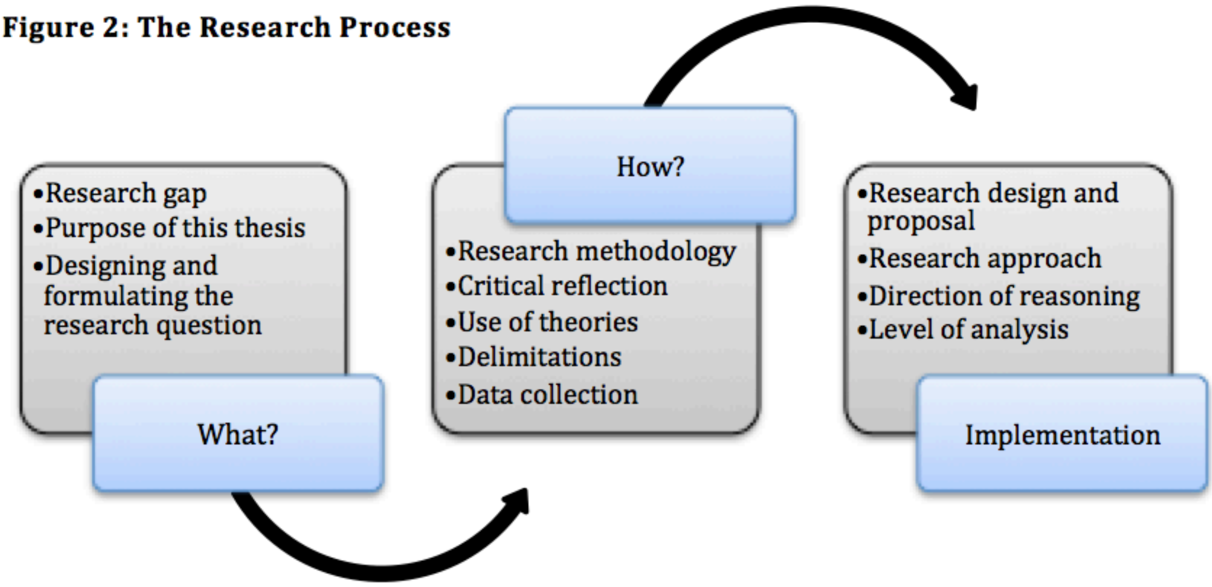
Another contribution is made to the research on the datafication of industries (Lycett, 2013; Mai, 2017; Mulligan, 2013). It relates to the use of digital technologies to collect knowledge from physical objects and people by decoupling them from the data associated with them. Datafication is often associated with sensors and IoT, but in many cases a mobile device and a sports tracker is enough to extract knowledge of a person's health and wellbeing. Figure 1 illustrates the evolution of digitalization and datafication over time.

Lastly, the discussion part of this thesis deals with surveillance capitalism (Zuboff, 2015) and the concept of data as a resource in contemporary society. Researchers must acknowledge that we are experiencing a changing paradigm towards data being an important force in economy, society and everything. The academic contribution of this paper is to argue for evolutionary research of economies and industries, while the empirical contribution is a focus on industry dynamics and the transformative power of technology through history. This serves as a validation for the main argument that the value and importance of data-centric technologies will continue to increase as the current technological paradigm unfolds.

4. The Research Process

The following section will address the research process and the methodological considerations, which have guided the research of this thesis, as well as the qualitative and quantitative data sources.

Figure 2: The Research Process



The research process can be divided into three parts (see Figure 2). The first step, which was detailed in the previous section, is a description of the research gap that will be covered by this thesis. This section takes a closer look at the process of designing and formulating the research question, which is also a part of the first step. This step can be identified as *the what*, as in what is the purpose of this thesis and what has been the process of designing and formulating the research question. The second step of the research process can be identified as *the how*, demonstrating the process of how to find the answers to the research question. This is an important step, which elaborates on the methodological and theoretical considerations. This step will also address delimitations and the methods used for data collection. The goal of the third step is to elaborate on the research design and proposal, illustrating how this thesis will implement *the what* and *the how* in the research design. This step delivers an overview of the thesis including the direction of reasoning, research approach and level of reasoning.

My attention was guided towards the European life and health insurance industry for two reasons: First, companies in this industry will be able to collect highly sensitive personal health information, which requires unwavering attention to privacy rights and data protection. Second, if data has the power to transform an industry as conservative as insurance, it will surely have the power to transform other industries and economies as well. These considerations, together with the gap in academic and empirical research, led to the previously mentioned research question.

4.1. Research methods

The second step, analyzing *how* to answer the research question, starts by addressing the methodological and theoretical considerations and continue by elaborating on the delimitations of this thesis as well as presenting the data collection techniques.

4.1.1. Theory of science

This thesis will follow a critical realist interpretation of the world. According to Roy Bhaskar (1978, 1986, 1998), critical realism is a philosophical approach to sciences that criticizes the positivist approach, which argues that science can measure a reality which is real and apprehensible. At the same time, it contradicts the constructivist argument that our reality can simply be reduced to our interpretation of it. According to Archer et al.:

> *"Critical realism is not an empirical program; it is not a methodology; it is not even truly a theory, because it explains nothing. It is, rather, a meta-theoretical position: a reflexive philosophical stance concerned with providing a philosophically informed account of science and social science which can in turn inform our empirical investigations."* (2016, p. 4)

Critical realism can be thought of in terms of three layers: the empirical data, the theories that are used to explain the empirical data, and the metatheories or philosophy behind the theories. Baskar (1978) argues that the most important point of critical realism is the shift of focus back to ontology. Critical realism maintains that the world must have a certain structure for knowledge to be possible. Critical realists believe that there are unobservable events, which cause the observable events, such that the social world can only be understood if people understand the structures that generate these unobservable events. This understanding allows the researcher to distinguish between a technological paradigm and what causes it.

Castellacci (2006) has used critical realism to interpret evolutionary theories of economic change, which studies processes that transform economies for companies, institutions, industries and employment. This theory is similar to Dosi's (1982) theoretical framework of technological paradigms and trajectories, which is the foundation of this thesis. Evolutionary growth theory is focusing on economic agents as the starting point for understanding the complexities associated with the process of growth and transformation in the long run (Nelson & Winter, 1982). Individuals follow routines and habits in their economic activities, and they can be transmitted from one agent to another, thus explaining stagnation and inertial patterns in technological change. Similarly, this thesis focuses on effects of technological change in an industry, where incumbent firms may be resistant to change or unable to respond to radical innovation because of organizational inertia.

The use of Porter (1979) and Dosi's (1982) theoretical frameworks illustrate a Schumpeterian interpretation of technological change and its influence on competition as a selective device. So, where Porter (1979) focuses on microeconomics and the determinants of competition within an industry, Dosi (1982) sees shifting economic systems caused by changes in technology. Similarly, modern neo-Schumpeterian theory focuses on the importance of radical innovations in determining long-wave patterns of macroeconomic growth (Castellacci, 2006). The challenge for evolutionary scholars, when interpreting neo-Schumpeterian long-wave theory, is to investigate the microeconomic process, which explains the co-evolution of technological and institutional changes at the macroeconomic level. This thesis will primarily build on microeconomic reasoning during the analysis to explain the complex, differentiated and structured reality of the insurance industry and its transformation over time. The focus in the discussion will shift to a more macroeconomic and political perspective.

In regards to methodology, critical realism shares further similarities with evolutionary economics (Castellacci, 2006). The objective is to understand the evolutionary process, which has generated the empirical evidence that is being observed. Thus, the necessary starting point must be a historical, and in this case technological transformative, analysis of the mechanisms that form the economic system.

One of the main discussions within critical realism is the possibility of combining quantitative and qualitative research (Castellacci, 2006). The argument is made within critical realism that quantitative analysis implies an attempt to infer universal causal laws from empirical evidence (Lawson, 1997). It is possible, however, when combining the critical realist and evolutionary perspective, to combine qualitative and quantitative analysis. While this thesis does not rely on independent quantitative analysis, it will combine the qualitative analysis required by technological, economic and institutional history with quantitative analysis in the form of statistical and econometric secondary sources to increase the validity of the arguments during the analysis. Finally, given that in critical realism the social system is understood as a complex interrelated whole, one must apply interdisciplinarity in order to fully understand the forces that shape industry competition in the wake of technological innovations. This is why it makes sense, methodologically, to include political science and engage in a discussion on the changing power structures in the global economy and the importance of privacy rights.

4.1.2. Delimitation

This thesis will focus on the industry effects of introducing data-centric technologies and particularly technologies that make use of big data analytics, such as machine learning and IoT. A brief explanation of the concepts will be provided, but a deeper and more technical clarification of the specific algorithms and techniques will not.

An important delimitation for this thesis is in regards to the choice of industry. Defining the relevant industry, in which competition actually takes place, is important for good industry analysis (Porter, 2008). Although big data analytics and other data centric technologies have the potential to disrupt many industries, and even other lines of insurance, the focus here is on life and health insurance because the data utilized in this industry is particularly sensitive, which emphasizes the concern for privacy and data protection. The geographical scope is also important since competition within Europe is essentially a product of the single market for insurance in the EU.

The decision to focus on private and voluntary life and health insurance is a consequence of a heterogeneous European insurance industry, where numerous models exist for public vs. private financing. For private insurance, the model of calculating risk is the same across borders and the insurance coverage is specified by an insurance contract unlike what is the case for public insurance, which is often mandatory and financed through taxation.

4.1.3. Data collection

Data collection is a very important part of any case study (Yin, 2013). To answer the research question, both secondary and primary data sources have been collected, which are qualitative as well as quantitative. The analysis relies solely on secondary sources to explain the developments in data-centric technologies over time, as well as both secondary and primary sources to understand the use of these technologies in insurance. A number of historical sources from the 70's and up until today have been included. The main contributor to this historical review of technology is JoAnne Yates (2005), who is the leading author on the subject, although she is primarily concerned with the evolution of the US insurance industry.

Limited industry data has been available at the European level. Most data is country specific, which makes it difficult, if not impossible, to generalize about the use of technology in the European life and health insurance industry as a whole. The technological advancements within each technological paradigm should be seen as possibilities for insurance companies to gain competitive advantage by the use of these technologies. The penetration is often unknown, and the assumption must be that it is minimal and often very slow for new technologies. Quantitative analysis with information about the industry has been gathered from Datamonitor, Insurance Europe, OECD and Statista. In regards to primary sources, an interview with two representatives from TopDanmark, a small Danish insurance company, provided valuable insights into the adoption and use of data-centric technologies in a slow and conservative industry.

4.3. Research design

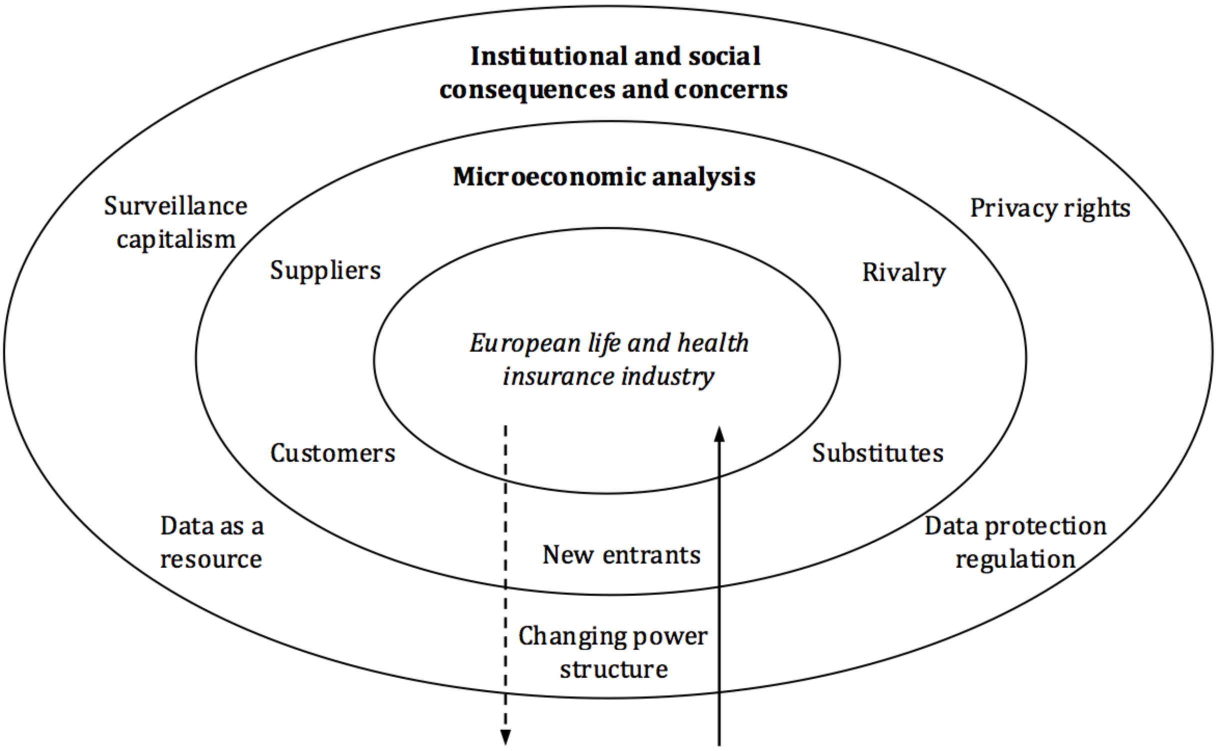
The last step in the research process is to describe the actual way of conducting the research. The point of this section is to organize *the what* and *the how* within the limitations of this thesis by elaborating on the research design and proposal.

This thesis will follow a traditional research design by combining empirical data and theory, which will provide an answer to the research question. The research approach can be characterized as qualitative, since the purpose of this thesis is to seek particular explanations to the research question in a descriptive way instead of looking for general laws through quantitative analysis and testing of hypotheses. This thesis is essentially a qualitative case study of the European life and health insurance industry, seen from a microeconomic perspective in order to comprehend the cause and effect of a changing competitive structure. According to Dul and Hak (2008), most authors consider case study research to be a relevant research strategy when (a) the topic is broad and highly complex, (b) there is not a lot of theory available, and (c) "context" is highly important.

Figure 3 illustrates the relationship between the use of theories during the analysis and the political discussion during the final parts of this thesis. The two theories interplay to create a better understanding of how an industry and its competitive structure transforms as a result of technological innovation over time. During the data paradigm, the surrounding institutional and social concerns are both affecting and getting shaped by this transformation, which is the focus in the discussion section. Thus, this thesis is operating at multiple levels of analysis.

During the analysis section, the focus is microeconomic and industry specific, while it shifts to a more macroeconomic focus in the discussion section.

Figure 3: The relationship between the use of theories and the discussion section



Technological paradigms and trajectories (Dosi, 1982) shape and influence the microeconomic forces while the industry itself gradually selects the technologies, which become the basis of competition. The surrounding institutional and social concerns are both a product of the recent technological paradigm (the data paradigm) and an influencing factor in their own right.

5. Theoretical Discussion for the First Part of the Analysis

The aim of this section is to provide an overview and justification for the use of the theoretical frameworks in this thesis. Giovanni Dosi's (1982) theory of technological paradigms and technological trajectories is used to illustrate the determinants and directions of technological change in the insurance industry. Porter's five forces (1979) is used analyze the competitive forces in each of the three technological paradigms, which makes the different paradigms more understandable and translates Dosi's ideas into something more practical. Together these theories allow us to understand how technological changes can shape and reform the competitive forces of an industry.

5.1. Technological paradigms and technological trajectories

The concepts of technological paradigms and technological trajectories are closely related. According to Giovanni Dosi (1982) a technological paradigm can be defined as: *"an 'outlook', a set of procedures, a definition of the 'relevant' problems and of the specific knowledge related to their solution"* (p. 148). Each technological paradigm defines its own concept of '*progress*' based on its specific technological, social and economic trade-offs. Within the paradigm itself the direction of advance is called a *technological trajectory*. Technological innovations are supposed to follow general prohibitive and/or permissive rules, which leads to accumulative and continuous improvements. However, his theory of technological paradigms is not a general theory of technological change. Instead it tries to explain why certain technological developments emerge instead of others. History provides many examples of how technologies have followed specific trajectories or directions (Hughes, 1989; Rosenberg, 1976).

Dosi (1982) argues that the previous economic theories of technological innovation and change are rather crude instruments to explain the technological trajectory. He argues that the dichotomy between seeing market forces as the main determinants of technical change ("demand-pull") and defining technology as an autonomous factor ("technology-push") is very inadequate. Since firms are major actors in the process of innovation, it is important to understand their role in the process of technological change.

Dosi (1982) has translated the paradigm metaphor to a technological analogy from Kuhn's (1962) framework of scientific paradigms. Radical technological innovation, which occasionally occurs, involves some change in the organization of production and markets. Thus, organizational and institutional innovations are greatly associated with the process of technological innovation. The fact that some technological paradigms become institutionalized, while others do not, suggests that they can be seen as social as well as technical resources (Ulhøi & Gattiker, 1998). A technological paradigm is then a model and a pattern of solutions for technological problems based on "*selected principles derived from natural sciences and on selected material technologies*" (Dosi, 1982, p. 152). A technological trajectory is the pattern of 'normal' problem solving activity or progress within a technological paradigm. The identification of a technological paradigm relates to the generic tasks to which it is applied (e.g. automation of inputs), to the material technology it selects (e.g. microprocessors and silicon) to the physical properties it exploits (e.g. ICT and microand nanotechnology) to the technological and economic dimensions and trade-offs it focuses upon (e.g. density of the circuits, speed, unit costs etc.).

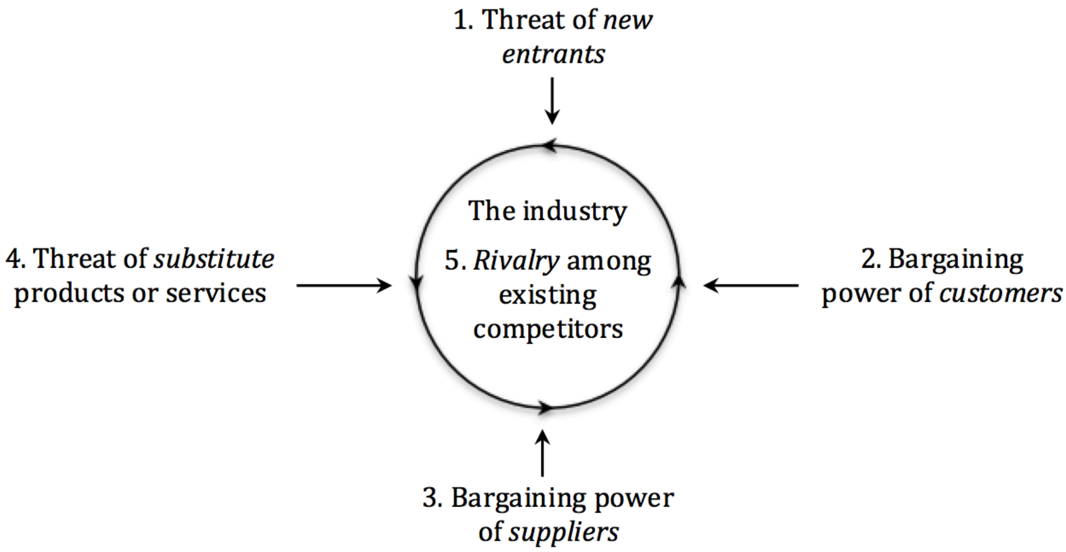
Once we understand these technological and economic dimensions it is also possible to obtain an idea of "progress" as the improvement of the trade-offs related to those dimensions. A technological trajectory is then a group of possible technological directions whose boundaries are defined by the nature of the paradigm itself (Dosi, 1982). This leads to a crucial question in Dosi's paper: how did an established paradigm emerge in the first place and why was it preferred to other possible ones? He makes a bridge between the demand-pull and technology push theories saying that economic, institutional and social factors operate as a selective device. However, it is important to recognize that it is hardly possible to compare, rank and assess the superiority of one technological trajectory over another ex ante. This is also one of the reasons why Dosi advocates a mix of technology-push and demand-pull in understanding the technological trajectories. The argument is that market forces operate ex post as a selecting device among a range of products already determined by the broad technology patterns chosen on the supply side (Dosi, 1982). Extraordinarily technological innovations emerge either from new opportunities derived from scientific developments or from the increasing difficulty going forward on a given technological direction due to technological and/or economic reasons.

Using this theory we are able to identify characteristics of each technological paradigm in the insurance industry, and how they differentiate from each other. In our analysis we will describe the transition from one technological paradigm to the next and assess the factors, which allowed the emergence of a winning technology in each case.

5.2. Porter's five forces

Porter's five forces is a framework for analyzing the level of competition within an industry by understanding the industry's strengths and weaknesses. It was developed by Michael E. Porter (1979) and identifies and analyzes five competitive forces that shape every industry (see Figure 4). The framework has been frequently used to identify an industry's structure and to determine corporate strategy in search of profitability and attractiveness.

Figure 4 – Porter's five forces



Source: (Porter, 1979)

First, new entrants to an industry bring new capacity and a desire to gain market share, which puts pressure on prices, costs and the rate of innovation necessary to compete. This is particularly true when new entrants are diversifying from other industries since they can leverage existing capabilities to shake up the competition. The threat of entry depends on the height of entry barriers, which are advantages that incumbents have relative to new entrants. These include, but are not limited to: economies of scale, switching costs, capital requirements, advantages independent of size, political factors etc.

Second, powerful customers can capture more value by forcing down prices, demanding higher quality services or products (driving up costs) and playing competing companies off against each other. In industries that are price sensitive, customers tend to have more leverage relative to companies. Potential factors that could influence the power of customers in the insurance industry include: purchasing power, price sensitivity, switching costs, standardized or undifferentiated products etc.

Third, powerful suppliers can exert bargaining power by raising prices or reducing quality or services. They can squeeze profitability out of an industry where companies are unable to pass on higher costs to its customers. Examples that would make suppliers to the insurance industry more powerful include: if they pose a credible threat of integrating forward into the insurance industry or if they are more concentrated as a group than the insurance industry.

Fourth, substitute products or services can limit an industry's profit potential by placing a ceiling on prices. If the insurance industry does not distance itself from substitutes through innovation, product performance, marketing etc., it will suffer in terms of profitability and growth potential. Insurance companies should keep an eye on industries with substitute products, such as savings and investments products. The threat of substitutes is high if: they offer an improved price-performance trade-off relative to the insurance industry's products or if customer switching costs are low.

Finally, high rivalry among existing competitors limits the profitability of an industry. It can take many forms, including price competition, product innovation, service improvements and advertising campaigns. The degree to which rivalry will drive down profit in an industry depends on the *intensity* of the rivalry and on the *basis/dimensions* of which the companies compete. First, the intensity of rivalry is greatest if: competing firms are numerous and of equal size, industry growth is slow (this triggers fights for market share), the product or service lacks differentiation or switching costs and exit barriers are high. Second, the basis or dimension on which competition takes place is particularly destructive to profitability if rivalry is based solely on price. Price competition is likely to be greatest if: products or services are nearly identical, there are low switching costs, fixed costs are high and marginal costs are low. When insurance companies are competing on dimensions other than price (product features, services etc.) they are less likely to erode profitability since it improves customer value allowing them to charge higher prices. This is one of Porter's main arguments that competitive strategy is about being different: "*it means deliberately choosing a different set of activities to deliver a unique mix of value*" (Porter, 1996, p. 64). Rivalry can be a positive sum game and increase the average profitability of an industry as long as each competitor aims to serve different customer needs and segments with different mixes of price, products, services, features, or brand identities (Porter, 2008).

Although Porter's model has been used worldwide to analyze industry structures as well as its corporate strategy, the model has not evaded criticism (Downes, 1997; Dulčić, Gnjidić, & Alfirević, 2012; Grundy, 2006; Karagiannopoulos, Georgopoulos, & Nikolopoulos, 2005; Merchant, 2012). Most notably is Larry Downes' critique in his article 'Beyond Porter' (1997), where he argues that the five forces model is outdated due to technological changes and increased competition. For this reason, he defined three additional forces, which stand above Porter's five forces: Digitalization, globalization, and deregulation. He argues that the model is getting too old for today's digital and globalized world. However, the model is not outdated since the basic idea that each company is operating in a network of new entrants, buyers, suppliers, substitutes, and competitors is still valid. The three forces, digitalization, globalization and deregulation, make the network unstable, more extensive, and more dynamic but this does not challenge the validity of the original model. The model is still applicable, but it is necessary to know its limitations. The three new forces are influencing each of the five forces, which is also evident from the analysis of the technological paradigms in insurance and the influence institutional and social concerns will have on the industry going forward.

The value and contribution of this thesis is embedded in the combination of Dosi's (1982) and Porter's (1979) theoretical frameworks to analyze the industry transformation. The point is not to declare the insurance industry attractive or unattractive but to understand the forces of competition and the root causes of profitability. The competitive structure is a perfect focus of analysis to illustrate what is happening to an industry, when innovative technology is introduced. Our modern society is a system consisting of two separate subsystems: the social-institutional and techno-economic systems (Pérez, 2004). When a new technological paradigm arises, there is a strong impulse in the techno-economic system to adopt these new technologies because of the high profit prospects related to it. However, the socio-institutional system on the other hand is more rigid and it may take some time before implementing the changes associated with a new technological paradigm. This is due to some social, organizational and institutional changes, which must be carried out before the technological paradigm can be diffused to the whole economy. The purpose of combining Dosi (1982) and Porter (1979) is exactly this; to understand the microeconomic processes that may explain the co-evolution of technological and socio-institutional changes at the macroeconomic level. Understanding the microeconomic forces that shape competition is important if one is to understand why some technologies get selected as the foundation of a new paradigm. At the same time, understanding a technological paradigm and its trajectories and their value for product development and business model transformation, is essential to understanding the intensity and basis of competition within an industry.

6. Analysis

The developments in data-centric technologies have influenced the collection, processing and use of data in the industry. Social, institutional and economic factors act as selective devices through the competition within the industry, determining which technologies will form the basis of future competition. The two theoretical frameworks work together in this section to provide a historical analysis of the technological developments in insurance and its effects on the competitive structure of the industry. This is essential to answering the research question, but also to understanding why some technologies get selected over others. Technology has the power to change industries again and again. This section will analyze the insurance industry structure in three different paradigms: the analogue, the digital and the data paradigm. Porter's five forces are used to illustrate the influence of technology in a practical way. This includes: identifying the participants in the industry, mapping the competitive forces, understanding their dynamics, prioritizing the forces, digging deeply into the most important ones. While this section focuses particularly on the transition from the current digital paradigm to the data paradigm it starts with a description of modern insurance, the science of actuaries and the reason for focusing on a particular sub-industry in insurance.

6.1. Modern insurance and the science of actuaries

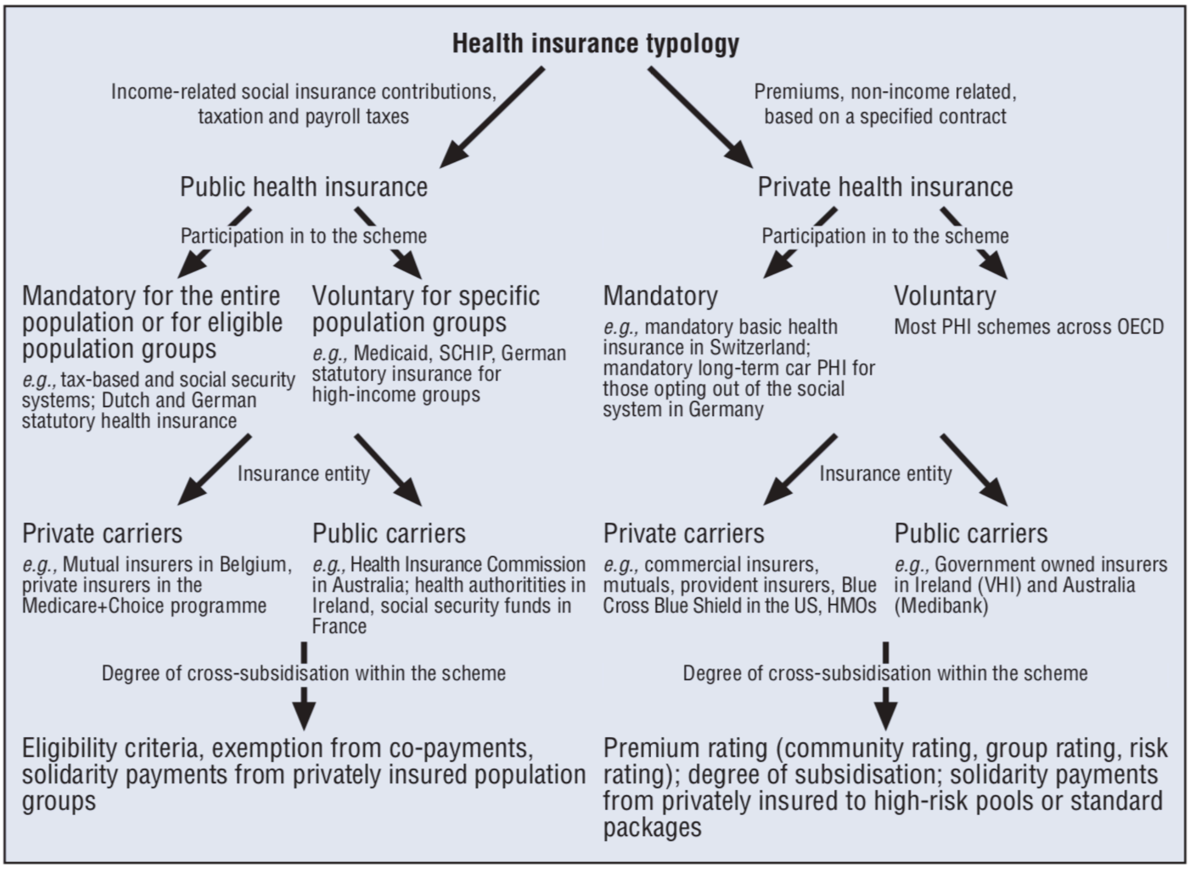
Modern-day insurance takes many forms: life, health, property, auto, casualty, liability, income protection and many other types of insurance. Furthermore, some companies have thousands or millions of each type of policy. They also have hundreds of applications and tools for managing the insurance life cycle (Thomas & McSharry, 2015), ranging from underwriting systems, to policy administration, to customer relationship management. Another common trait among insurance companies is that they work through multiple channels: A mix of online, agency, indirect, and direct contact with consumers.

Insurance companies rely on data and statistics to determine risk and to set prices of their insurance policies. When a consumer buys an insurance policy he/she will have to sign a contract, which requires the consumer to disclose all information that the insurer determines as relevant to pricing the risk. The goal for the insurer is that no information asymmetries exist between the consumer and the insurer. In most lines of insurance, insurers are free to choose the factors they require to calculate the risk and price (Swinhoe et al., 2016). Data relevant to calculating life insurance includes: credit history, family health history, personal health status, age, gender and hobbies. Insurers are able to price discriminate based on age and other factors if there is a proven actuarial or statistical basis to do so. However, due to anti-discrimination laws it is illegal to discriminate based on race or sexual preference although these factors might be statistically significant. The EU has taken it one step further by including unisex pricing in its gender equality legislation. Following the European Court of Justice's (ECJ) ruling in the Test-Achats case (Test-Achats ASBL v. Conseil des ministres, 2011), the ECJ gave insurers until 21 December 2012 to change their pricing policies in order to treat individual male and female customers equally in terms of insurance premiums and benefits (ECJ, 2011). This was a controversial ruling since gender is indeed a determining risk-rating factor for at least three main product categories: auto insurance, life insurance and private health insurance. However, as we shall uncover in the analysis of the data paradigm, this will no longer be an issue with the promise of big data analytics. Apart from pricing premiums, there are many other areas where insurance companies use data, including marketing, analytics and valuations etc.

There are differences between general insurance, such as health, auto, household and property insurance, which is considered short term because it can be underwritten and re-priced every year and life insurance, which is long-term. The latter is usually underwritten only once when the policy is first taken out. Thus, insurance companies cannot bump the price of their insurance policy based on the insured's changing state of health. In most European markets, the main function of life insurance products is a long-term, tax-efficient savings medium (Joy, 1996), while the protective element is normally secondary. Simple term life insurance, providing financial protection in the event of death, only constitutes a small part of most markets.

Before diving into the analysis of the different technological paradigms it is important to notice that health and life insurance policies differ in the degree of cross-subsidization (across time, risks and income groups) built into the policy, the ownership and management of the policy, the level of compulsion of the policy, and the sources of funding (OECD, 2004a, 2004b). Public and private health insurance can be distinguished based on the method of financing (see Figure 5). Public health insurance includes health coverage that is mainly financed through taxation or income-related payroll taxes including social security contributions. Private health insurance, by contrast, is coverage of a defined set of health services financed mainly through premiums made to a mutual pool (OECD, 2004a).

Figure 5 – Health insurance typology



Source: (OECD, 2004a, p. 27)

The focus in this analysis will be on private voluntary health and life insurance. It does not matter, that health insurance is considered general insurance while life insurance is long-term contracts or that they are subject to slightly different regulations. Although the source and usage of funds are different, both types of insurance receive premiums from customers, pay them in case of accidents, and invest their reserves in financial markets. Furthermore, most international insurance companies are engaged in both life and non-life insurances (Rai, 1996). Both rely on roughly the same data to calculate premiums, which is why both lines of insurance will be influenced in the same way by changes in data-centric technologies. Table 1 illustrates the different technological paradigms. The following section will dive into each of them separately starting with the analogue paradigm.

6.2. The analogue paradigm

Insurance is often considered a very conservative industry where incremental changes are favored over abrupt and radical transformation (Yates, 2005). This section will illustrate just how slowly the industry was to acknowledge the value of computers and instead chose to build on existing technologies and processes, changing only very gradually.

Table 1 – Overview of the three technological paradigms

Paradigms	The analogue paradigm (c. 1945 – c. 1995)	The digital paradigm (c. 1995 – 2017)	The data paradigm (c. present – onwards)
Technologies in insurance	Tabulators Early mainframe computers Punch cards + magnetic tape Phone Mail Fax Web 1.0	Web 2.0 Webpage Online insurance E-mail Self-service (info on demand) Web 3.0	Big Data Analytics Machine learning Internet of Things Cloud computing
Core technology	Pen and Paper	Microprocessors and Internet	Data and Algorithms
Use of technology	Automation		Information
Porters five forces - New entrants	<u>Low</u> • Limited, but expensive, technological development • EU deregulation and harmonization • Limited access to distribution channels	<u>High</u> • Impact of Internet technology • Removal of legal barriers to entry • Cost of IT investment 1.	<u>Very high</u> • Low entry barriers for adjacent and agile entrants • Customer-centric business model by new entrants • First-mover advantage
- Customers	<u>Very low</u> • Price (in)elasticity • Limited buyer information available • Some switching costs	<u>Low</u> • Information complexity and asymmetry • Increasingly complex purchasing process	<u>Low</u> • Individual risk assessment and premium pricing • Closer customer relationships
- Suppliers	<u>Medium</u> • Supplier concentration • High switching costs • Impact of human capital on costs and differentiation	<u>High</u> • IT investments becoming cheaper • High switching costs • Restructuring of human capital requirements	<u>High</u> • New partnerships with ecosystem platform providers • Shortage of highly skilled talent
- Substitutes	<u>High</u> • Savings and investment products (vs. life) • Public health care systems (vs. health)	<u>High</u> • Rise of complementary products	<u>Medium</u> • Aggregators as digital agencies • Continued threat public health care
- Rivalry	<u>Low</u> • Company concentration ratio • Limited price and product competition	<u>High</u> • Technology as an enabler • Price comparison websites	<u>Very high</u> • Data as a competitive advantage • Customer-centric value chain and innovation • Adapting to technological innovation

6.2.1. Technology in the analogue paradigm

Life insurance firms showed immediate interest in computing after WWII had ended. And, although life insurance helped shape early commercial computing technology (Yates, 2005), there was always a tension between two conflicting desires: a conservative preference for a very gradual transformation process, on the one hand, and the desire for rapid transformation, on the other, to benefit more from this new technology. In the pre-war era insurance companies used tabulators and punch cards to store data. Top of the line was IBM's eighty-column card, which had enough capacity to last as a storage medium well into the early era of computing (Yates, 2005). Although the introduction of computers started after WWII, and increased throughout this paradigm, it can still be considered an analogue paradigm due to the way the insurance industry handled applications, data collection, data storage, customer communication, underwriting, etc. Until the 1970s, paper contracts and processing relied on technical advancements in filing systems, which was expensive and developed very slowly. The industry effectively chose not to transform itself right away but to build on existing technologies and processes, changing only very slowly. IBM, who was a big player at the time, introduced its IBM 650 in 1953 (Yates, 2005). This allowed IBM to capitalize on the insurance industry's preference for incremental adjustments toward full integration of processes. It was mostly used in premium billing and accounting operations. Firms chose this incremental path, moving from tabulators to IBM's 650 and adopting applications that built on existing tabulator applications. In the mid-1970s insurance companies were now using computers most commonly in premium billing and accounting, while fewer used the technology in policy writing, actuarial research and analysis, and even fewer in underwriting applications.

Although the industry had introduced computers quite early it was still dominated by analogue processes and relied heavily on clerical work, while the automated processes were fraught with inefficiency. In 1975, data processing costs, including computer hardware, software and operating costs, accounted for 20% of total expenses in insurance (Yates, 2005). However, productivity growth lagged significantly behind the initial computer investments because organizational changes were necessary to realize the benefits. The preferred incremental migration path of insurance companies was flawed with "*mismeasurement and time lags for learning and adjustment*" (Yates, 2005, p. 261). Furthermore, during the analogue paradigm, underwriting would often take as long as eight weeks (Thomas & McSharry, 2015).

The process often included 15-20 checkpoints and with manual inputs, data was frequently missing or more information was required to continue the process. Data collection and entry was all manual, and if a customer filled out a form, that form was re-keyed into a specific system to start the process. Moreover, data had to be recreated at each step, which led to errors and loss of productivity. All this contributed to the entire process taking eight weeks. Ultimately, decisions were based on experience and informed judgment, using the limited data available.

Up through the 1980s, computing capabilities improved significantly, and both carrier and agency systems became more complex. The systems were used to supplement and enhance human underwriting activities, and not as a substitute for experienced underwriters. Expert systems were mainly introduced to increase the speed, accuracy and consistency in underwriting. Other, less important, reasons for adopting expert systems included: administrative cost advantages, increased efficiency of policy issuing and enhanced underwriting reporting (D. Cummins & Santomero, 1999). Despite attempts to standardize development of this new processing software, new upgrades and applications required huge, and growing, amounts of machines and staff to maintain. Most systems were a combination of products from different outside vendors, or off-the-shelf systems, that were customized to meet the needs of the individual insurance company (D. Cummins & Santomero, 1999). Simultaneously, and especially in life insurance, wealthy consumers were demanding more specialized products, requiring insurance companies to develop an array of products that took into account the specific needs of each individual (D. Cummins & Santomero, 1999). This requires a fleet of extensively trained agents or other service personnel that have training and knowledge covering many existing fields and products, such as: traditional insurance, investment management and asset allocation, tax law etc.

Apart from the increasing use of computer technology in underwriting processes, insurance companies continued to use analogue technologies in regards to marketing, data collection and customer service. When transmitting applications and in follow-up communication with agents, the primary means were mail, fax, phone and air express. As of 1996, very few companies used computer communication or e-mails (D. Cummins & Santomero, 1999). In regards to the use of technology in customer or policyholder service, the most common means of communication were phone, voice mail, automated telephone answering and call monitoring/recording.

Following Dosi's theory the interesting questions should be: Why was this analogue paradigm preferred to other possible ones? Is there any economic rationale to choosing this technological paradigm? And, what determined the direction or trajectory of the paradigm as it changed towards a digital paradigm. The fact that insurance companies had used tabulators before WWII, and had developed organizational capabilities in using this equipment, led the industry to prefer incremental changes in technology and a very gradual transformation towards computerization. As the industry started to use computers in underwriting processes it became increasingly important to transform as many processes as possible in order to automate the entire process, from application to underwriting, and to stay competitive. According to the Dosi, "*once a path has been selected and established, it shows a momentum of its own*" (1982, p. 153). Thus, the initial introduction of computers, albeit very limited, set in motion a lock-in effect, where computerization became the natural trajectory of technological progress.

6.2.2. Porter's Five Forces in the analogue paradigm

The competitive forces in place within the insurance industry were influenced a great deal by the technological landscape at the time. Each of the forces are analyzed in detail, emphasizing the forces that are more relevant to insurance in general, and the use of technology in this paradigm in particular. Factors that increase the power and value for established companies are are marked with '+', whereas factors that decrease this value are marked with '–'.

Threat of new entrants (low)

Although the technological development was limited during the analogue paradigm, it was still a factor that led to an increase in competition from new entrants. Several factors influenced this threat in the analogue paradigm:

1. Limited, but expensive, technological developments (+)
2. EU deregulation and harmonization (-)
3. Limited access to distribution channels (+)

First, in most EU states, insurance remained a paper-intensive task throughout this paradigm. Towards the end, expert and workflow systems, that could reduce the volume of paper, were becoming universal in EU's most advanced insurance markets. The ability of some life insurance companies to manage policies faster, with less staff and fewer errors gave such companies a competitive advantage in the less developed, but faster growing, markets. In

Greece, non-Greek insurers were achieving far higher sales growth, profit margins, retention and investment returns than the Greek companies (Joy, 1996). Thus, even with all the analogue processes in place at the time, cost savings through better use of technology and the fear of major life insurance companies entering new markets still pressured insurers to reduce their cost and increase productivity. However, compared to today, the effect technology had on new entrants was negligible due to high costs and the low degree of penetration. Technology was mostly in the hands of incumbent firms, serving as a barrier to entry instead of a threat.

Second, towards the end of the analogue paradigm EU's goal of harmonization and a single market forced numerous established life insures in southern Europe to lose ground to more advanced new entrants. Based on market size, growth potential, concentration and availability of distribution channels, Germany and Spain appeared to be the most attractive market for new entrants in the middle of 1990s (Joy, 1996). The concentration was a measure of perceived space for new entrants in each market, reflecting market share held by the five market leaders in each market. Here the Scandinavian markets seemed to be more concentrated while the UK, German and French markets were the least concentrated industries (Joy, 1996).

Third, in the middle of the paradigm, distribution and selling was agent-driven and management's attention was focused on the top line. Thus, the company with the most agents generated more growth and gained market share. Later, the use of the telephone as a distribution channel enabled the insurers to avoid the normal distribution-related barriers to entry. However, the technology was expensive then, and required heavy advertisement directly to the consumer. For life insurers in particular it was difficult to sell their products over the phone due to its sophisticated and long-term characteristics. When entering the market of another member state, life insurance companies preferred to establish a local office because of the difficulties of servicing complex mass markets remotely (Joy, 1996). A number of studies showed that the more efficient insurance firms were larger, utilized exclusive distribution and were organized as stock companies (D. Cummins & Santomero, 1999). Due to the limited technological penetration it required a large staff to handle all the paperwork in this paradigm. Thus, the size requirement put a downward pressure on the threat of new entrants.

Bargaining power of customers (very low)

The limited buyer power in the analogue paradigm was mostly an effect of the following factors:

1. Price (in)elasticity (+)
2. Limited buyer information available (+)
3. Switching costs (+)

First, the existence of a market for voluntary health and life insurance is dependent on a positive demand (some consumers must be risk averse) and it must be possible to supply insurance at a price the consumers are willing to pay. The demand for these products is influenced by the probability of an illness occurring, the size of the loss such an illness might incur, the price of insurance and the consumer's wealth and education level etc. However, the influence of such factors will vary greatly between EU member states, and some factors are more difficult to measure than others. Most studies on price elasticity from this period were performed on the US insurance market. They found price elasticities in life insurance ranging from –0.32 to –0.92 in one study (Babbel, 1985) and –0.24 in another (M. J. Brown & Kihong, 1993). Studies of the US demand for health insurance revealed price elasticities ranging from –0.03 to –0.54 (Marquis & Long, 1995). A Spanish study found that price elasticity of voluntary health insurance in Span for the period 1972-1989 was –0.44 (Murillo & González, 1993). This is expected from a system that is not heavily subsidized, but it cannot be generalized for other EU member states. Although there is limited direct evidence regarding price elasticity of health and life insurance in the EU, estimates should be rather inelastic. This agrees with the notion that consumers tend to be less price-sensitive towards insurance than they are with less complex, more familiar financial products (Joy, 1996). Because of their long-term nature and combined insurance and investment function, life insurance policies in particular, are complex in relation to other forms of financial products.

Second, due to the relative complexity of insurance products and the limited information available to consumers in regards to comparing different insurance products and companies, consumers experienced low bargaining power in the analogue paradigm. The limited number of distribution channels made it difficult to compare insurance products and companies with ease. In many cases it required talking to multiple agents. Getting quotes from insurance companies could be a daunting task that could take weeks due to the amount of paperwork it required.

Third, throughout this paradigm, individual insurance companies started to carry many types of life and non-life insurance simultaneously. Through bundling and packaging of different risks into single comprehensive policies they sought to eliminate coverage overlap for consumers, increase selling efficiency and improve administrative economies and profitable cross-selling. In Germany, for example, the average family had seven or eight insurance policies in total (Joy, 1996), often through three or four different insurance companies. Naturally, life and health insurance has synergies and the more products an insurer sells to a client the stronger and more secure the relationship between them will be. This puts a downward pressure on consumer bargaining power since packaged policies results in higher switching costs. However, cost savings from packaging can be passed on to the consumer, incentivizing and increasing a loyal, long-term, and profitable relationship. In conclusion, customers experienced some switching costs, limited information and were relatively price-insensitive resulting in a very low bargaining power.

Bargaining power of suppliers (medium)

There are few suppliers specific to the insurance industry. However, inputs such as technology and human capital have influenced the competitive structure slightly in this paradigm. Most important factors were:

1. Supplier concentration (-)
2. High switching costs (-)
3. Impact of human capital on costs and differentiation (-)

First, in the beginning of the analogue paradigm, few vendors were dominating the supply and development of early computing. IBM and Remington Rand were central suppliers to the life insurance industry while all other vendors were peripheral (Yates, 2005). IBM was market leader in hardware industry selling to insurers up through the 60s and 70s due to its 650 computers, which favored gradual changes in technology investments. This was exactly what the conservative insurance industry preferred. However, the increasingly large volumes of data that insurance industry had to store safely and process repeatedly meant that firms could not afford to ignore the improvements promised by computer technology. Thus, suppliers of technology had some bargaining power throughout the paradigm, and investments in new technology were very expensive.

Second, before computers, insurance companies were accustomed to working with IBM tabulators, sales representatives and technical support people. Additionally, some of the biggest companies already possessed millions of 80-collumn punch cards full of data (Yates, 2005), which is why they preferred to maintain continuity by retaining a familiar vendor and using their existing punched cards on a small IBM 650 computer. IBM built on the industry's desire for incremental changes by developing its card-based 1401, buying itself more time as they developed their more advanced computers. Thus, IBM and other suppliers built lock-in effects where switching costs to another system became higher for every new product they launched.

Third, insurance in this paradigm was very labor intensive. In regards to distribution channels, life and health insurance companies relied on tied agents and direct sale people as their main distribution channels (Joy, 1996; Mossialos & Thomson, 2002). Tied agent systems are where the agent is contracted to sell the products of only one insurer, or a very limited number, while direct sales are internally employed agents selling the products of a single company through telephone sales, direct mailings, personal appointments and other means. These traditional channels are labor intensive, and regulatory requirements at the time, were increasing the levels of training and expertise demanded of those working as insurance intermediaries. In summary, the cost of traditional distribution through human capital and early IT requirements meant that suppliers in this paradigm, experienced medium bargaining power.

Threat of substitute products or services (medium)

There were a number of substitute products competing with life and health insurance in the EU. The most important threats were coming from the customers' perceived level of product differentiation and the relative price performance of the substitute products. Substitutes include:

1. Savings and investment products (vs. life) (+)
2. Public health care systems (vs. health) (-)

First, life insurance products compete primarily with other savings and investment products, such as deposit accounts, mutual funds and direct investment in equities and bonds etc. While life insurance, by definition, pays a sum upon the death of the insured, other products have an equally significant function as tax-efficient saving. And although life insurance saw an absence of close competition from non-insurance products up to the 1980s (D. Cummins & Santomero, 1999) it picked up towards the end of the paradigm. Due to the diverse national preferences of the European insurance market, the popularity of various types of savings and investment products varies greatly between markets. For this reason "*there is no common pattern … in the precise form that life insurance products take*" (Joy, 1996, p. 49). Towards the end of the analogue paradigm, in 1994, Datamonitor estimated that the total European retail savings and investment market was worth over $10 trillion (Joy, 1996). Retail bank deposits accounted for 37% in 1994, down from 44.5% in 1990, and although it was the preferred form of investment throughout the paradigm it was slowly getting replaced towards the end by life insurance, which accounted for 20% in 1995, up from 15% in 1990.

Second, voluntary health insurance does not play a dominant role in funding healthcare in the EU. Instead, countries have aimed to preserve the public health care system with health care funded by the state or social insurance and made available to all citizens, regardless of their ability to pay. This has led to the development of a health care system characterized by high levels of public expenditure, close to universal coverage and mandatory participation (in most cases). In the 1990s, private expenditure on private voluntary health insurance accounted for less than 10% of total expenditure on health care in most EU countries (Mossialos & Thomson, 2002). Expenditure on voluntary health insurance remains low in the EU partly because the states continue to provide comprehensive benefits, and because they tend to rely on other methods for shifting health care costs to the consumers such as user chargers, rather than promoting or subsidizing voluntary health insurance. Thus, out-of-pocket payments make up the largest part of private expenditure on health care in all EU member states (Mossialos & Thomson, 2002). Combining the two sources of substitutes, there was medium but recognizable threat from substitute products in the analogue paradigm.

Rivalry among existing competitors (low)

The intensity of competitive rivalry is probably the best indicator of competitiveness in the industry. While technology has had a negligible effect in this regard, some factors played a more critical role in the analogue paradigm:

1. Company concentration ratio (+)
2. Limited price and product competition (+)

First, since the internal market for insurance did not come into effect prior to the implementation of the EU's Third Life and Third Non-life Directives in 1994, the European insurance market was not considered an industry in itself. For this reason no data from this paradigm was available on the overall European market shares of the largest companies. Instead, we find statistics from 1994 for market shares of life insurance companies in individual countries. France was the largest life insurance industry. Here, the top five companies accounted for 41.3% of the long-term insurance market (Joy, 1996). In the UK, which was the third largest market and the least consolidated, the top five companies had 32.3% market shares (Joy, 1996). In contrast, Norway was the most concentrated market with just three companies accounting for 68.5% of the market shares and top five accounting fro 87.4% (Joy, 1996). In general, however, there was a logical relationship between market size, number of firms and their relative market share. Health insurance was slightly different. Here, the industry was dominated by a relatively small number of players. According to one industry report, 54.9% of all voluntary health insurance premiums in Europe in 1998 were written by only 25 companies, 17 of which were German (Datamonitor, 2000). The most concentrated markets were Ireland, Denmark, Finland, Austria, and the UK, while France, Italy, and Spain were the least concentrated, with over 100 companies in each country (Mossialos & Thomson, 2002). The limited technological innovation and penetration, as well as the absence of a single market in insurance, could be one of the reasons why the European insurance market was relatively unconsolidated in this paradigm. The companies were not in a position to take full advantage of economies of scale. Some companies tried to find a solution through M&As. The European commission reported that the number of insurance companies engaged in merges showed a consistent 20% annual growth through the 1990s (Joy, 1996). This increased competition put a pressure on companies to cut costs and invest more in technology. However, it should be clear, that this was also an effect of deregulation and that consolidation was mostly happening towards the end of the paradigm. The intensity of rivalry picked up throughout the paradigm.

Second, until the end of the paradigm there was a lack of strong price competition due to regulation, which allowed life insurance firms to compete primarily on sales and growth. Because companies did not face competition to cut costs, firms had decreased incentive to take a more risky (with potentially higher return) approach to adopting and using computers. The single market following the EU's Third Life and Third Non-life Directives outlawed price and product regulation in the expectation that competition alone would lower prices and increase consumer choice (Mossialos & Thomson, 2002). However, this was not the case as premiums continued to increase steadily in price (Joy, 1996; Mossialos & Thomson, 2002) and there was no evidence of consumers shopping around for more competitively priced premiums. The fact that there were no standardized products, combined with the abolition of product regulation, further exacerbated the information problems to an extent where consumers might find it hard to purchase the appropriate policy. Summing up, the rivalry between competitors in this paradigm was relatively low.

6.3.3. Technological trajectories and competition

This first round of Porter's five forces has created a starting point for studying the effects of technological change. Following Dosi's theoretical framework, the analogue paradigm was characterized by manual labor and limited capabilities in mainframe computing. The invention of computers created a lock-in effect early on, where insurance companies gradually would have to invest in information technology to remain competitive. The initial push for computing was based on a wish to store data more easily. Later it was found that computers could help with processing and be implemented throughout the business functions in insurance. This created a shift in the competitive structure and formed a new trajectory, one that coincided with the establishment of the Internet, where automation of the insurance business operations was the main objective. Thus, economic and organizational forces shaped the trajectory towards automation and the digitalization of the insurance industry.

Although competition in this paradigm was comparatively low, as illustrated by the five forces analysis, the insurance market was characterized as a complex and quite difficult market to enter for foreign companies. Since the single market for insurance was not in effect within the EU until the final years of this paradigm, the market was particularly heterogeneous, due to differences in culture, language, economic and political environments. The use of technology was mostly limited to a few business operations and much work still relied on manual labor. The technology that was available created a trajectory that had the potential to influence (1) scale economies in underwriting and policyholder service, (2) scope economies in distribution and servicing by offering complementary products/services, and (3) the extent of product and service differentiation. However, the use and penetration of information technology remained limited and rather inefficient until the start of the 21st century.

6.3. The digital paradigm

With the introduction of digital technologies it became possible for insurance companies to transform the underwriting process so it only took eight days instead of eight weeks (Thomas & McSharry, 2015). Online processes has made it possible to limit loss of data, speed up data collection and entry as well as decision making procedures. Consumers can now receive insurance quotes online within minutes, which increases competition significantly, drives down prices and creates more risk for insurance companies.

6.3.1. Technology in the digital paradigm

The core technologies that have defined the current digital paradigm are microprocessors and the Internet. Together, these inventions have transformed not just insurance, but the competitive structure of most industries in the developed world. Although early mainframe computers were already introduced to insurance in the analogue paradigm, it was not until data started to be focused around the consumer rather than around individual products that insurers would take full advantage of the digitalization. Properly utilized, the introduction of computers to manage consumer data would increase efficiency in the processing of policy applications, from data collection by the agent, through underwriting to customer service and claims payment. Companies that could better use technology for marketing and provide information to consumers quickly and cheaply would even accrue further competitive advantages. But, a significant challenge to the industry was the conversion of historically independent legacy systems to the new networked environment (D. Cummins & Santomero, 1999), which was necessary for more comprehensive information management.

Following Dosi's framework, the economic forces of the insurance industry determined that computation and automation should be the boundaries of this paradigm. The economic criteria acted as a selector defining more and more precisely the actual path, of technological innovation and adaption, followed inside a larger set of possible ones. Once a path has been selected and established, it shows momentum of its own. The direction towards automation, influenced by the power of information technology, eventually lead to the application of the Internet, which completely disrupted the insurance industry. The technological trajectory, which can be understood as a cylinder in the multidimensional space defined by the technological and economic determinants in the industry, is then 'the Internet'. This technology has influenced all fields of the insurance industry in this paradigm:

> *"The Internet is at once a world-wide broadcasting capability, a mechanism for information dissemination, and a medium for collaboration and interaction between individuals and their computers without regard for geographic location. It is one of the most successful examples of the benefits of sustained investment and commitment to research and development of information infrastructure."* (Leiner et al., 1997, p. 2)

The power of the Internet is enhanced through the network effect produced as resources link to each other. The value of this power can be determined by Metcalfe's Law, which states that the value of a network is proportional to the square of the number of users, for example: given n users with internet connections, the number of possible connections that can be made is $(n-1) = O(n^2)$ (Hendler & Golbeck, 2008). This law has been used to explain the growth of many technologies from the first phone to new social networks like Facebook and Twitter, because none of these would have any real value if only very few people were on the network. The value of the Internet was very low in the early Web 1.0, which could be considered the "read-only web". Instead, in Web 2.0 the idea that users can create content is considered a critical aspect, and the value of the network effect is coming from the links between people arising from the interactions using particular sites (Hendler & Golbeck, 2008).

The core technology with the most influence on the competitive structure of this paradigm is without a doubt the Internet. Web based business models have forced changes on many industries, including insurance (Porter, 2001). Back when the Internet was first introduced in the insurance industry, consumer activists already began to tie the concept to privacy issues (Garven, 2002). The basic understanding was that companies could acquire detailed personal information about consumers so they could manipulate consumers' economic decisions. However, most attention was asserted towards the cost advantages promised by this technology. One study found that internet insurers would have a 23% cost advantage over agency insurers (Datamonitor, 2000), while another study found the cost advantage over traditional insurers would be in the range of 58–71% over the life-time of a customer (Booz Allen & Hamilton, 1997). Appendix 1 illustrates the growth in Internet users worldwide since 1995. By 2000, the penetration, as a percentage of the world population with access to Internet, was 6.8% (this increased to 15.8% in 2005, 29.2% in 2010 and 43.4% in 2015). With the constant increase in penetration throughout the paradigm, the Internet have, according to Cassiman and Seiber (2007), influenced conventional competitive strategies in at least three ways:

> *"(1) the greater efficiency generated by lower transaction costs and new organizational forms reduce the firm's cost structure, (2) the reduction of consumer's search costs and new opportunities for product differentiation and redefinition affect the consumer's willingness to pay, and, (3) electronic markets affect pricing and allow new pricing mechanisms"* (2007, p. 299).

Both health and life insurance companies rely on data to price individual risk-rated premiums. Prices differ according to several factors, including age, occupation, family history of disease, past health care utilization, and claims experience (Mossialos & Thomson, 2002). Risk adjustment is expensive to administer and to carry out with accuracy, even when using the Internet to transmit the information. Many insurers rely on these crude indicators, which may give insurers strong incentives to cream-skim, damaging both equity and efficiency (Puig-Junoy, 1999). Cream-skimming is the process by which insurers seek to encourage individuals with below-average risk to buy insurance and discourage or refuse individuals with above-average risk. Insurers offering supplementary health insurance are free to rate premiums on any basis they choose, while insurers offering substitutive health insurance are generally subject to some degree of regulation regarding the price of premiums and policy conditions (Mossialos & Thomson, 2002). Thus, even with the influence the Internet has had on the transparency of information, the consumer still does not have complete access to information. However, comparing different products and companies has never been easier than it has been in the digital paradigm.

The insurance industry's adoption of the Internet has been relatively fast considering the risk-averse nature of the business. The adoption rate and acceptance of a paradigm shift towards digitalization came from a deep knowledge of the complexity of insurance itself. It is necessary for IT managers and executives to acknowledge the practical realities of their business processes in order to pursue the possibilities of IT. The conservative organizational structure and other barriers including the constraints of IT legacy systems and the complexities of managing change across physical channels all challenge the digital transformation of insurance. Nevertheless, by 2013, policies sold through digital channels accounted for 11% (Luu & McDonagh, 2013). The digital paradigm offers an entirely new way of doing business affecting all strategic and functional areas across the entire insurance value chain. Thus, economic forces, influenced by social and organizational forces, have been forming the technological trajectory and the boundaries of the technological paradigm. These forces set the playing field of the digital paradigm and the competitive structure of the industry.

It is important to recognize that despite the introduction of the Internet, and the capabilities enabled by this technology for both insurers and consumers, the technology itself has generally not created new products or services. The basic insurance business operations such as underwriting, rating, and policy renewal still need to be performed. Instead, the power of online insurance comes from the ability to redefine workflows and reduce the time component in many operations. For the consumer this means that convenience is now a greater component of service. As the following analysis will illustrate, it was the insurance companies that were able to adjust their business model to the new digital paradigm that would gain a competitive advantage over the ones that were stuck with analogue technologies and traditional agency distribution models.

6.3.2. Porter's Five Forces in the digital paradigm

The second five forces analysis looks at the effects of introducing computers and Internet technology for automation purposes. The Internet, in particular, provides better opportunities for companies to establish distinctive strategic positions, compared to previous technological paradigms. The Internet is an enabling technology, a set of tools that can be used wisely or unwisely, so the question in this paradigm is not *whether* to deploy Internet technologies and automate processes, the question is *how* to deploy these enabling technologies. The evolution has been gradual throughout this paradigm, and will continue this way (Pain, Tamm, & Turner, 2014). Even as we reach the end of the paradigm, European countries are at different stages of digital transformation. Due to technical, economic, cultural and organizational factors not all will follow the same path or the same pace of transformation.

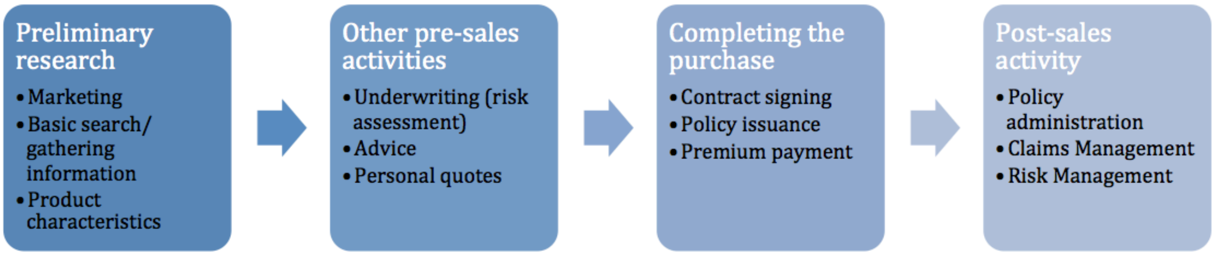
Threat of new entrants (high)

Industries, such as insurance, which have been constrained by high costs for communicating, gathering information and completing transactions, are reconfigured due to the threat of new entrants enabled by new technology. The most interesting factors influencing this force in the digital paradigm are:

1. Impact of Internet technology (-)
2. Removal of legal barriers to entry (-)
3. Cost of IT investment (+)

First, selling insurance products online is relatively difficult due to several factors: they are less standardized, can be rather complex, they are purchased infrequently and there are some regulatory hurdles. The Internet mitigates the need for an established sales force or access to existing distribution channels, which reduces the barriers to entry. By enabling new approaches and reducing the difficulty of purchasing, marketing, and distribution the Internet has opened up the market to new entrants.

Figure 6: Activities in the insurance distribution process

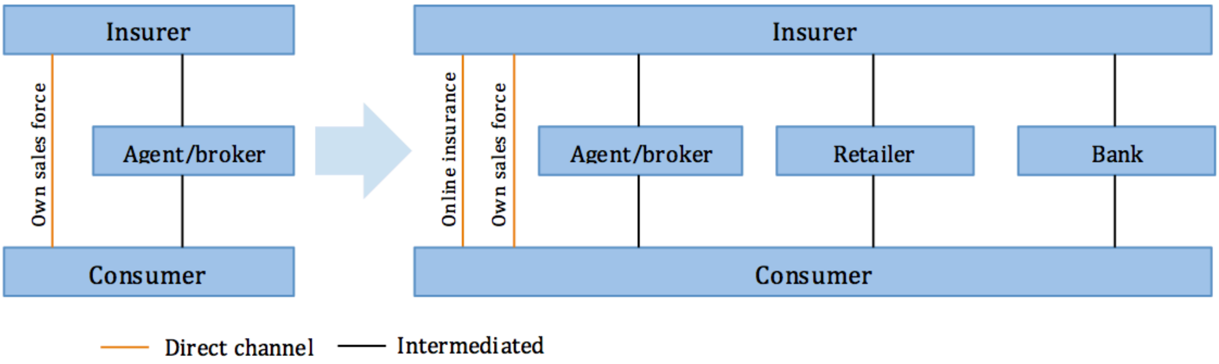


Source: adopted from Pain et al. (2014)

Figure 6 illustrates the activities in the insurance distribution process, all of which has been influenced by Internet technology to some degree. While the Internet has spawned new types of intermediaries such as price comparison websites, traditional intermediaries continue to dominate insurance distribution in Western Europe with 85% and 72% of sales in life and non-life respectively in 2012 (Pain et al., 2014). The traditional intermediaries will not necessarily be squeezed out by direct sales and digital distribution as long as consumers continue to value the personal interaction and expert advice of agents and brokers, which is often required for complex private life and health insurance products. The challenge for incumbent intermediaries and insurers is to adapt their business models to the changing preferences of the consumers, while minimizing the costs of integrating and maintaining multiple distribution channels.

Figure 7 illustrates the transition from a traditional distribution model to a modern multi-channel model. The most dramatic change is that insurers are now selling directly to the consumer through digital channels (spreading to life and health products by the end of this paradigm) and via retail and bancassurance. The latter has existed for decades, but are now expanding especially for life insurance (Pain et al., 2014). Bancassurance is an arrangement where a bank and an insurance provider partner to sell insurance products, typically through the bank's branches. Technology is disrupting the traditional insurance distribution process

Figure 7: Analogue vs. digital paradigm distribution channels in insurance



despite modest online insurance sales throughout the paradigm. Consumers are increasingly expecting to be able to interact with their insurance provider at any time through multiple channels, such as phone, online, self-service and click-to-chat. The purchasing process is fragmented and dispersed across many different points of interactions between insurers, intermediaries and consumers. Consequently, insurance companies need to be leaner to adjust to these changes. However, the Internet is not only a new distribution channel, it is also a platform with opportunities for quality and service improvements such as: better marketing, better customer service, policy administration, self-service, more personalized products, faster response times, greater flexibility in insurance covers and better support for risk management. All these factors are increasing competition and the threat from new entrants who are in a position to take advantage of these opportunities of processing customer data through internet technologies. New entrants in this paradigm, who are able to develop a lean and digital business model, continue to pose a serious threat to the established industry.

Second, the creation of a single market for insurance in the EU should in theory have removed all the significant legal barriers to entry. The principle of home-country control aims to prevent national regulators from establishing barriers to entry. This should, for example, place German insurers at a competitive disadvantage due to the nature of Germany's strictly regulated insurance market, while British insures should have an advantage because they are subject to relatively few restrictions in their home country (Mossialos & Thomson, 2002). Nevertheless, in regard to health insurance in particular, the single market has not stimulated the demand across borders. The growth of internet-based insurance have indeed promoted cross-border sales, but tax harmonization, as well as culture, language, economic and political differences, continue to pose problems (Mossialos & Thomson, 2002). A study by Cummins, Rubio-Misas and Vencappa (2017) found that the deregulation of the EU life insurance market, following the establishment of the single market, had no impact on competition in the period 1999-2011. Most of the countries in their study even experienced a worsening of competition measured by the Boone indicator. It seems that the impact of the single market for insurance has mostly influenced the purchase of foreign insurance companies through M&As rather than through increased cross-border sales or the establishment of subdivisions in other countries. All things considered, the formation of a single market and removal of legal barriers to entry is a factor that increases competition, although the exact effect is difficult to measure.

Third, the high cost of IT-investments, especially in the beginning of the digital paradigm, acts as a barrier to entry and a barrier to a single market. Insurance companies planning to establish a business in other member states need to invest in technical, commercial and actuarial studies. This might be an expensive investment for an insurance company to justify selling insurance policies outside its own national market (Mossialos & Thomson, 2002). The Internet provides new entrants with the possibility to establish a distribution channel at low cost, and although expensive IT investments are a significant cost, new entrants are not burdened by legacy systems. New entrants are more agile and able to exploit modern information and communication technologies, which increases competition. Building a new customer base from scratch requires additional advertising and marketing expenses on top of the heavy IT-investments required for new entrants. Lateral entrants from other member states or other insurance sectors who have a well-known brand name can disrupt the European insurance market by using the Internet to set up efficient e-business systems, without the burden of legacy systems or conflicts with other distribution channels. The ability to collect and process data is a prerequisite for new entrants hoping to capture market shares. Summing up, the threat of new entrants from other member states, industries or start-ups, has significantly increased after the transition to the digital paradigm, and is considered high.

Bargaining power of customers (low)

Although the Internet has made it easier for consumers to collect information about insurance products, it has also made the purchasing process more complex. Thus, the factors that influence customers bargaining power are:

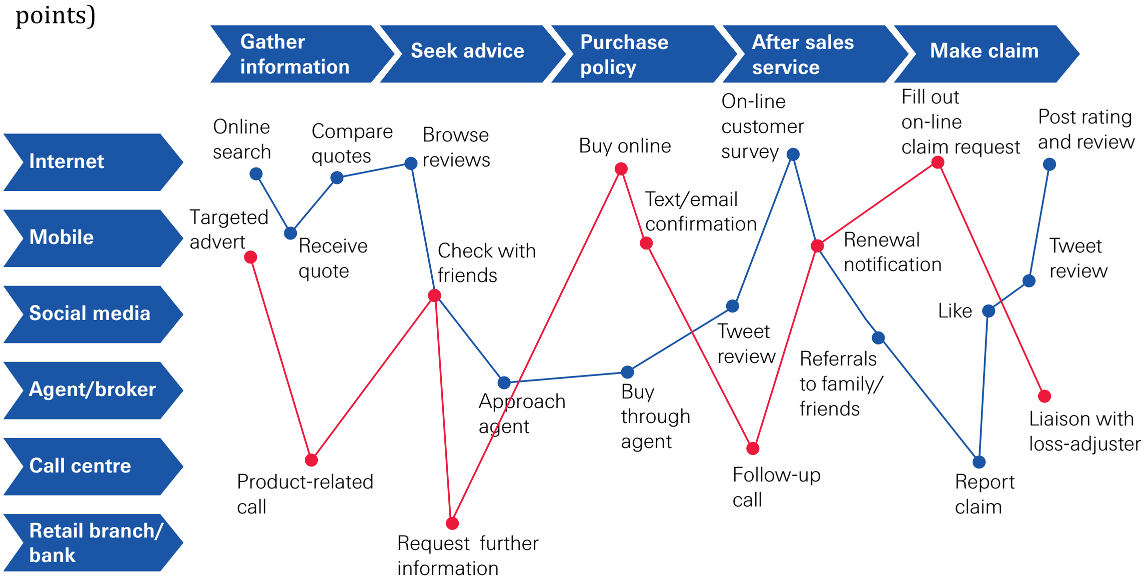
1. Information complexity and asymmetry (+)

2. Increasingly complex purchasing process (+)

First, although the increased availability of information and online tools, such as company websites, expert and consumer blogs, chat rooms, comparison websites etc., has enabled consumers to better assess the risk they face and the potential need for insurance, they still remain reluctant to buy insurance online, especially life insurance (Pain et al., 2014). Consumers generally have a high preference for personal interaction and expert assistance when buying life insurance (Rorbye, 2013) and as a result they tend to research online while purchasing offline via traditional intermediaries. For uninformed consumers, the recommendation on what life insurance policy to buy, and how much, is of major importance. Comparison sites and insurance company sites can provide a substitute for traditional advice via intermediaries, but Dorfman and Adelman (2002) found that consumers where given misleading advice and should not rely on online recommendations alone. However, this study is relatively old, and a new study should be conducted to evaluate the current state of online insurance recommendations. In regards to health insurance, information asymmetry is more likely to be problematic for consumers of complementary and supplementary voluntary health insurance since this market remains largely unregulated in the EU (Mossialos & Thomson, 2002). Clear information about price, quality and product specifications are vital to consumers and insurers in a competitive market but variations in insurance policies makes them difficult to compare in terms of value for money.

Second, with the advent of the Internet, the purchasing process is becoming increasingly complex. As mentioned earlier, the traditional distribution process has been disrupted by new communication technologies where consumers increasingly expect to be able to interact with their insurance provider or advisor at all times. Purchasing is a fragmented process scattered across different interactions or touch points between insurance companies, intermediaries and consumers. Figure 8 illustrates the complex purchasing process for insurance today, at the end of the digital paradigm. The integration of multiple physical and digital distribution networks and touch points is important to a smooth customer experience. The introduction of the Internet, and later social media, allows potential customers to search for information on the range of life and health insurance products that could be suitable for them and their associated risk (at least for standard types of products).

Figure 8: The increasingly complex purchasing process for insurance (multiple touch points)



NB: The red line illustrates a purchasing process initiated by a mobile advert, and the blue line a purchase experience via online search
Source: Pain et al. (2014, p. 6), based on insights from Oracle (2012)

Meanwhile, "*the diffusion of online and mobile phone technology and the associated multiple touch points are providing insurers with a vast and potentially rich source of data about their customers*" (Pain et al., 2014, p. 6). This, combined with new capabilities in Big Data Analytics, marks the beginning of the next technological paradigm. The diffusion of online and mobile phone technology is acting as an enabler in this regard, much like the Internet has done for competition in the digital paradigm. While the Internet has made it easier for consumers to compare insurance products, there are still information asymmetries present due to the complex nature of life and health insurance products. Thus, the bargaining power of consumers remains low.

Bargaining power of suppliers (high)

Suppliers of interest in the digital paradigm are the providers of IT solutions and the human capital employed by the insurance companies. Three factors are interesting in the digital paradigm:

1. IT investments becoming cheaper (+)
2. High switching costs (-)
3. Restructuring of human capital requirements (-)

First, whereas early mainframe computers could cost $3,200 monthly, for the IBM 650, and $1,2m for a tape-based alternative (Yates, 2005), computers and information technology today is considerably cheaper. From 1997 to 2015 the Consumer Price Index (CPI) for personal computers and peripheral equipment declined 96%, whereas the CPI of internet and electronic information providers declined 24% over the same time period (Bureau of Labor Statistics, 2015). The CPI for personal computers takes into account attributes such as CPU speed, RAM, and hard drive storage capacity, which are important technological dimensions in the digital paradigm. The index for personal computers is a subcomponent of the Information Technology, Hardware and Services component of the CPI, which has declined 83% from 1997 to 2015 (Bureau of Labor Statistics, 2017). Thus, the cost of information and communication technologies has declined, while quality has increased, considerably during this paradigm. Since 2011, insurance companies worldwide has spend around 3.6% of direct written premiums on IT investments (Statista, 2017a). Unfortunately, no data is available specifically for European life and health insurance companies. The fact that IT investments are relatively cheaper in this paradigm means that bargaining power of suppliers is diminished.

Second, although information and communication technologies are becoming cheaper, they are entirely necessary, and companies increasingly rely on tailored IT solutions to generate a competitive advantage. A simple online search reveals more than 400 insurance management companies (Insurance & Technology, 2017) offering different solutions and services, which support the essential management functions of an insurance company. Everything from agent and HR systems to policy administration and underwriting can be categorized under the heading of insurance management. The abundance of IT solutions, and limited standardization, makes switching costs high, while the problem is exacerbated as companies settle with current systems creating lock in effects. Switching to new systems is an expensive endeavor and a number of studies provide evidence of switching costs in IT markets (Chen & Hitt, 2002; Knittel, 1997; Whitten & Wakefield, 2006). Issues such as complementary investments (e.g. employee training) and compatibility may lead to switching costs. Although the European insurance IT solutions market is crowded and fragmented (Weiss, 2014), meaning the suppliers experience competition among each other, it does not outweigh the switching costs experienced by insurance companies in regards to the bargaining power of the suppliers.

Third, the traditional agent broker roles have changed. The digital transformation has forced insurance companies to concentrate on human capital management. The focus should be on recruiting, developing, and enabling information employees and on providing the processes and systems to empower them with the knowledge and tools required to remain productive. Many of the tasks the agents have performed in the analogue paradigm have been transformed by the development of digital distribution channels, and the trend is accelerating. This does not mean that agents are becoming obsolete. Instead they are expected to perform roles that complement the multi-channel distribution strategies where digital capabilities are key. Agents are providing customers with advice and insights, cross-selling wide ranges of products, and building deeper relationships with customers (Gasc, 2016). All of these are high-value activities in the digital paradigm, so the training and development of agent skills, as well as recruitment strategies, are more important in this paradigm than ever before. Furthermore, the demand for cross-selling skills in agents is slightly higher in Europe than elsewhere (Gasc, 2016). As a consequence of the higher requirements for human capital and higher switching costs, the bargaining power of suppliers in the digital paradigm is high.

Threat of substitute products or services (medium)

The substitute products discussed in the analogue paradigm are still in place. Savings and investment products and public health care are still threats to the market share of European life and health insurers. But, with the spread of the Internet, something new has become important:

1. Rise of complementary products (-)

Complementary products such as price comparison websites have spawned in the wake of traditional intermediaries. While substitutes reduce potential profitability, complements can exert either a positive or a negative influence. Price comparison websites work as intermediaries, as an additional distribution channel for established insurance companies. However, these sites also increase rivalry by seeking to standardize the insurance industry's product offering. To the extent that they reduce transaction costs they are creating opportunities for new intermediaries but they also influence product complexity. Early research on the US life insurance market indicated that the growth of Internet from 1995-1997 reduced term life prices by 8-15% and increased consumer surplus by $115-215m a year (J. Brown & Goolsbee, 2000). The most common type of comparison websites in this paradigm is simple *comparison only* or *lead generators*. These websites use a comparison-shopping format to attract consumers to provide personal information. They then sell these leads, often to traditional insurance companies. This works best for standardized products. Thus, health and simple life-term insurance policies are easier to compare online than are more complex life insurance products. A report by the European Insurance and Occupational Pensions Authority (EIOPA) found that six countries had more than 20 comparison websites operating (CZ, ES, FR, NL, RO, UK), eight countries had 10-20 websites operating (DE, GR, HU, IE, IT, LV, PL, SK), while twelve countries had 1-10 operating comparison websites (AT, BE, BG, DK, EE, FI, HR, LT, MT, NO, PT, SE) (EIOPA, 2014).

These sites cause consumers to be more price-sensitive and force insurers to reduce rates as far as possible to improve their rankings and acquire a larger share of new customers. Furthermore, another study indicates that customers acquired from price comparison sites are less profitable long-term than those acquired from traditional channels since they perceive their relationship to be with the price comparison site and not the insurance company (Robertshaw, 2011). Thus, competing for rankings through comparison sites can indeed erode profit margins and lead to disloyal customers. The primary threat of substitutes comes from online comparison sites, which essentially is a complementary product forcing insurers to compete on price. However, questions have been raised about the credibility and trustworthiness of these sites (Mayer, Huh, & Cude, 2005), and for this reason threat of substitutes is still perceived as medium in the digital paradigm.

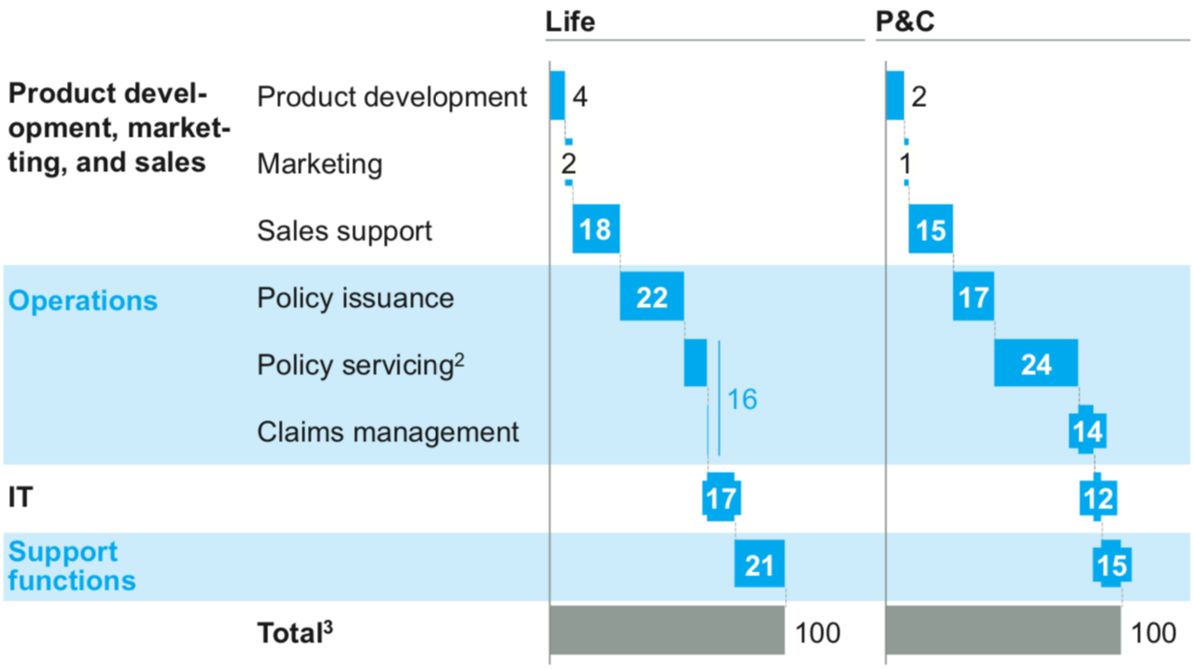
Rivalry among existing competitors (high)

The Internet has mitigated the need for a traditional distribution channel, an established sales force and it has reduced barriers to entry. Because it is an open system, companies have more difficulty maintaining competitive advantages, which intensifies rivalry significantly. The following factors will be considered:

1. Technology as an enabler (-)
2. Price comparison websites (-)

First, technologies such as microprocessors and the Internet have been applied to automate the insurance industry. However, automation is not a finished chapter in the evolution of insurance. Currently, a majority of the insurance workforce is concentrated in operations and support functions (see Figure 9). A recent report by McKinsey & Company (2016) reveals that

Figure 9: Current insurance workforce distribution (2010-2013)
FTEs[1] in %



1. "Full-Time Equivalents", McKinsey benchmarking tool
2. Including benefits administration in life insurance
3. Because the size of the salaried sales force varies greatly from one company to another, salaried sales reps are not included

Source: Johansson and Vogelgesang (2015, p. 3)

positions in operations and administrative support are especially likely to be consolidated or replaced in the following years although the extent of the effect differs by market, product group, and capacity for automation. It is important to understand that automation is not leading to a competitive advantage in itself. When an insurance company cannot be more operationally effective than its rivals, the only way to generate economic value is to gain a cost advantage or by differentiating and providing better products. The Internet and the automation stemming from better microprocessors and IT systems are nothing without a distinctive strategic direction. If there are no unique competitive advantages, improvements are generic and cannot be sustained, then speed and flexibility leads nowhere. Although technology was initially used to automate and save costs, the industry is now starting to move beyond that by embracing technology as an enabler through self-service portals. With a younger, more tech-savvy generation on the radar, insurers are now focusing on innovation through communication technologies. Technology is now enabling different sets of functionalities to different users of a system, such as customers, agents and employees. This increase in demand for faster and quality service is pushing insurance companies to be more innovative and increases rivalry among existing competitors.

Second, price comparison sites have forced insurers who use them to compete mostly on price, which is very destructive to profitability. It drives down margins and transfers profit directly from the industry to the consumers. Comparison websites are heating up rivalry among existing competitors, and as these partnerships proliferate, comparison websites are increasingly allowing customers to shop and buy entirely online, thus slowly taking over the role of traditional insurance companies' websites.

Lastly, a note should be made on the market consolidation of European life and health insurance companies in the digital paradigm. The trend has been that of increased consolidation with the total number of active life insurance companies declining by 11.1% from 2005 to 2014[1] (Insurance Europe, 2016b). For health insurance the decline was 5.9% during the same period, although the sample is rather incomplete[2]. Interestingly, however, the market share of the top five largest life insurance groups in each country has declined by 4% from 2005 to 2013 (Insurance Europe, 2016b). There was no statistics available specifically on the European market shares of health insurance companies. This trend of consolidation and decreasing market shares by the largest companies illustrates that competition from smaller players have intensified over the past 10 years. With this in mind, as well as the effects of the technological developments explained in this section, we characterize rivalry as high during the digital paradigm.

6.3.3. Technological trajectories and competition

While Internet and communication technologies have expanded the insurance market it has also increased competition considerably. Furthermore, it pushes companies to compete on price for non-complex insurance products such as simple life term and health insurance. Porter (2001) observes the following:

> "*The great paradox of the Internet is that its very benefits – making information widely available; reducing the difficulty of purchasing, marketing, and distribution; allowing*

1 Based on the following sample of 24 countries: CH, CY, CZ, DE, DK, EE, ES, FI, FR, GR, HR, HU, IT, LI, LV, MT, NL, NO, PT, SE, SI, SK, TR, UK.

2 Based on the following sample of 12 countries: CH, DE, FI, GR, HR, IT, LV, MT, NO, PT, SI, TR.

2 Based on the following sample of 12 countries: CH, DE, FI, GR, HR, IT, LV, MT, NO, PT, SI, TR.

3 Based on a sample of the following 19 countries: AT, BE, CH, CY, CZ, ES, FI, FR, GR, HR, HU, IS, IT, MT, NO, PT, SE, SI, TR

3 Based on a sample of the following 19 countries: AT, BE, CH, CY, CZ, ES, FI, FR, GR, HR, HU, IS, IT, MT, NO, PT, SE, SI, TR

4 Regulation (EU) 2016/679 of the European Parliament and of the Council on the protection of natural persons with regard to the processing of personal data and on the free movement of such data, and repealing Directive 95/ 46/ EC (hereinafter The General Data Protection) (EU, 2016)

buyers and sellers to find and transact business with one another more easily – also make it more difficult for companies to capture those benefits as profits." (2001, p. 66)

Similarly, Neirotti and Paolucci (2007) studied the strategic value of IT investments in the insurance industry, and found that competitive advantages were not correlated with IT spending levels nor with the kind of IT investments that made general productivity growth in the industry possible. In order to secure a competitive advantage, insurance companies must build a governance system where decision-making processes on IT investments are based on discipline, and consistency with strategic goals, which requires a complex accumulation of new procedures.

The insurance industry has seen some advances during the digital paradigm in business processes, decision-making and time to market. However, the slow rate with which insurance companies have adopted these new technologies have partly been due to the adequacy of old systems to manage lower transactions and the conservative behavior of the insurance industry in general. Following Dosi's (1982) framework, the technological trajectory from the analogue paradigm was based on an understanding that computers should assist with processing and be implemented throughout the business functions of insurance in order to automate operations. The industry welcomed information technology as a means to save costs, which has been the dominating reason behind further implementing information and communication technologies (ICT) throughout this paradigm. This has created a shift in the competitive structure, as demonstrated through the five force's analysis, to a point where insurers are now embracing technology as an enabler. The organizational and economic forces have formed the current technological trajectory towards information and digitization of the insurance industry. The younger more tech savvy generations are ready to embrace self-service portals built by consolidating disparate systems through web-service portals. Due to the demand for faster and quality service, better and innovative products, and access to information on-demand, the insurance industry is starting to prepare itself to be able to handle large amounts of customer data. Although customers will continue to value the personal interaction and expert advice of agents and brokers, especially for complex life and health policies, their advice will be based on data analytics rather than informed judgment. This is the technological trajectory of insurance.

Even if insurance companies use personal data such as age, profession, family history of diseases, past health care utilization, and claims history etc. in the underwriting process, this type of estimate does not seem to be sufficient in the following data paradigm. As the quality and quantity of data increases, it will be possible to calculate increasingly accurate estimates based on direct information instead of informed judgment. This will slowly remove the need for human judgment, which is a good thing, both for the industry and for the greater part of the consumers. During the digital paradigm, insurance companies have started to accept new approaches to managing risk and optimizing customer relationships, and although the innovation in insurance over the last 15 years have been significant, it is only as we enter the next industrial revolution, the data paradigm, that these new approaches can be managed in an optimal way.

6.4. The data paradigm

The work of actuaries is bound to change with the introduction of big data analytics. The challenge for actuaries will be to find new ways to bring data under control and for insurance companies not to become paralyzed by fear because of the complexity and size of the data they collect. Gathering large masses of multi-dimensional information and turning it into much simpler summaries for actuaries to understand and use, is no simple task. As this analysis will show, it is about tools as well as culture, since the insurance companies must be willing to adapt and evolve with this new technological order or risk losing the race to newcomers.

6.4.1. Technological expectations for the data paradigm

Whereas the previous paradigms were focusing on automation of the workflow, data collection and entry and the decision making processes, the data paradigm is going to transform the ability to analyze and act based on rich access to large data assets. Investment in insurance technology has soared in recent years. According to CB Insights' (2017) data, investment in insurance technology startups reached $2.67B and $1.69B, in 2015 and 2016 respectively, which is more than three times what was invested in 2014. Geographically, 59% of the deals in 2016 went to US-headquartered startups, while startups in Germany, the UK, and China each pulled more than 5% of the deals. This rise in investment deals and volume has the potential to greatly disrupt the industry. Soon, almost every sector of the industry, including life and health insurance, will have to deal with rising competition and innovation, where much of it will come from new entrants.

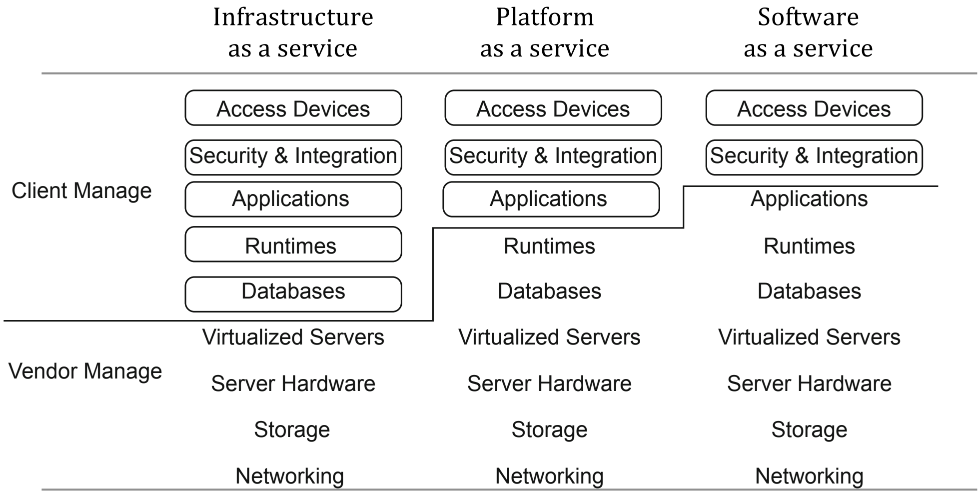
Agile insurance companies are using digital technologies to leapfrog competitors by delivering highly personalized products and online customer services, thus forming a new and very lucrative market. I have chosen to analyze the impact of the data-centric technologies that are most likely to be disruptive within the next 3-5 years. Other technologies, even potentially important ones like self-driving cars and smart contact lenses, have been excluded since they fall outside that timeframe. The selection is inspired by research from Google and Bain & Company who have identified and analyzed more than 100 digital use cases in the insurance industry and grouped the most interesting ones into seven categories of technology (Naujoks, Mueller, & Kotalakidis, 2017). The analysis will center around each of the following data-centric technologies, and their potential impact on the health and life insurance industry:

1. ICT Infrastructure and cloud computing
2. Online sales technologies
3. Big Data Analytics
4. Machine learning
5. Internet of Things (IoT)

First, the main characteristic of digital insurance is that it is virtual and not physical. In a market like Europe, it allows companies to operate in many markets at the same time, but the challenge is that insurers have to design one solution for many countries, languages, cultures, economies, types of customers, diverse risks, compliance etc. (Nicoletti, 2016). Digital solutions, focusing on infrastructure and cloud computing, can help with customizing products, processes, organizations and business models. A modern IT infrastructure is critical for digital innovation. Many insurance companies consider cloud computing to be best option for processing, computation and storage (Naujoks et al., 2017). With the arrival of big data analytics, legacy systems struggle to handle the heavier dynamic workloads of web and mobile apps. These systems have not been constructed to bring interactions and communication together, but to automate and manage customer interactions in isolation. Instead, solutions build around big data analytics embrace a new generation of software designed to extract value in velocity, from large volume of data and from a variety of structured and unstructured data, and to provide better value for the customer and the organization.

Cloud computing promises access to scalable hardware and software distributed online through services accessible from any device. Cloud computing can transform the ICT

Figure 10: A comparison of management responsibilities between traditional ICT infrastructure and cloud computing



Source: Nicoletti (2016, p. 173)

infrastructure through three different delivery methods: Infrastructure as a Service (IaaS), Platform as a Service (PaaS), or Software as a Service (SaaS). These define the management responsibilities of the insurance company as well as the strategic solution through which a vendor acquires competitive advantages (see Figure 10). The benefits of cloud computing include economies of scale, time and cost reduction for accessing new services, reduction in risk associated with implementation of new applications and total flexibility and scalability of services. With cloud computing, insurance companies can strengthen their ICT infrastructure, and reduce costs (reductions tend to be 35-65% compared to in-house implementation (Nicoletti, 2016)), but they must be aware of security concerns and management, data location and regulatory compliance. Vendors of cloud computing include large companies such as Amazon, Google, Microsoft, Salesforce and IBM.

Second, as previously explained, online sales technologies are becoming increasingly popular by mitigating the need for sale and service through agencies. During the digital paradigm, the industry became accustomed to multi-channel distribution, whereas now the goal should be omni-channel distribution. Supported by an effective digital platform, omni-channel is not about maximizing channel efficiency. Instead it puts the customer at the core of the strategy. Where multi-channel distribution makes multiple channels available to the consumer, omni-channel also makes these channels interconnected and the goal is then to deliver consistent and seamless experiences for the customer. An important actor in this environment is comparison sites, or aggregators, moving towards digital agencies and thus allowing customers to shop and buy insurance online without the need for a human sales agent. These digital agencies work similarly to call-center agencies, by generating income from commissions, but while the latter will have to split commissions with their licensed call center agent, the former do not. The aggregator is operating strictly 'in the middle' with the insurance companies taking all responsibility for account servicing and claims processing. According to a recent study by Accenture (Jubraj, Sandquist, & Thomas, 2016), aggregators are expected to continue growing at a rapid pace, both through expansion into new markets and offering new products, such as simple life term and health insurance, in existing markets. This development is driven by consumers' growing trust in online services and their comfort with making increasingly complex purchases online.

Third, digital processes based on big data analytics can be used to extend and redefine the decision-making processes of insurance companies. According to a study by the Centre for European Strategy Foundation (Buchholz, Bukowski, & Sniegocki, 2014), EU-28 will see an additional €206B in GDP by 2020 from sectors in which data-driven solutions are introduced. Insurance and finance is estimated to account for 13% of this additional GDP, illustrating the power of data-driven decision-making in this sector. Recalling, the definition of big data analytics is:

> "*Extracting, transforming, loading, and storing a relatively large amount of data; retrieving and examining (or mining) them; getting appropriate information; and; identifying hidden patterns, unknown correlations, and similar in support of decision-making*." (Nicoletti, 2016, p. 143)

These analytics are starting to be deployed by innovative insurance companies in order to get competitive advantages, better strategic and operational decisions, effective marketing and increased customer satisfaction. The characteristics of big data analytics in general are that it is automatically generated by a machine (i.e. a sensor embedded in a wearable device), it is using a new source of data (i.e. the Internet) and it is using data not designed to be computer-friendly (i.e. medical records as text and unstructured data). Insurance companies can improve risk taking by utilizing big data analytics in product design and underwriting. It is estimated that 15-20% of the data that is available to insurance companies is in structured form, while the remaining data is available in an unstructured format, such as documents, emails etc. (Feldman & Sanger, 2007). The first organizations to utilize big data analytics were online and start-up companies. Firms such as Google, eBay, LinkedIn, Amazon and Facebook are all build around big data analytics from the beginning.

Big data analytics creates value from its ability to store and process very large quantities of data or digital information that cannot be analyzed with traditional computing techniques. In regards to policy underwriting, insurance companies are now able to transform customer data into actionable insights and make better-informed individual and dynamic risk assessments rather than relying on informed judgment through responses to standard questions. This process is already in place in auto insurance, where insurers utilize dynamic risk management in what is called 'usage-based insurance'. They often provide two different types of policies under this type of insurance: Pay-As-You-Drive (PAYD) and Pay-How-You-Drive (PHYD). Dynamic risk management can be understood as an accelerated form of actuarial science. It allows insurers to make real-time decisions based on a stream of data. With PAYD and PHYD the consumer will have to install a sensor in his/hers car. Depending on the type of sensor it then collects data on: mileage, time of day the car is being used, distance of rides, GPS data, acceleration/deceleration, gearshifts etc. Basically everything about *how* and *when* the car is driven can be collected and used to constantly price the insurance policy based on the personal driving behavior of the consumer. If the driver is driving well, the next premium may be lower and vice versa.

Compared to traditional actuarial insurance, this policy will be based on actual personal data as opposed to estimates. With the ECJ's ruling on gender being a discriminatory risk factor in insurance there is now increased momentum for dynamic risk management (Thomas & McSharry, 2015). It is important to understand that dynamic risk management can apply to any data-centric insurance process, whether it is leveraging telematics in the case of auto insurance or data points from multiple sources to calculate the customer risk-profile in life- or health insurance. The increased volumes of data the industry can gather about consumer behavior, and increasingly sophisticated techniques to analyze them will cause insurers to rely less on crude rating factors when pricing premiums. In the data paradigm, individual and dynamic risk assessment will become routine. On any given day, insurance companies might collect data from a variety of sources including (Nicoletti, 2016):

- Call detail records in a call enter;
- detailed sensor data from wearable devices, IoT, mobiles, points of sale, radio-frequency identification (RFID) devices etc.;

- external data or information, such as open data, marketing research and behavioral data;
- Unstructured data from social media and reports of different types etc.

With all this data being collected about consumers, it is crucial that insurance companies ensure that the security of the data is not compromised, that all the necessary safeguards are in place, and that they remain compliant to regulation concerning data privacy.

The development of big data analytics will happen in three directions: There will be historical analysis to understand the pattern and characteristics of past sales; predictive analysis to understand and define best strategies; and operational analysis, which will support operational decisions-making such as the pricing of life or health insurance for a specific customer. For the purpose of this thesis the latter is interesting, which is the value big data analytics has in decision-making processes of functions such as underwriting and policy management. This amount of data collection and analysis is only possible through technological developments in software and hardware. Replacing legacy systems with cloud computing, and securing good collaboration between ICT and business, is a solution as long as the insurance companies build a culture in which organizational leaders trust the analytics and act on the insights they generate.

Fourth, machine learning incorporates disciplines such as statistics, predictive analytics and pattern recognition to make fast and efficient algorithms for real-time processing of big data. This allows companies' ICT systems to quickly adapt to new data, without the need for re-programming. Thus, insurance companies can use machine learning to improve underwriting and manage claims. In 1959, Arthur Samuel defined machine learning as "*the field of study that gives computers the ability to learn without being explicitly programmed*" (Naqa, Li, & Murphy, 2015, p. 6). Ethem Alpaydin defines it as "*programming computers to optimize a performance criterion using example data or past experiences*" (Alpaydin, 2014, p. 3). Machine learning is a subspecialty of computer science, and the most developed technology under the term cognitive technologies, focused on the design and development of algorithms based on historical data. Big data is also important for machine learning since the more data points the system has to learn from, the faster it well get better at performing.

According to Domingos (Domingos, 2012), there are thousands of learning algorithms available, but the variety can be reduced to a combination of three components:

$$\text{Learning} = \text{Representation} + \text{Evaluation} + \text{Optimization}$$

Representation means that a classifier must be represented in a formal language that the computer can interpret. Evaluation is required to distinguish good classifiers from bad. And finally, optimization is a method to search among the different classifiers for the highest scoring. The goal of machine learning is to generalize beyond the examples in a training set, which requires that the classifiers are able to perform equally well on new data as on the test/training set. The system should then be able to adjust its decisions and actions automatically, based on new data, making it more relevant for underwriting and policy management than traditional analytics. There are two main ways to do machine learning, supervised or unsupervised (see Appendix 2 for an illustration of the differences between supervised and unsupervised learning):

- *Supervised learning* is when the input data has a know label or result (structured data). The computer can then infer a function or relationship from a set of training data. The algorithm is then trained using historical data to recognize patterns and correlations. If the system is wrong, the algorithm will be adjusted causing it to become more accurate.
- *Unsupervised learning* is used when the input data does not have labels or results are unknown (unstructured data). The input data is then categorized, i.e. using cluster analysis, to find hidden structures in the unlabeled data, so that the algorithm will be capable of differentiating correctly between classifications. By informing the system when it has made the correct classifications, it well learn over time how to perform better

As mentioned earlier, it is estimated that 15-20% of the data available to insurance companies is in structured form, whereas the rest is unstructured, often presented in a natural language format (e.g. medical journals and social media posts). IBM Watson is an example of a technology platform utilizing machine learning and natural language processing to explore and understand big data sets and to integrate diverse data sources (Shader, 2016). Watson has been applied in the medical industry, reading through millions of pages, medical journals, research and documents, and is now able to help doctors identify, evaluate and compare treatment options (Roberts, 2017). Implementing this technology in the insurance industry, together with IoT, would allow companies to manage risk in real-time, but also to influence customer behavior through premium pricing based on individual behavior, lifestyle and overall health.

Finally, a valuable source of big data is through IoT. Devices characterized by a combination of Internet connection and numerous sensors that are connected to cars, buildings, things and people. By analyzing data from sensors embedded in wearable devices, such as fitness wristbands, smart watches, sleep monitors etc., insurers can gain insights into customer behavior and health. The use of such data is particularly relevant to health insurance. For people with chronic diseases, such as diabetes or heart disease, it is possible to monitor the customer's health and provide them with health and lifestyle advice, which will lower their premium if they follow the instructions. For this reason, consumers could potentially become more aware of the preventive measures they need to take to reduce risks associated with diseases and thereby control medical costs. Furthermore, these sources of data will allow insurers to perform individual risk assessment and price risks more accurately by using data illustrating how healthy and active a person is. The sensor technology has the ability to keep records of such things as daily steps, exercise, hearth rate, work routines, sleep patterns, stress levels, sun exposure, blood pressure etc. Measuring body temperature and potentially even blood-glucose levels could provide insights into what someone has eaten, which is of great value since diet has a much higher impact on health than exercise. And while health insurers already use body mass index to set premiums, data from IoT could play a much bigger role in these calculations through machine learning and big data analytics. However, the penetration of IoT and wearable technology, and its use in calculating and adjusting premiums is still in its infancy.

In 2015, the global average spending on IoT as a percentage of insurance companies' revenue was 0.3% (Tata Consultancy Services, 2015), while the distribution of this spending was as follows: 34.7% on customer monitoring (i.e. apps, wearable devices), 33.4% on product monitoring (i.e. tracking products or services after they are sold), 16.8% on supply chain monitoring (i.e. tracking products/services operations) and 15.2% on premises monitoring (Statista, 2017b). The same survey revealed that nearly half of the global insurance companies surveyed use digital devices to monitor customers, primarily via mobile apps, while 4.5% monitor wearables (Tata Consultancy Services, 2015). Although telematics will continue to be the leading use case in insurance, remote health monitoring will see the greatest investment towards 2020 in the healthcare industry (Torchia, 2017). By exploring large datasets collected through IoT insurers are essentially producing a digital ecosystem, which poses significant challenges when it comes to respecting the EU charter of Fundamental Rights, which includes the rights to freedom, privacy and personal data protection (Fuster & Scherrer, 2015).

From the analogue paradigm, through the digital paradigm, to today, insurers have leveraged automation with the help of technological developments. Today, we begin a new paradigm, where information, through data and algorithms, play an increasingly larger role. Thinking of Dosi's (1982) framework, it is impossible to guess what future technological trajectories will be ex ante. However, as we become more and more connected through digital devices, the social factor is going to be an important selective device for the next technological paradigm.

6.4.2. Porter's Five Forces in the data paradigm

This last five forces analysis will focus on the effects of introducing data-centric technologies for information and decision-making purposes to the European life and health insurance industry. Big data analytics will, similar to the Internet in the digital paradigm, disrupt the competitive structure of the industry in the future.

Threat of new entrants (very high)

As data-centric technologies become more and more embedded in the insurance industry, established companies will have to fight their conservative approach to new technologies, while new entrants are ready to embrace technology as their core competency. The threat of new entrants is influenced by:

1. Low entry barriers for adjacent and agile entrants (-)
2. Customer-centric business model by new entrants (-)
3. First-mover advantage (-)

First, new entrants who have technology as their core competency, and smaller agile entrants, will have a competitive advantage over the incumbents in a conservative insurance industry. Companies with strong customer relationships, built through access to big data, will have a deep knowledge of their needs and be able to identify and meet their individual life and health insurance requirements. Non-traditional entrants are taking advantage of the opportunities of digital technologies and the shift towards ecosystem-based insurance. Google is an example of a company who already has collected an enormous amount of data on its customers, and know how to leverage digital technologies. Although they shut down their Google Compare experiment in 2016, where they sold auto insurance online (Jergler, 2016), they are in a position to disrupt life and health insurance provided they understand the regulatory and operational aspects of insurance. Instead of focusing on comparison only, Google is in a position to gain consumer insights from their own core operations and leverage that competitive advantage to offer their own insurance products. A report by IBM (2015) reveals that 20% of millennials would be willing to buy insurance directly from online service providers such as Amazon and Google. Another global study reveals a shift in consumer attitude towards sharing personal health information (Pickard & Swan, 2014). They found that 14% of consumers were willing to share health and medical information with insurance companies, including data related to: diet (88%), exercise (88%), behavior (85%), diseases and conditions (81%), genomic data (80%), fitness tracking information (80%), medications (79%), and electronic medical records (72%).

The big question is whether adjacent entrants will be able to overcome barriers to entry established by incumbents in the industry, such as strong brands, ownership of distribution and accumulated expertise in pricing and underwriting. However, most of the established insurance companies in the European market are weighed down by legacy systems. New, smaller and more agile, entrants will be better equipped to implement multiproduct ecosystems by leveraging consumer insights right away. Most new entrants using IoT to build life and health insurance products are US-based companies. Vitality, which is a UK-based company specializing in private health and life insurance and a subsidiary of the South African company Discovery, currently covers close to 1 million people through its connected life and health insurance products (Discovery, 2016; Vitality, 2017). Vitality provides new customers with an activity tracker and discounts on fitness gear while rewarding healthier lifestyles:

> *"Through Vitality, clients are encouraged to understand and improve their health, with regular wellness checks and discounts for the use of health facilities and the purchase of health-related equipment…"* (Discovery, 2016, p. 86).

The company has calculated that its members received £51.1m in benefits and rewards during 2016 as a result of their engagement with Vitality's connected life and health insurance products (Discovery, 2016).

Second, the use of data-centric technologies should add value to the customers. New entrants, i.e. Vitality, who have made a case of collecting and leveraging customer data, must turn this data into innovations in products, processes and business models. Value for the customer is the most important of these characteristics (Nicoletti, 2016). If the customer finds value in the relationship where he/she shares personal data with the insurance company, the insurer will

also collect value. The threat for many European insurance companies is that often they are stuck with multiple legacy systems due to the merger and acquisition trends of the analogue and digital paradigms. These old systems are not equipped to follow a customer-centric approach, which is a radical departure from most insurers internally focused stance (NTT Innovation Institute, 2015). In order for European life and health insurers to add customer value through personalized products they must build greater loyalty and increase customer retention and profitability. The biggest challenge is that the European market remains complex with various legal, regulatory, accounting, and tax challenges, all dragging resources.
Third, new entrants that develop new connected products and services, similar to Vitality, will have a first-mover advantage for two main reasons: First, they will build up data and experience in converting data into actionable insights, faster than their competition. Second, they could experience network effects meaning that as more people use their products and services, the better they become for new and current customers.

Figure 11: Internet of things and big data analytics in insurance

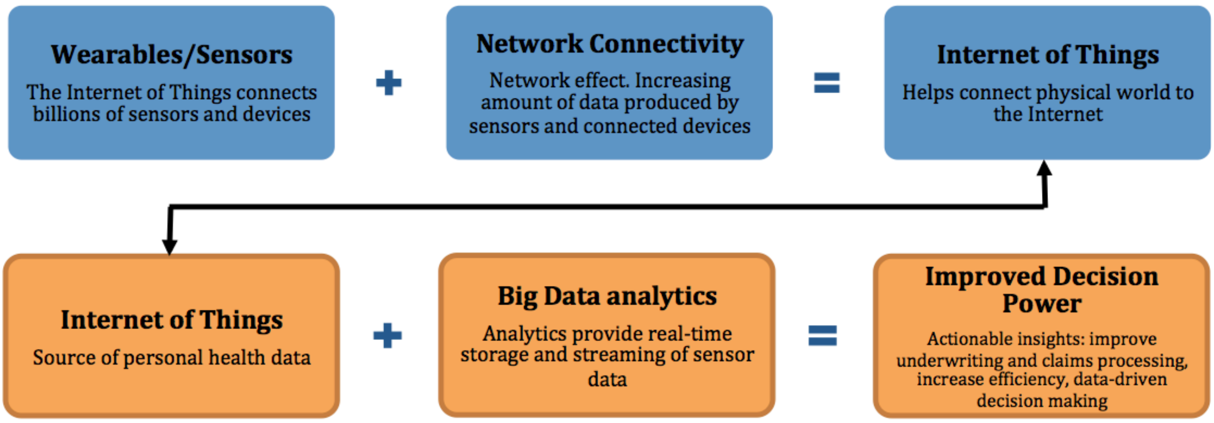


Figure 11 illustrates how new entrants, exploiting big data analytics and IoT, would gain improved decision power through better and actionable insights. Innovative and agile new entrants as well as adjacent entrants can take advantage of their core competencies in digital innovation and put up barriers to entry for incumbents who still struggle with a conservative culture and the weight of multiple legacy systems. They have the possibility to redefine life and health insurance products and services by reengineering their value chains in a way that increases customer value, loyalty and retention. For this reason, the threat of new entrants is considered very high in the data paradigm.

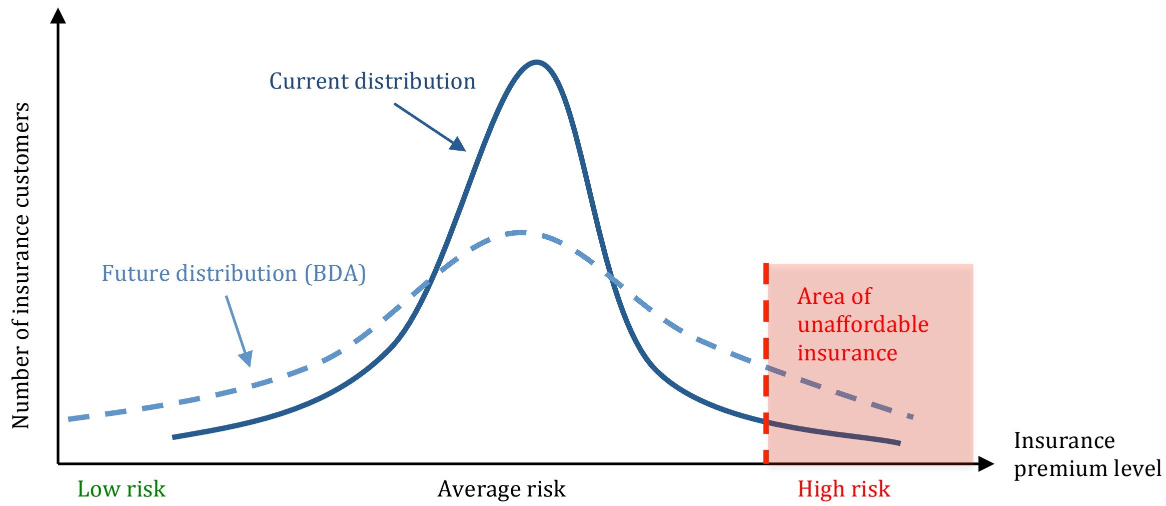
Bargaining power of customers (very low)

Developing connected products through IoT and big data analytics will expand opportunities for product differentiation, moving competition away from price, which was the main feature of online comparison sites in the digital paradigm. These connected products will influence the bargaining power of customers due to:

1. Individual risk assessment and premium pricing (+)
2. Closer customer relationships (+)

First, individual risk assessment has the potential to change the model of risk pooling, which is essential to insurance. Insurers will be able to improve underwriting and capture value, but with better risk assessment capabilities comes greater premium dispersion. Some customers will enjoy lower premiums since they bring less than average risk and are priced accordingly. The individuals that bring higher risk to the pool will only be able to get life and health insurance in exchange for a more expensive premium or on worse terms (limited coverage). Some customers will face higher premiums, while at the extreme; some customers will have their risks assessed so high that they will be unable to afford insurance altogether (see figure 12). In this way, big data analytics will lead to a broader spread in the distribution of premiums between lower and higher risks. The distribution of insurance premiums will 'flatten out'. Overall, this means that fewer customers will be treated as average risk and paying average premiums. Instead, they will increasingly be classified, through individual risk assessment, as either lower or higher than average. In the previous model insurers could find themselves in a position where customers had more information about their own level of risk, making it difficult for insures to distinguish between high and low risk individuals and those

Figure 12: Distribution of insurance premiums



who where merely risk averse. However, as a consequence of insurers now having more information than the consumers, there is now a potential for cream skimming instead. This is extremely likely to occur in cases where insurers are able to reject applications or exclude individuals with pre-existing conditions. This can be addressed through a regularly response, to some extent, by guaranteeing access to life and health insurance coverage, automatic renewal of contracts and limiting exclusions for pre-existing conditions. Mossialos and Thomson (2002) found evidence, particularly in the period 1970-1994 until the third non-life insurance directive abolished product controls, of cream skimming by health insurance companies in the EU. This might be a regulatory issue again in the data paradigm. As more people change from insured to uninsured status because of increasing premiums, the greater the burden will be on public insurance and others outside the insurance system. In the long run, the model of risk pooling, which is essential to insurance, could be dramatically changed by big data analytics. However, it will still be relevant since insures will not be able to predict with certainty which insured events will happen, when and with what impact (Swinhoe et al., 2016). Thus, the basis of insurance will not change, and insurance companies will continue to have a role in pooling risk across many individual risks.

Second, connected products will allow companies to develop a closer relationship with their customers by increasing retention and loyalty. Through the capturing of historical data and product-usage data, buyers' costs of switching to a new supplier will increase. Products that reward loyalty and use, such as prizes for exercising with wearables, can make customers feel more involved with their insurance and increase their levels of satisfaction. With more detailed data sources from IoTs it is will also be possible to predict long-term trends and provide cover for health risks that would otherwise be uninsurable. Ideally, customers will gain better insights and involvement in their own health and wellbeing as a result of having wearables and medical records connected to their insurance policies, which could lead to healthier lifestyles and optimal use of medication. A closer relationship with customers will also reduce problems with fraudulent claims. Although the extent of insurance fraud varies between countries, it is estimated to represent up to 10% of all claims expenditure in Europe (Insurance Europe, 2013). Big data analytics offers some opportunities to detect and prevent fraud through improved communication and focused data mining. The result is an optimized cost structure, higher customer satisfaction and loyalty. The factors discussed here will change customer relationships and remove information bias between customers and insurers. As a result bargaining power of customers is very low in the data paradigm.

Bargaining power of suppliers (high)

Developing a data-centric business model and a wearable ecosystem requires significant investment in specialized skills, technologies and infrastructure that have not been present in insurance companies. The following factors are likely to influence the power of suppliers in the data paradigm:

1. New partnerships with ecosystem platform providers (-)
2. Shortage of highly skilled talent (-)

First, digital insurers need to rethink traditional supplier relationships across their value chain. In the digital paradigm, most ICT developments and investments were designed to support and automate internal processes of large insurance companies. These systems are rather inflexible compared to the IT infrastructure requirements of the data paradigm. In order for European life and health insurance companies to compete in the data paradigm, they have to form symbiotic ecosystems of partners with knowledge in software as well as platform-as-a-service. As the shift towards software continues, the bargaining power of hardware and software product manufacturers alike will decrease and shift towards multi-sided platform providers (NTT Innovation Institute, 2015). Big data analytics and connected devices introduce new suppliers, who have the talent and capabilities that most life and health insurers have not historically needed: providers of sensors, software, connectivity, embedded operating systems, data storage, analytics and other data-centric technologies.

Many insurance companies need to consider changing their business models to ecosystems suitable for the data paradigm. This could be done through partnerships with the major technology companies, such as Facebook, Apple, Microsoft, Google or Amazon (FAMGA), or through acquisition of innovative firms targeting ICT companies, policy aggregators and firms specializing in big data analytics. Google, for example, provides a multi-sided platform through Android, creating a strong operating system and higher customer value along with an ecosystem of developers to build applications. Vitality, the UK life and health insurance company, has taken this approach one step further and partnered up fitness gyms, healthy food deliveries, doctors, wearable technology providers (Garmin, Apple Watch and Polar), but also travel agencies, coffee shops and cinemas. These partnerships add value to the customer through a reward system for living healthy lifestyles. Generally, new partnerships will form on the idea that combining previously disparate datasets can lead to new insights, new customers, or new markets. The bargaining power of ecosystem platform providers can be very high, allowing them to capture a bigger share of overall product value and profitability.

Second, there will be a shortage of talent necessary for life and health insurers to take advantage of big data. A survey by the European Commission (2016) revealed that if the trend of demand for ICT professionals continues, there will be more than 700,000 unfilled vacancies for ICT professionals in the EU by 2020. The largest gap between demand for and supply of ICT professionals can be found in Germany, the UK and France, which are all large insurance markets. Again, partnerships with platform providers will be the best answer since insurance companies cannot attract enough skilled talent. Google's platform, for example, will give insurers access to significant technology innovations and access to scarce talent for software development and big data analytics. If insurers keep a traditional model of proprietary business services and products, the desire to keep capabilities in-house might dramatically reduce the ability to tap into these new platform providers. However, life and health insurers will also have to develop their own talent with skills in statistics, data mining, econometrics, business analytics, software and visualization techniques. As illustrated by Google's failure with online insurance, knowledge of ecosystems, data science *and* insurance are both requirements to succeed. Combining these factors, a shortage of highly skilled talent and the formation of new partnerships will allow suppliers to exceed high bargaining power in the data paradigm.

Threat of substitute products or services

Smart and connected insurance will not replace traditional life and health insurance policies completely, at least not in the near future. Instead they will work as substitutes.

1. Aggregators as digital agencies (-)
2. Continued threat of public health care (-)

First, aggregators working as digital agencies will allow customers to shop and buy insurance online through multiple vendors. Algorithms provide search results using real-time access to price information supplied by partnering insurance companies. As long as the aggregators' business model remains focused on standardized products, the threat is manageable for digital life and health insurers. Potentially, when and if consumers are able to collect and store personal health data via cloud services, aggregators could use this data to force insurers to compete on price, even for customized insurance policies. However, consumers are unlikely to collect and store the variety, quality and volume of data necessary for insurers and aggregators to provide individual risk assessments. Currently, professional athletes or people with chronic diseases are probably the only ones interested in gathering high volumes of personal health data from various data sources. Regulatory developments towards placing personal data in the hands of consumers could allow customers to transfer data gathered by their previous insurance provider to aggregator sites in the quest for new and better quotes. Such a scenario would lower switching costs and force insurance companies to increasingly compete on price.

Second, the public health system remains a powerful substitute for voluntary health insurance in the EU. In 2014, more than 75% of health spending was publicly financed across the EU member states, while voluntary health insurance only accounted for 5% (OECD/EU, 2016). Thus, the threat of substitutes in the data paradigm is medium, but not immediate.

Rivalry among existing competitors (very high)

Data-centric technologies have the potential to shift rivalry, opening up new possibilities for value-added services while enhancing differentiation and price realization. Rivalry will intensify as a result of the following factors:

1. Data as a competitive advantage (+)
2. Customer-centric value chain and innovation (-)
3. Adapting to technological innovation (-)

First, the industry will use data as competitive advantage built on cloud, mobile, social and big data solutions. Data-driven technologies, the cloud, and ecosystem platforms are enabling insurers to aggregate and understand diverse sources of information and improve decision-making. These technological developments have led to unprecedented availability and access to data and information that historically was very expensive, and in most cases impossible, to collect. This democratization of data is influencing the information marketplace, and is allowing small and medium sized companies to have access to the same information that larger insurance companies have, without being burdened by legacy systems.

Competition will resolve around how well insurance companies are at leveraging personal health data to balance price and service with the statistical models and machine learning capabilities they use to underwrite customer's risk profiles. The key to leveraging data as a competitive advantage in the data paradigm is to develop systems that follow three characteristics of (1) flexibility, (2) scalability, and (3) interoperability. First, digital insurers will achieve sustainable competitive advantages by being flexible, agile, and responsive. This enables insurers to effectively use predictive and real-time analytics at all touch points of the data value stream, from data mining to underwriting, claims management and after-sales services. Second, insurers must learn how to start small with a proof of concept and experiment with solutions. This helps to design flexible business models that can be expanded across the company and to develop partnerships with providers of cloud, SaaS, PaaS, and security solutions, so that in-house teams can focus on analytics and customers. Lastly, today's customers expect on-demand service, which is secured by interoperable ecosystems, which can exchange and interpret shared data (HIMSS, 2005). For two systems to be interoperable, they must be able to exchange data and subsequently present the data such that a user can understand it. Focus on interoperability allows insurers to deliver better customer value through experiences that easily travel across multiple platforms, devices and networks. Access to such a volume and variety of big data naturally raises privacy concerns. Insurers must provide a full range of security services that extend from the corporate strategy down to the billions of personal health data points that are monitored daily. European life and health insurance companies will have to incorporate best practices and take necessary measures to secure against cyber threats. The insurers who build flexible, scalable and interoperable data systems without neglecting security concerns are the ones who will experience sustainable competitive advantages.

Second, companies who use big data analytics to add value for the customers are more likely to experience sustainable competitive advantage. In the data paradigm, customers value personalization, customization, and even co-creation of their experiences. Through individual risk assessment and premium pricing, customers will be able to track in real-time how lifestyle choices are influencing their premiums and insurers are able to track incidents that impact the mortality and health of the insured. Customers will reward digital insurers who foster more direct, simple, secure, seamless and effective relationships (Nicoletti, 2016). This focus on customer relationships represents a shift from focusing on what is best for the company to what is best for the end user's perspective.

Third, in order to create value for the customers and leverage data, IoT and wearables to gain competitive advantage, EU insurance companies must forget their conservative culture and adapt to technological innovation. Instead of focusing on product development and distribution, companies should focus their digital efforts on underwriting and claims management, where machine learning, big data analytics and IoT will have the biggest impact. An industry analysis by Google and Bain & Company reveals that a typical German insurer who consistently pioneers the use of digitalization can expect gross premiums to increase by 28% in the next five years (Naujoks et al., 2017). Most of this increase in revenue will come from gains in market share. Their analysis also found that an average insurance company could lower its cost by up to 29% over the next five years as a result of savings from better claims management. Furthermore, these insurers will also be able to invest some of their savings in more and better digital innovation, forming a virtuous cycle.

In order to fully leverage the potential of big data, wearables and IoT, companies must adapt to technological innovations by (1) educating customers, (2) developing partnerships and (3) building capabilities. First, customers need to be educated on the benefits wearable devices can provide by sharing personal health data. Mitigating customer's privacy concerns through design strategies will ease the transition to digital insurance. Second, life and health insurers will have to develop partnerships with multiple suppliers such as hardware providers (e.g. fitness trackers), software platform providers (e.g. Google, Apple, Salesforce), wellness companies (e.g. fitness gyms, sport facilities), doctors and other health personnel. Lastly, insurers will have to invest heavily in the developing sufficient analytical capabilities to drive insights from big data. Successful life and health insurance companies in the data paradigm have accelerated and improved decision-making. They are securing their competitive advantage by adapting to the latest technology, which allows them to enhance individual risk assessment, reduce costs and improve the customer experience. Rivalry intensity will be very high and existing companies will have to reconsider their conservative culture in order to secure a sustainable competitive advantage.

6.4.3. Technological trajectories and competition

Thinking back to Dosi's (1982) framework, the technological trajectory from the digital paradigm has been to connect people and devices through the internet, which in turn has made it possible to collect large volumes of data from various sources. With IoT and wearables, the availability of data now allows insurers to make better-informed strategic and operational decisions. Thus, the winning formula in the data paradigm is to turn structured and unstructured data into actionable insights. Compared to the analogue and digital paradigms, the data paradigm is less constrained by the core technologies and their possible applications. Instead, and because we stand of the edge of a new paradigm, the constraining factors are limited capabilities in advanced analytics and a conservative culture. The data paradigm in insurance is still an emergent industry, where lock-in effects are starting to evolve, but the technological trajectory has yet to materialize. Innovative life and health insurance companies, such as Vitality, are establishing themselves in the market, each trying to set the standard for this new paradigm. This analysis has illustrated how data-centric technologies will transform the competitive structure, but the winning strategies have yet to be revealed. Over the coming years, innovative insurers will compete to have their way of leveraging data within this paradigm become the standard for the rest of the industry. Only then will the data paradigm have materialized. Looking even further ahead, there is no way of knowing what the next technological trajectory will be, or when it will start to deviate from data-centric technologies. However, one thing is certain, technological innovation is not going to slow down. Economic, institutional and social factors will continue to operate as selective devices for new technologies in the future.

6.5. Summary: A partial conclusion

This analysis has focused on the technological developments in data-centric technologies since WWII and their power to transform the insurance industry. The introduction of computers in the insurance business environment drove automation as insurers began adopting digital tools to perform processes that previously required manual entry and endless paperwork. As computers evolved from mainframes to client-server architectures, and later with the development of the Internet, large insurance companies also started to leverage new computing power to model and understand risk, create complex statistical and actuarial models to segment risk pools and automate underwriting processes. Towards the end of the analogue paradigm, most life and health insurance companies had transitioned to a semi-automated, and technologically enhanced, version of the original analogue model of insurance. The Internet also allowed insurers to access new distribution channels and increase efficiency in their operations. While in the digital paradigm, insurers were mostly concerned with automating processes; in the data paradigm it is about informing and improving decision-making within these processes. Big data analytics has the potential to disrupt traditional life and health insurance. During the transition to the data paradigm, smaller insurance companies are starting to harness technological innovation and strategic partnerships to leapfrog their larger competitors. Table 2 illustrates the evolution of data analytics through the three paradigms.

Table 2: Data analytics in the three paradigms

Paradigm	Analogue paradigm	Digital paradigm	Data paradigm
Culture	Competition not on analytics	Early focus on data based products and services (primarily towards the end of the paradigm)	Real-time decision-making driven by data
Type of analytics	• 95% reporting, descriptive • 5% predictive, prescriptive	• 85% reporting, descriptive • 15% predictive, prescriptive	• <10% automated reporting, descriptive • >90% predictive, prescriptive
Data	Internal, structured	Large, mostly structured, multisource	Big data (5 V's) Analytics embedded in operational and decision processes

Adapted from Davenport (2013) and Nicoletti (2016)

Taken together, Porter (1979) and Dosi's (1982) theoretical frameworks have illustrated how technology has influenced the competitive structure of the industry. Although the adoption of new technology has been slow for life and health insurance companies, they have experienced intensifying competition over the course of the three technological paradigms. Economic forces have shaped the technological paradigms as insurers try to capture value by leveraging innovative technologies. Today, during the transformation towards the data paradigm, insurers must apply innovation in areas outside their fields of expertise such as data science, software programming and IT architecture. With the changing competitive structure over the three paradigms, new competitive positions have appeared. In a quest to increase customer and company value, insurers have to battle their conservative culture or risk losing market shares to more agile and digital insurance companies.

The analysis has illustrated the relationship between economic forces and the relatively autonomous momentum that technological progress appears to maintain. During each of the technological paradigms, the search for new products, distribution channels, data management tools etc. has been the result of the cognitive window generated by each paradigm. The way innovation and technical progress accumulates is a way of reducing the uncertainty, which is inherent to innovative activity. There is no way for insurers to know what the effects of a new paradigm will be ex ante, which is why many prefer incremental changes. What will determine the success of the data paradigm is how institutions and the broad socio-economic environment will act as a selector and focusing device. Competition is important for innovation during this phase, since it will help to select the most vital companies, who are better at generating value for the customers.

7. Discussion

The discussion is split in two. First, a discussion on the consequences of a new genus of capitalism that monetizes data acquired through surveillance. Second, a short discussion on public vs. private responsibility for health care in the data paradigm. With the new technological capabilities it is necessary to discuss the consequences for consumer privacy and access to affordable insurance. This discussion will highlight some of the institutional and social factors that Dosi (1982) argues will act as selective devices for a new technological paradigm together with the economic forces of competition, which have received most attention in this thesis.

7.1 Surveillance capitalism

Shoshana Zuboff (2015, 2016) has popularized the term 'Surveillance Capitalism', which denotes a new genus of capitalism that monetizes data acquired through surveillance. She explores the proposition that 'big data' is the foundational component in a deeply intentional and highly consequential new logic of accumulation, which aims to predict and modify human behavior as a means to produce revenue and market control.

7.1.1 Privacy concerns under Surveillance Capitalism

Zuboff's argument is based on Hal Varian's (2010, 2014) four uses of computer-mediated transactions:

1. Data extraction and analysis
2. New contractual forms due to better monitoring
3. Personalization and customization

4. Continuous experiments

First, as illustrated by the technological paradigms in insurance, information technology has the capacity to *automate* and *informate*. This is now institutionalized in millions of new actions within firms every single day. A lot of the data generated in the data paradigm, are purchased, aggregated, analyzed, packaged, and sold by data brokers who operate, in the US at least, in secrecy, outside of statutory consumer protections and without consumers' knowledge, consent, or rights of privacy and due process (U.S. Commitee on Commerce, Science, and Transportation, 2013). Until now, this thesis has assumed that insurance companies are granted consent in each case to use personal health data in underwriting. However, today it is common with "click through" agreements (Porter & Heppelmann, 2014), which gives broad consent to collect product data the first time a wearable or IoT product is being used. This procedure essentially allows companies to universally collect product data and use it with few constraints.

Revenue in this paradigm depends upon data assests appropriated through pervasive automated operations. Zuboff (2016) is criticizing these surveillance assets for not producing appropriate reciprocities. I would argue that the real problem is that surveillance capitalists have exploited a lag in social evolution since the constant development of their abilities to aggregate date for profit outrun public understanding and the development of law and regulation. The average consumer does not fully understand the implications this data accumulation has for privacy rights and often they will see it as essential for basic social participation.

Second, as illustrated by the introduction of individual risk assessment and IoT, insurance companies now have the ability to observe behavior that was previously unobservable and write contracts on it. This will inevitably remove uncertainty, which is an important aspect of a contract. Dynamic and individual risk assessment will eliminate the need for trust, and the ability to develop it. Zuboff argues that contracts are "*lifted from the social and reimagined as machine process*" (2016, p. 81). By automatically adjusting your insurance premium based on your lifestyle actions, surveillance capitalism establishes a new form of power where contract and the rule of law are replaced by the rewards and punishments of a new kind of invisible hand. According to Varian (2014), consumers will agree to invasion of privacy if they get something they want in return. This is not completely true yet. Recall the study by Pickard and Swan (2014), only 14% of consumers were willing to share health and medical information with insurance companies. It could be argued that the reciprocities are simply not valued enough for people to be swayed, but an important question is also whether these supposed reciprocities are the product of genuine consent. Zuboff (2015) argues that surveillance does not erode privacy but rather redistributes them. Instead of many people having some privacy rights, these rights are now concentrated within the surveillance regime. Following this line of thought, surveillance capitalism can be thought to replace contracts, the rule of law, and social trust, with the sovereignty of ubiquitous companies. The response from consumers in the data paradigm should be to demand improved contractual frameworks governing their privacy rights.

Third, there is a desire to personalize and customize the services offered to users of digital platforms. This is very much the case with insurance, as explained throughout the analysis of the data paradigm. The problem is that the typical user has little or no knowledge of the business operations of these digital companies, the full range of personal data they contribute to their servers, the retention of those data, or how those data are processed and monetized (Zuboff, 2016). Surveillance capitalism thrives on public ignorance. This trend is disturbing since consumers have few meaningful options for privacy self-management (Solove, 2013). Another issue with personalization is to be found in the business model of insurance companies. The data paradigm will make it easier for life and health insurance companies to cream skim due to the accumulation of personal data. To some extent, this can be addressed through a regulatory response by guaranteeing access to life and health insurance coverage, automatic renewal of contracts and limiting exclusions for pre-existing conditions. However, in the long run, the model of risk pooling, which is essential to insurance, could be dramatically changed by big data analytics.

Consumers does show some pushback in a survey by the Financial Times, which found that both EU and US citizens are altering their online behavior as they seek more privacy (Kwong, 2014). The concern is that 'lack of knowledge' rather than 'careless attitude towards privacy' is an important reason why many consumers engage with digital companies in an unconcerned manner.

Finally, big data analytics have the potential to intervene with and modify behavior for profit. This is why Vitality provides new customers with an activity tracker, discounts on fitness gear and rewards for healthier lifestyles. From the analogue to the data paradigm, reality itself has undergone a metamorphosis: "*Now, reality is subjugated to commodification and monetization* *and reborn as 'behavior'"* (Zuboff, 2015, p. 85). Data about the behaviors of bodies, health and things are produced in a universal real-time dynamic index of IoTs. This gives all digital companies the possibility to alter the behaviors of people and things for profit and control. According to Zuboff's understanding of surveillance capitalism, there are no individuals, only the global organism and all the tiniest elements, people, within it. All consumers with the material, knowledge and financial resources to access the Internet participate in this new genus of capitalism, where people are nothing but targets of data extraction. The game is selling access to the real-time data of your daily life, your reality, in order to influence and modify your behavior for profit.

7.1.2. Dealing with privacy concerns

Zuboff's paper portrays a grim reality and an even darker future. We have seen great technological achievements, but we lack transparency, accountability and collaboration in governing these technologies. The question is what alternative trajectories to follow. I will discuss some of the solutions and countermeasures currently pursued by the EU with its General Data Protection Regulation (GDPR)[4].

The GDPR enters into force 25 May 2018 and it is the most important change in data privacy regulation since the Data Protection Directive (95/46/EC)(EU-Lex, 1995), which it also replaces. The key changes include: (1) Increased territorial scope, (2) penalties, (3) consent and (4) data subject rights (EUGDPR, 2017). First, according to Art. 3 (EU, 2016), the regulation applies to all companies processing the personal data of data subjects residing in the EU, regardless of the company's location. If an international insurance company has EU customers, then they must comply with the GDPR. Second, according to Art. 83 and 84 (EU, 2016), a breach of GDPR can be fined up to 4% of annual global turnover or €20 million, whichever is higher. This is the maximum fine given for serious infringements of the data subject rights. Third, according to Art. 7:

> "*the request for consent shall be presented in a manner which is clearly distinguishable from the other matters, in an intelligible and easily accessible form, using clear and plain language*" (EU, 2016, p. 37).

4 Regulation (EU) 2016/ 679 of the European Parliament and of the Council on the protection of natural persons with regard to the processing of personal data and on the free movement of such data, and repealing Directive 95/ 46/ EC (hereinafter The General Data Protection) (EU, 2016)

Furthermore, the purpose for data processing must be attached to that consent, the data subject has the right to withdraw his or her consent at any time and it must be as easy to withdraw consent as it is to give. Finally, data subject rights are strengthened through several changes. Some of the more interesting ones are highlighted here:

Breach notification (EU, 2016, Art. 33) is mandatory within 72 hours if the breach is likely to result in a risk to the rights and freedoms of individuals.

Right to access (EU, 2016, Art. 15) by the data subject to obtain information on whether or not personal data concerning them is being processed, where and for what purpose. Furthermore, the data subject can demand a copy of the personal data, free of charge, in an electronic format, which marks a shift to data transparency and empowerment of the people.

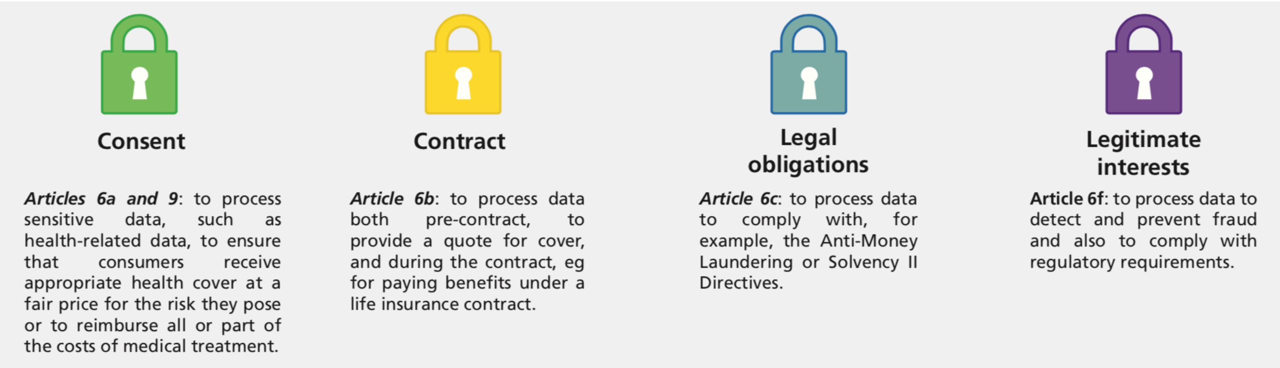
Right to be forgotten (EU, 2016, Art. 17) entitles the data subject to have his/her personal data erased, cease further spreading of the data and potentially have third parties stop processing the data as well.

Data portability (EU, 2016, Art. 20) gives the data subject the right to transfer his/her personal data to another company in a 'commonly use and machine readable format'. This could be interesting for insurance customers who want to change insurance provider and be able to prove a history without injuries and claims payments.

Privacy by design (EU, 2016, Art. 25) calls for the inclusion of data protection and privacy from the onset of the designing of IT systems, rather than an addition.

With the GDPR the EU is establishing a harmonized data protection framework across the EU. The rules should become clearer and simpler for companies while also facilitating the European Commission's aim of developing a Digital Single Market. One of the main issues is securing informed consent. Often, people are not behaving rationally when making privacy related decisions (Acquisti & Grossklags, 2005), and some research has shown that decisions on whether to share data is highly dependent on how the question itself is framed (Bellman, Johnson, & Lohse, 2001). Sandrina Dimitrijevic (2014) argues that this behavior can be explained by the notion of bounded reality. The idea is that individuals are limited when making decisions by their computational power, cognitive bias, information and time (Kahneman, 2003; Simon, 1997). Bounded rationality is important because it prevents informed consent, which is very important from a legal point of view, and from an ethical and moral one as well. The GDPR is a big step in the right direction, since it gives more power to the data subject over his/her data.

Figure 13: Legal basis provided by the General Data Protection Regulation



Source: Insurance Europe (2016a)

The EU's approach to privacy and data protection can be distinguished from the US approach in the following: (1) EU believes in data privacy as a fundamental right, whereas the US legal tradition is different; (2) EU is mostly focused on privacy invasion by big corporations, whereas the US cares more about invasion by government; and (3) EU believes in comprehensive legislation, hands-on, whereas the US supports self-regulation and a more hands-off approach (Esteve, 2017). However, big companies can be sued in both US and EU courts for unlawful practices with personal data, although the GDPR provides users with more complete protection. The question is whether the market is capable of 'self-regulation'. It seems that big US companies, such as Facebook and Google, are taking advantage of this self-regulation and the fact that consumers are not fully aware of what personal data they are giving up. Figure 13 illustrates the legal basis provided by the GDPR on which life and health insurers process their client's data.

Since data will become a core asset and a competitive advantage in the data paradigm, data security and governance will become increasingly important for EU life and health insurance companies. The right to be forgotten, data access and portability means that companies must have data readily available, which require extensive retrieval of archived e-mails and other electronic files. The argument could also be made that the GDPR might be a breakthrough for new economic creativity since data security could become a locational factor in the data paradigm. When the EU is striving for better privacy and data protection legislation it triggers investments, which could expand the market for Internet security and give European companies a competitive advantage relative to their US counterparts. Regulation, legal actions and resistance will be necessary to secure privacy and data protection in the future of surveillance capitalism. Thinking of the future, Zuboff (2014) asks an interesting question: "*Will we be masters in a community of masters, or … unwitting slaves subdued by interests beyond our influence or understanding?*" and states: "*If the digital future is to be our home, then it is we who must make it so*". Privacy rights will undoubtedly receive more attention as the data paradigm moves forward. The same is true for big data ecosystems and Public Private Partnerships that can increase the value for money of EU's healthcare system, which is the topic of the following discussion.

7.2. Public Private Partnership (PPP) in healthcare

Central to the European social model is that economic and social progress must go together (Constantineschu, 2012). A partnership between the public and private sector is based on the assumption that there is a set of advantages specific to the private sector, it is more competitive and efficient, while the public sector is more responsible toward the society and public spending. Recall Figure 12, which illustrated the changes in distribution of insurance premiums as a result of individual risk assessments in the data paradigm. As a society we might ask:

> *"Given insurers' increasing ability to accurately price risks, do we want to charge individuals the price that reflects their risk level or do we sometimes want to ensure that everyone has access to affordable insurance? At what point do we want to interfere with a free market?"* (Swinhoe et al., 2016, p. 21).

The problem is that some risk factors are within the control of the individual, such as improved fitness and diet, whereas other factors are uncontrollable, such as genetic make-up. A closer relationship between the public and private sector can help securing affordable health care for all. However, the two parties' approach to health insurance is currently completely different. The public sector simply intends to offer equal health services for the entire population, according to accepted standards and legal rights (Constantineschu, 2012). One reason for using PPP in healthcare is the ability of private companies to experiment with new technologies in a less sensitive context and then provide governments with 'safe' technology options to avoid public criticism. Successful PPPs requires: relative equality between the partners, mutual commitment to health objectives, autonomy for each partner, shared decision-making and accountability, equitable returns and benefits to the stakeholders (Raman & Bjorkman, 2009).

In the data paradigm, both insurers and governments will own big health data on individuals. With the power of big data analytics private insurance could increasingly take the role of the welfare state in the EU. As previously mentioned, there is significant value in influencing customer behavior through premium pricing based on individual behavior and lifestyle. This can also make individuals more aware of preventive measures, such as health checks, which is better for the consumers, the state and of course the insurance companies. Forming PPPs throughout EU could allow big health data from governments and private companies to guide the welfare state to lower spending on healthcare. A report by McKinsey (Groves, Kayyali, Knott, & Van Kuiken, 2013), define five new value pathways for big data in healthcare:

1. Right living: Informed lifestyle choices to help patients remain healthy, such as diet and exercise.
2. Right care: Ensuring that patients get the most timely, appropriate treatment available.
3. Right provider: Care provider and setting that is most appropriate to deliver the best outcome.
4. Right value: Ensuring cost-effectiveness of care, such as tying provider reimbursement to patient outcomes, or eliminating fraud, waste, or abuse in the system.
5. Right innovation: Advance the frontiers of medicine and R&D productivity in discovery.

Using big data can help doctors make better choices more quickly on the basis of data collected by other medical staff and insurance companies. Patients will benefit from more timely and appropriate treatment. Furthermore, analyzing large clinical datasets can result in the optimization of the cost and clinical effectiveness of new drugs and treatments. Since 2016, the European Commission has entered into a PPP with industries, researchers and academia in order to cooperate in data-related research and innovation, enhance community building around data and to set the grounds for a thriving data-driven economy in Europe (European Commission, 2014). Fostering a partnership between relevant stakeholders in biomedical and health research, both public and private, will be essential to leverage big data and implement an elaborate ecosystem to tackle health challenges (Science Europe, 2014). One such partnership is My Health, My Data (MHMD), which aims to change the existing models of privacy and data protection by introducing a distributed, peer-to-peer architecture, based on Blockchain and Personal Data Accounts (European Commission, 2017). As explained, individuals are often not able to have a clear understanding of who uses their personal information and for what purposes. The objective for MHMD is to find "*new mechanisms of trust and of direct, value-based relationships between people, hospitals, research centers and businesses*" (European Commission, 2017). Furthermore new data models are required for collect, share, integrate and analyze good quality and multi-dimensional big data. It is necessary to develop PPPs, thus enabling a big health data ecosystem based on an open data-sharing model. This will enable stakeholders to efficiently retrieve, exchange and analyze data, while ensuring EU citizens' right to privacy. EU life and health insurance companies could play an important role as data suppliers, but also as contributors to the knowledge network through big data analytics in their quest for risk minimization. It is necessary to develop data-sharing protocols and interoperability of databases to provide better health services, while also solving the issue of data privacy, in the data paradigm.

8. Conclusion

This thesis addresses a gap in the research literature on big data where most studies are conceptual in nature (Frizzo-Barker et al., 2016). Very few studies have focused on the critical and ethical aspects of big data, and even fewer have focused on insurance and big data.

The purpose of this thesis has been to analyze the developments in data-centric technologies and its influence on the competitive structure of the European life and health insurance industry. The analysis has shown how technological innovation and transformation plays a central role in industry competition. Furthermore, it shows how these economic forces of competition act a selective device for the technological trajectories that eventually become established as technological paradigms. The analogue paradigm in insurance was characterized by manual labor and limited capabilities in mainframe computing. Towards the end of the analogue paradigm, most life and health insurance companies had transitioned to a semi-automated, and technologically enhanced, version of the original analogue model of insurance. The introduction of computers was driven by a competitive requirement to automate. This pursuit of automation formed the technological trajectory, which led to the establishment of the digital paradigm. Here, the Internet played a central role since it allowed insurers to access new distribution channels and increase efficiency in their operations. Lastly, the possibility to connect things and people with the Internet has formed the current technological trajectory towards information and data collection. The data paradigm is only beginning and it has the power to transform not only business operations, but also the general insurance model of risk pooling. Big data analytics, machine learning and IoT has the potential to disrupt traditional life and health insurance through individual and dynamic risk assessments. Established companies will experience heavy competition from smaller players seeking to leapfrog their larger competitors through technological innovation and strategic partnerships. In the data paradigm, insurers must apply technologies from areas outside their field of expertise, such as data science, software programming and IT architecture.

Using Porter (1979) and Dosi's (1982) theoretical frameworks together the analysis illustrated how technology has influenced the collection, processing and use of data in insurance and, as a result, intensified the competitive structure of the industry throughout the paradigms. This also revealed the relationship between economic forces and the relatively autonomous momentum that technological progress appears to maintain. Although the insurance industry alone cannot dictate the technological progress of the world or other industries, it can influence the general trajectory. The way technology and innovation accumulates speaks in favor of the preferred conservative strategy towards technological innovation in insurance. Although the adoption rate of new technology has been slow for health and life insurance companies, the economic forces will act as a selective device for the technological paradigms by choosing the companies and technologies that are better at generating value for the consumers. As the data paradigm is starting to materialize, its success will be determined by the access to the necessary capabilities in data-centric technologies and advanced analytics.

Besides the economic factors, institutional and social factors will also play an important role in the beginning of this paradigm, acting as selective devices for big data analytics can be used without restricting access to affordable insurance or violating privacy rights. The question is whether consumers are ready to sacrifice some privacy for the rewards of customized insurance products. Concerns may arise over the use of private health data: What type of data may be collected? Who owns the data? What may it be used for and whom may it be passed onto? The EU is making big waves with the GDPR entering into force in a couple of months, but future research should analyze how the GDPR is influencing the use of data-centric technologies in the insurance industry. Will it be enough to protect its citizens without putting unnecessary restrictions on the use of data and thus risk placing EU life and health insurers at a disadvantage relative to their US competitors? Furthermore, with data becoming the new gold standard in the data paradigm we might want to think about interfering with a free market through PPPs. Ensuring affordable and better insurance should be a key objective for the EU. Future research should focus more on the role of insurance companies in PPP's and how their increasing ability to collect, process and analyze data can help improve EU's healthcare system.

Although the data paradigm will inevitably change the game for virtually every industry, it also changes the playing field by favoring some industries in the early stages of adoption. The EU life and health insurance industry is one of those industries where the opportunities for value-creation are highest. But since surveillance is central to the data paradigm we have to create a digital future where our privacy rights are well protected or we risk becoming slaves to a new genus of capitalism.

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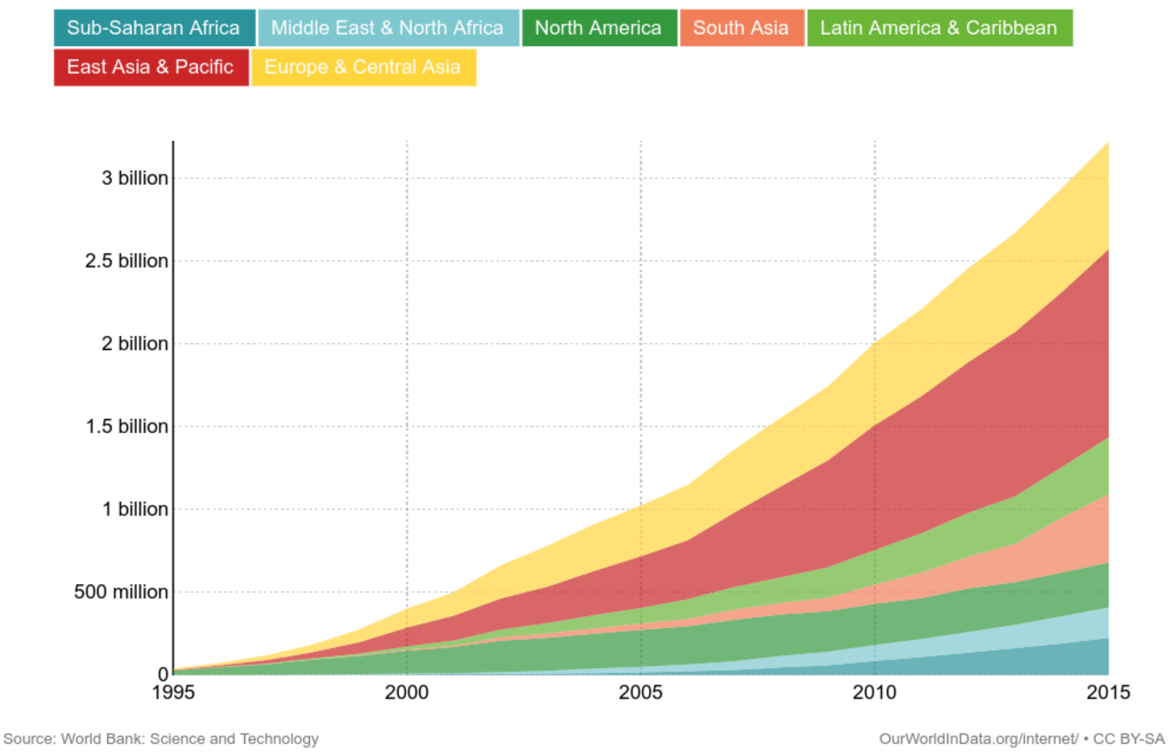
10. Appendices

Appendix 1 – Number of Internet Users Worldwide 1995-2015



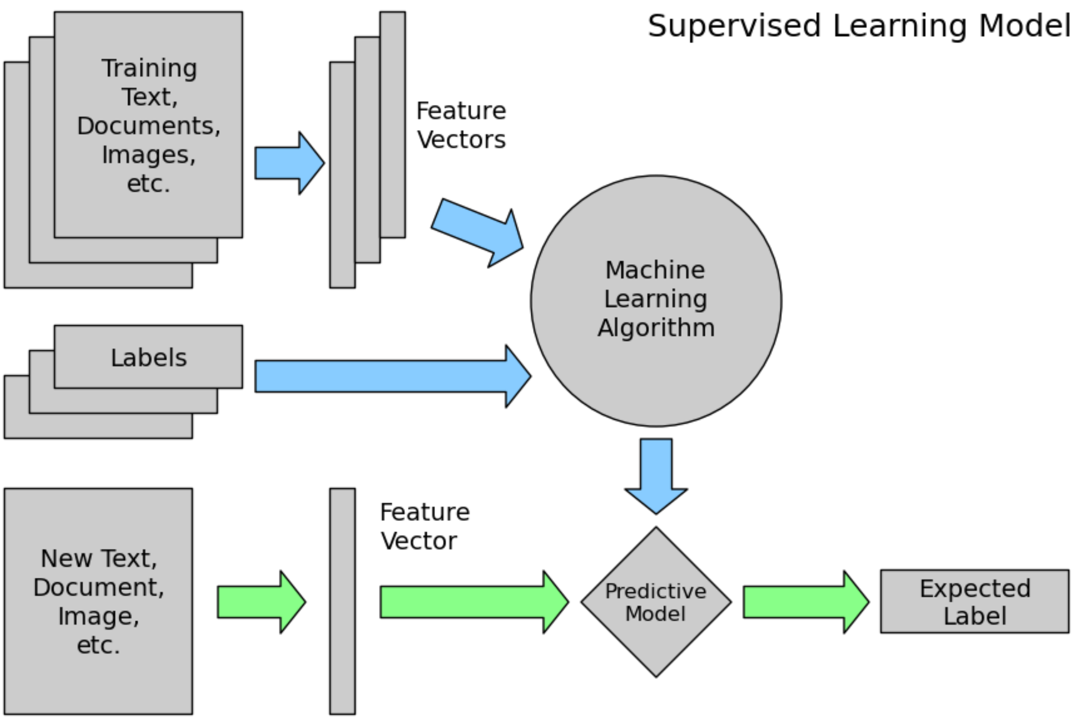
Year	Internet Users	Penetration (%)	World Population	1Y User Change	World Pop. Change
2016	3,424,971,237	46.1 %	7,432,663,275	7.5 %	1.13 %
2015	3,185,996,155	43.4 %	7,349,472,099	7.8 %	1.15 %
2014	2,956,385,569	40.7 %	7,265,785,946	8.4 %	1.17 %
2013	2,728,428,107	38 %	7,181,715,139	9.4 %	1.19 %
2012	2,494,736,248	35.1 %	7,097,500,453	11.8 %	1.2 %
2011	2,231,957,359	31.8 %	7,013,427,052	10.3 %	1.21 %
2010	2,023,202,974	29.2 %	6,929,725,043	14.5 %	1.22 %
2009	1,766,403,814	25.8 %	6,846,479,521	12.1 %	1.22 %
2008	1,575,067,520	23.3 %	6,763,732,879	14.7 %	1.23 %
2007	1,373,226,988	20.6 %	6,681,607,320	18.1 %	1.23 %
2006	1,162,916,818	17.6 %	6,600,220,247	12.9 %	1.24 %

Year	Internet Users	Penetration (%)	World Population	1Y User Change	World Pop. Change
2005	1,030,101,289	15.8 %	6,519,635,850	12.8 %	1.24 %
2004	913,327,771	14.2 %	6,439,842,408	16.9 %	1.24 %
2003	781,435,983	12.3 %	6,360,764,684	17.5 %	1.25 %
2002	665,065,014	10.6 %	6,282,301,767	32.4 %	1.26 %
2001	502,292,245	8.1 %	6,204,310,739	21.1 %	1.27 %
2000	414,794,957	6.8 %	6,126,622,121	47.3 %	1.28 %

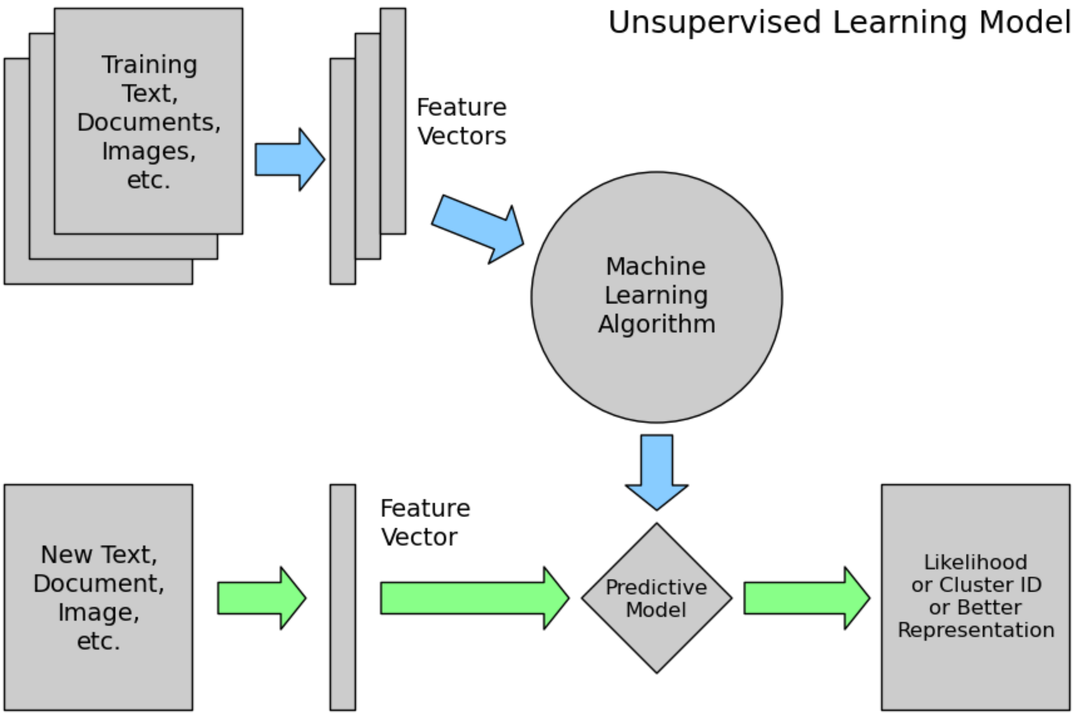
Sources:

1. Murphy and Roser (2017) Internet. Retrieved from: https://ourworldindata.org/internet/
2. Internet Live Stats (2016), Retrieved June 21, 2017, from http://www.internetlivestats.com/internet-users/

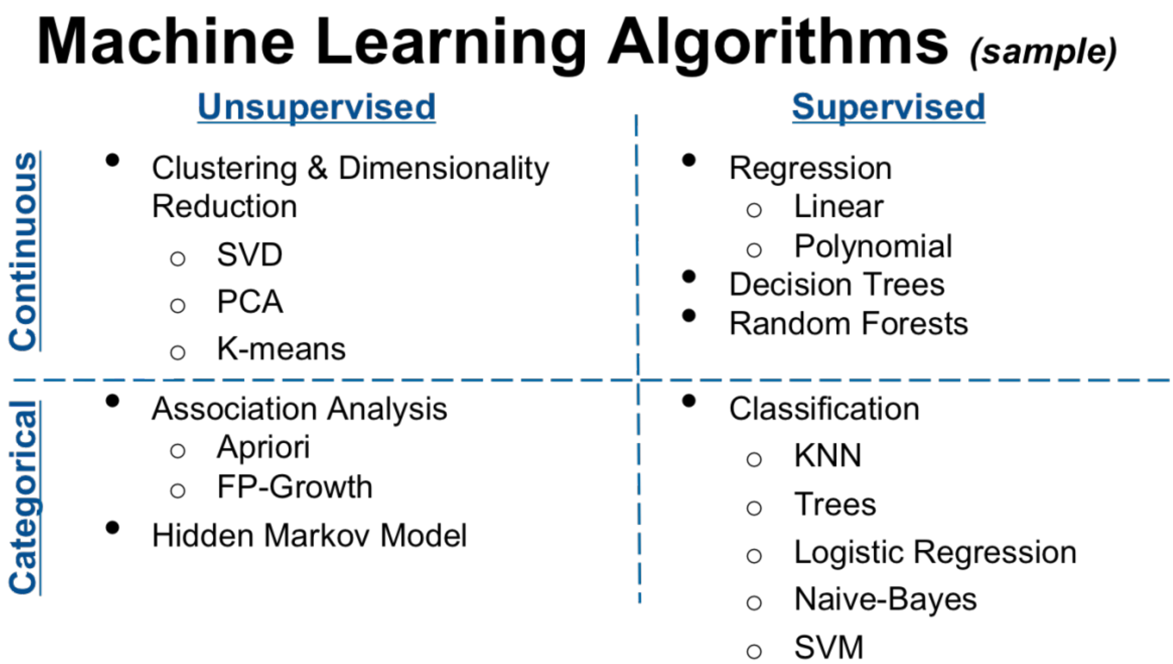
Appendix 2 – Supervised vs. Unsupervised Learning Models



Source: Amit Kumar (2015),



Source: Amit Kumar (2015),



Source: Hackbright Academy (2015)