A COMPILATION OF STUDIES ON INNOVATION IN FIRMS: PERSISTENCE, STRATEGIES, AND CAPABILITIES

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Een compilatie van studies omtrent innovatiepotentieel van bedrijven:
het belang van blijvendheid, strategieën en competenties
(met een samenvatting in het Nederlands)

Proefschrift

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door

Mikko Uolevi Pohjola
geboren op 24 februari 1977
te Kerava, Finland

Promotor: Prof. dr. dr. S. Kraus
Co-promotor: Dr. A. Koponen

To Ilona, Aamu, and Viima

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Dear reader,

Since this book is actually, physically in your hands, it must mean that I have successfully defended my dissertation. Wow. There were times, when I definitely was not the first one believing it would to happen!

During this journey, I have learnt, if nothing else, that I am a people person. An example of this is the fact that this dissertation, would not have been completed had it not been for the support from my family, guidance of my supervisors, and help from colleagues and friends. For me this journey was about the people around and with me during its duration. I want acknowledge these numerous individuals who helped me take this journey to its successful finish. After working on a project as long as I have, this list of people is immensely long and at this point, I am sure I will forget to mention some of them along the way. So, do forgive me, if you are not listed, it is not intentional.

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Dear reader, I am extremely happy to, finally, be at this stage of the journey, where it has come time to move on to new challenges. This means saying a goodbye to the academia - for a while, at least. However, if you find the studies in this dissertation interesting, please, do not be a stranger, but let me know and let’s have a chat over a beer or two!

In the warmth of Menorca, Spain
September 2013

Mikko Pohjola

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CHAPTER 1: OVERVIEW AND SUMMARY OF THE DISSERTATION

1. Introduction

Innovation in firms and the determinants of such innovation have been subjects of increasing interest for the last half a century within the social sciences. Especially in the last twenty years or so, scholars have tried to understand the organisational antecedents of innovation and the process and the capabilities within firms that lead to successful innovation output. Scientific research on the concept of innovation dates back to the early 20th century and the seminal works by Joseph A. Schumpeter (1934, 1939, 1942). Schumpeter's research has been the most important guiding framework in the establishment of social science research on innovation. As interest in entrepreneurship and innovation research within the fields of economics, management studies and sociology in the last 30 years has increased, interest in the work of Schumpeter has also increased (Becker & Knudsen 2009). The contemporary innovation literature, however, owes at least as much to the work by Nelson & Winter (1982) and their highly influential book "*An Evolutionary Theory of Economic Change"*. Together with scholars such as Giovanni Dosi (1982), Nathan Rosenberg (1982) and Keith Pavitt (1984), research on innovation began to emerge as a new scientific field incorporating the themes raised in the works of Schumpeter. Due to these contributions, during the last two decades research on innovation at the organisational level has witnessed a dramatic development (Castellacci et al. 2005). The aim has been to open the "black box" of the firm and understand the processes and determinants of innovation.

The dissertation continues this strand of research by introducing six research papers that address the determinants and effects of innovation from different perspectives. The unifying aim of these papers is to increase our understanding of organisation level differences in innovation activity, output and effects within organisations, while focusing on the capabilities and strategies with which organisations pursue new products, processes and organisational structures. This thesis contributes to the research tradition within the field of Innovation Studies, namely the determinants of innovation and the innovative capabilities of firms.

Thematically, the dissertation is organised around two core themes: organisational capabilities, and the innovation strategies of firms. Organisational capabilities are examined in chapters 2, 4, 6 and 7. Innovation strategies are studied in chapters 3 and

5. These two specific themes of innovation on the organisational level are addressed in the six chapters that can be divided into three topics. These are innovation persistence, innovation in family firms, and organisational (dynamic) capabilities. The outcome variable in this dissertation, organisational performance, is analysed from two perspectives, innovation performance (covered in chapters 2 to 4) and firm performance (covered in chapters 5 to 7) or evolutionary fitness – as firm performance is defined in the dissertation.

The dissertation is structured to address the research problems and is divided into three topics as presented in Table 1, which also includes the titles of the studies that make up the dissertation, including the names and affiliations of the co-authors. The topic of innovation persistence is addressed, in the first two studies, which focus on the ability of firms to innovate continuously. Next, the study analyses differences in organisational characteristics by looking at the specific organisational domain of the family firm. In those two studies both the antecedents and the effects of different forms of innovation in family firms are compared to nonfamily firms. The last two chapters, on the topic of organisational capabilities, explicitly address intrafirm differences and develop work on dynamic capabilities, their relationship to innovation and their effects on organisational performance. *Chapter* 8 presents the discussion and conclusions of the core studies of this dissertation.

This introductory chapter is organised as follows. The next section discusses the theoretical framework on which the studies in this thesis are founded. The third section introduces the empirical strategy applied in the thesis, including the datasets, methodological choices and reasoning behind them. The fourth section provides a summary of the research papers (chapters 2-7), which make up the core of the thesis as presented in the three topics described above.

Table 1.1. Dissertation overview and summary[1]

Topic	Chapter	Title	Co-Authors
Innovation persistence	2	Persistence of product innovation: Comparing breakthrough and incremental product innovation	Tommy H. Clausen (University of Nordland, Norway)
	3	Innovation strategies as a source of persistent innovation	Tommy H. Clausen, Koson Sapprasert (University of Oslo, Norway) & Bart Verspagen (Maastricht University, Netherlands)
Innovation in family businesses	4	Exploring Relationships among Proactiveness, Risk-Taking and Innovation Output in Family and Non-Family Firms	Justin B. Craig (Bond University, Australia), Soren Jenssen (Copenhagen Business School) & Sascha Kraus (Utrecht University School of Economics, Netherlands)
	5	Innovation in family firms: an empirical analysis linking organisational and managerial innovation to corporate success	Sascha Kraus and Aki Koponen (University of Turku, Finland)
Organisational capabilities	6	Dynamic capabilities and firm performance in a financial crisis	Hannu Makkonen (University of Turku), Rami Olkkonen (University of Turku), and Aki Koponen
	7	The hierarchical structure of dynamic capabilities and evolutionary fitness of the firm	Pekka Stenholm (University of Turku);

[1] Tables and figures are numbered in the following way throughout the dissertation: *chapter[.]running nr. of item*. In the text only the running number is displayed.

2. Theoretical background

2.1 Innovation studies

The overarching theoretical discipline under which this thesis can be positioned, is the field of innovation studies (see e.g. Fagerberg & Verspagen 2009). Innovation studies is an emerging scientific field, which has emerged as part of a broader trend resulting from the increased diversification and specialisation of knowledge that is blurring traditional boundaries and challenging existing patterns of organisation within social science (Fagerberg & Verspagen 2009). Fagerberg, Fosaas & Sapprasert (2012, 1) define innovation studies as "*the scholarly study of how innovations take place and what important explanatory factors and economic and social consequences are"*.

The field of Innovation Studies is, by nature, a multidisciplinary strand of social science research (Castellacci et al. 2005). In this thesis, the underlying research questions are fundamentally related to innovation, however, they are also closely related to the core issues of the entrepreneurship literature and strategic management. This dissertation is itself an example of the multidisciplinary nature of Innovation Studies – due to its presentation of six papers from different subdisciplines of innovation studies. The overarching approach is innovation management, ranging from the economics of innovation to entrepreneurship and organisational (dynamic) capabilities. Table 2 shows related subdisciplines for each of the studies.

Theoretically the thesis is closely linked to the entrepreneurship literature through the evolutionary perspective, especially as introduced by Howard Aldrich (1999), as it emphasises the evolution of organisations. Entrepreneurship research has played a central role in the development of research on innovation. The reason for this is that the most significant contributor to both contemporary innovation and entrepreneurship research is Joseph A. Schumpeter. Shane and Venkataraman (2000, 218) define entrepreneurship research as "*the scholarly examination of how, by whom and with what effects opportunities to create future goods and services are discovered, evaluated and exploited.*" It is clear that innovation studies and entrepreneurship research overlap to a large extent. However, after over thirty years of field development in entrepreneurship research and innovation, the fields have not yet fully integrated (Landström, Harirchi & Åström 2012). Parallel development has been experienced in the field of management as well, where innovation management has received increasing attention (e.g. Teece 1986) and become an integral part in the development of innovation research. The innovation management literature, within the field of strategic management literature, has merged both economic and

sociological approaches to innovation, especially through the work of Nelson & Winter (1982) and the concept of organisational capabilities, which has witnessed increasing attention in the form of dynamic capabilities research (Teece et al. 1997; Winter 2003).

This dissertation focuses on the organisational determinants of innovation and, as described below, evolutionary economics has developed a working foundation with which to study these issues in order to conceptualise change and dynamics, which are fundamental to the understanding of innovation in firms. Thus, the natural theoretical framework spanning the different subdisciplines of innovation studies – and the studies in this dissertation – is evolutionary economics. Below, the general theoretical framework is discussed. In the following chapters, different elements of the evolutionary framework are taken into use.

Table 1.2. Theory and methods summary

Topic	Chapter	Related subdisciplines	Methodology	Data
Innovation persistence	2	Economics of innovation, innovation management	Regression analysis: dynamic random effects panel model	Norwegian Community Innovation & R&D Survey data
	3	Economics of innovation, innovation management	Multivariate methods: factor and cluster analysis; regression analysis: dynamic random effects panel model	Norwegian Community Innovation Survey data
Innovation in Family business	4	Entrepreneurship, innovation management	Confirmatory factor analysis, regression analysis	Innocas survey data, Finland 2009
	5	Entrepreneurship, innovation management,	Structural equation modelling	Innocas survey data, Finland 2009
Organisational capabilities	6	Innovation management, organisational capabilities	Structural equation modelling, qualitative case studies	Innocas survey, Finland 2009, Financial data Orbis Database, Qualitative case studies Finland, 2011
	7	Innovation management, organisational capabilities	Structural equation modelling	Innocas survey, Finland 2009, Financial data Orbis Database

2.2 Approaching Innovation

The scientific study of innovations goes back to the seminal work by Schumpeter, who defined innovation as new combinations (Fagerbreg 2003, Schumpeter 1934). He gave a typology of these new combinations: new input, product, process, or market. He also added a fifth combination called new ways of organising the entire economic system or a subset thereof. These new combinations introduce novelty into the economic system, forcing firms to change or exit. This leads to what Schumpeter described as *creative destruction* – innovations leading to the destruction of competitive advantages and old ways of doing business (Schumpeter 1942).[2]

In his early work, Schumpeter focused on the entrepreneur as the causal mechanism for innovation and creative destruction. However, in the *Theory of Economic Development* he shifted the focus to the function of "carrying out new combinations," which were shifted in *Capitalism, Socialism, and Democracy* to emphasise the role of large corporations instead of individual entrepreneurs (Becker & Knudsen 2009, Schumpeter 1934, 1942). Later, the labels, Schumpeter mark I and Schumpeter mark II, have been used to distinguish these two perspectives and have been discussed extensively in the early literature on innovation studies that focused on the relationship between the size of the firm and innovation (e.g. Cohen & Levin 1989). The recent literature has continued to develop the organisational aspect of innovation, shifting the focus towards the "black box" of the firm.

One of the most significant contributions to modern innovation research is the so-called chain-linked model of innovation (Kline & Rosenberg 1986). The chain-linked model emphasises three core characteristics of the innovation process. First, innovation is understood as not a linear process, but as a process involving many interactions and much feedback during knowledge creation. Second, innovation is viewed as a learning process. Third, innovation does not solely depend on scientific knowledge. After Kline & Rosenberg's (1986) seminal contribution, the general view of the innovation process in the field of innovation studies can be linked to the idea that the traditional linear model of innovation is too simple a view of the innovation process. This dissertation incorporates the view generally held in innovation studies that innovations and the innovative process is a collective, uncertain, nonlinear, cumulative phenomenon, which mostly takes place in firms or other profit seeking, entrepreneurial organisations.

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[2] The emphasis on Schumpeter is, by no means, meant to downplay the importance of other seminal scholars who have contributed to the study on innovation, such as Kenneth J. Arrow or Alfred Marshall. However, Schumpeter has played a major role on the development of evolutionary economics, the underlying theoretical framework of this dissertation as well as the discipline of Innovation Studies, thus he is regarded as the leading scholar in this introductory chapter.

2.3 Innovation and Evolutionary Economics

Innovation is the one of the core concepts in evolutionary theorising, thus evolutionary economics has naturally become one of the most important theoretical foundations for studying innovations in organisations. Evolutionary theory is, in general, concerned with how social structures transform themselves from within (Stoelhorst 2008). From the perspective of innovation studies on the level of the firm, this means that the focus is on how organisations, as collections of individuals, are able to renew themselves and create new solutions to existing and new problems. The most influential strand of evolutionary thinking is the research stream created by the seminal research of Richard Nelson and Sidney Winter (Nelson & Winter 1982). In building on the ideas of Schumpeter, contemporary evolutionary economics emphasises the central role of innovation in economic development (Fagerberg 2003). To understand why evolutionary economics is fundamental to innovation studies, a brief introduction of the basic assumptions and principles of evolutionary theory, which provide the overarching principles of the theoretical and empirical approach to the economic and organisational analysis of innovation, is given.

In evolutionary theory, two issues are fundamental: first, the causal mechanisms, which produce different behaviour patterns and, second, the dynamic process of selection, which resolves these different behaviours into patterns of change (Metcalfe 1998). The reason for innovation becoming a central part of evolutionary economic theory is that innovation is the driving force of this change, introducing new variety to the economic relationships (Fagerberg 2003). This change is based on the three defining principles of the evolutionary process, namely the principles of variation, inheritance (or retention), and selection (Aldrich 1999, Campbell 1965, Metcalfe 1998). As Hodgson and Knudsen (2010) show, in evolutionary explanations, first, there must be some explanation of how variety is generated and replenished in a population. Second, there must be an explanation of how useful information concerning solutions to particular adaptive problems is retained and passed on. Third, there must be an explanation of the fact that entities differ in their longevity and fecundity. This is where the principle of selection comes in. Selection refers to the mechanism that brings about the survival of some variations rather than others, often reducing variety. Aldrich (1999) also includes competition over scarce resources as one of the evolutionary principles, which stems from the selection process. However, competition is the result of the three principles operating within the space of limited resources (Stoelhorst 2008).

For the evolutionary principles to exist, an evolving, economy, market or organisation, or “complex system” as they are called, must have three characteristics (Hodgson & Knudsen 2010). The system must involve populations of entities of specific types. These types are similar in key aspects, but within each type, the individuals vary. The entities within the populations have limited capacities to

consume materials and energy in order to survive, but they are able to process information about their environment. These entities face local and immediate scarcity. Together this means that the entities are engaged in a struggle for existence. Finally, these entities have the capacity to retain and pass on to others workable solutions to problems faced in the struggle for existence. In short a complex system involves populations of non-identical entities that face the problem of locally scarce resources and problems of survival.

These underlying foundations of evolutionary economics are called population thinking (Fagerberg 2003, Mayr 1976, Metcalfe 1998). In other words, evolutionary economics looks at economic and social phenomenon as interactions within populations of heterogeneous agents. Population thinking moves the approach, from the specific characteristics of firms or individuals, towards the dynamics of the interaction of heterogeneous actors generating the "population". Selection usually refers to the market mechanism, while the creation of new variations is innovation, making innovation an inherently important topic for understanding the evolutionary nature of economic activity. Following Schumpeter, evolutionary economics builds on the idea that economic emergence is essentially a product of the combinatorial actions of entrepreneurial individuals or groups who bring together physical and organisational technologies, capital goods and human capital in novel ways (Foster & Metcalfe 2012). The entrepreneurial activity is endogenous to the economic system, because it leads to innovation, and thus is an intrinsic part of the introduction of variety. Schumpeter already emphasised this "entrepreneurial function" as the driving force of innovation (Schumpeter 1934, Fagerberg 2003).

The creation of variety is essential for economic evolution: selection by definition reduces variety and unless there are some new injections of variety, the system will converge to a stationary state and growth will disappear. The question of how variety is generated, i.e. how firms innovate, is closely related to the micro foundations of how organisations learn and act (Fagerberg 2003). For this reason, evolutionary economics has emphasised the important role of variety and variety generation in economic evolution.

From the perspective of the theory of innovation at the level of organisations, this means that technological knowledge is often tacit and embodied in the routines of organisations (Castellacci et al. 2005). Knowledge is created in collective intra- and inter-organisational processes, which make knowledge dynamic, cumulative and evolving over time. The individuals and organisations operate in an ever-changing uncertain environment, where they perform based on bounded rationality. These assumptions lead to the recognition of two central features of the innovation process: first, innovation involves the coordination and integration of specialised knowledge, and second, it requires learning in conditions of uncertainty (Castellacci et al. 2005). The nature of the innovation process is complex and encompasses the whole spectre of organisational processes. To manage the inherent uncertainty in the innovation

process, firms must continuously engage in activities of strategising, financing, and organising. Innovation requires the ability to transform technologies and access new markets (Castellacci et al. 2005). The different abilities organisations possess are a core focus when studying the evolution of a firm. This is related to firm behaviour and the role of knowledge in firms, especially from the perspective of organisational memory, routines and skills. Nelson & Winter (1982) introduced the concept of routines, which – as the behavioural elements of firms – are the building blocks of organisations.[3] These routines are replication mechanisms and focus on the learning processes of organisations (Metcalfe 1994). Replication mechanisms are the micro foundations, and based on "procedural" or "bounded" rationality and "satisfying" behaviour stemming from the work of Cyert & March (1963) and Simon (1959). The way organisations function under bounded rationality is that they rely on the routines as a decision rule on which to operate. Firms do not change these routines when they produce satisfying results. If, however, the environment changes or the mindset of the owners a firm wants to deviate from the old path and change, new routines are created in the process of change. This change is not, however, easy as firms tend to be inert and resistant to change.

Recent evolutionary theorising has distinguished routines from organisational capabilities, shifting the emphasis on to the capacity and ability to intentionally bring an action to a wanted result (Dosi, Nelson & Winter 2000). Capabilities are in this perspective the know-how that enables firms to perform their characteristic output activities, i.e. creating product or providing services. The central role of organisational capabilities in evolutionary theory is based on the idea that capabilities within the firm and their evolution over time explain why firms differ, i.e. the heterogeneity of firms. In organisational research on these building blocks, routines and capabilities are sometimes defined rather vaguely. However, this need not be the case, extensive conceptualisation has been conducted on the topic and it is widely accepted that routines are "*repetitive, recognizable patterns of interdependent actions, carried out by multiple actors*" (Feldman & Pentland 2003, Felin et al. 2012). Capabilities and routines are separate but closely related concepts. In this dissertation, we follow Winter (2000, 2003) who defines organisational capabilities as high level routines or collections of routines that "*confers upon an organisation's management a set of decision options for producing significant outputs of a particular type*". Felin et al. (2012) state that the fundamental differences between capabilities and routines are contained in their micro-foundations. To put it simply, the difference between routines and capabilities can usually be expressed in terms of flexibility and rigidity: activities, which need to be executed in a highly reliable manner, are rigid and often

[3] In the social sphere, in addition to routines, the mechanisms of replication are for example habits, customs and rules (Hodgson & Knudsen 2010).

standardized routines, while capabilities allow more for managerial discretion that involves flexibility (Felin et al. 2012).

3. Empirical strategy

3.1 Measuring innovation

When studying innovation, the way in which it is defined affects the way it can be measured and thus plays a significant role in defining the empirical strategy of the study. Traditional measures of innovation are patents and research and development (R&D) expenditures. However, a recently popularised measure of innovation is the innovation survey, based on the OECD's *Innovation Manual,* the so-called *Oslo Manual* (Smith, 2005). Innovation surveys based on the Oslo Manual have become one of the most widely used statistical attempts to capture innovation activities (Mairesse & Mohnen 2010). These innovation surveys rely on the views stemming from the works of Nathan Rosenberg (1976, 1982, Kline & Rosenberg 1986), which heavily influenced the creation of the OECD's *Innovation Manual* (Smith, 2005). The Oslo Manual was motivated due to the need to complement patent and bibliometric indicators and R&D surveys and was done with the aim of directly characterising the innovation process within organisations (Mairesse & Mohnen 2010). The measuring framework is based on the chain-linked model discussed above (Smith 2005).

The dissertation mainly utilises quantitative survey data to study the research questions posed. Two main sets of data are used in the six studies that constitute the core of this dissertation. In chapters 2 and 3 the main data source is the so-called Community Innovation Survey (CIS). The CIS is one of the most extensive innovation surveys conducted since 1993. It is a harmonised, EUROSTAT coordinated, Europe-wide innovation survey conducted bi-annually by national statistical offices. The first survey, CIS1, was conducted in 1993 and the next three waves, CIS2-CIS4, were conducted every four years, and since 2007 (CIS2006) the survey has been conducted every second year.[4]

The CIS data used in chapters 2 and 3 were obtained from four waves of Norwegian CIS (namely CIS2, 3, 4 and 2006) carried out by Statistics Norway. In addition to the actual CIS surveys, Statistics Norway granted access to a CIS and R&D survey panel spanning the years 1995 to 2001, which is used in addition to the actual CIS datasets. In Norway, responding to the innovation surveys is obligatory,

[4] For a good over view of the content and structure of the Community Innovation Surveys see (Mairesse & Mohnen 2010)

leading to response rates of over 90 %. It is also useful to note that CIS in Norway follows a slightly different scheduling from the European standard, i.e. CIS2 was conducted in 1998 and CIS3 in 2002, which is one year later than usual. In chapter 2, we also utilise Norwegian business registry data.

The second dataset used in chapters 4 through 7 is a questionnaire survey (henceforth the INNOCAS survey) conducted in 2009 by a group of researchers from Turku School of Economics in a research project funded by the Finnish Foundation for Innovation and Technology (Tekes). The INNOCAS survey is a quantitative survey targeting three specific sectors in Finland. The data represent Finnish firms operating in the food industry (NACE 10-11), the media sector (NACE 18, 58-61), and the shipbuilding cluster, including ship construction (NACE 301) and any sub-contracting sectors, such as furnishing and maintenance. Stratified sampling identified a sample of 2,227 firms from the official Business Register of *Statistics Finland*. The sample was the full population of all firms within these sectors with five or more employees and a random sample of the smaller ones. The data collection took place during computer-aided telephone interviews in late spring, 2009. The survey targeted a member of the top-management team of the firm in question, preferably the CEO or the owner-manager. The researchers approached the respondents in random order, and contacted each non-responding number multiple times on different weekdays and at various times of the day. A total of 535 responses came from the 2,227 firms, a response rate of 24 percent. Chi-square tests assessed non-response bias, the analysis taking into account the size of the 535 firms that responded and the size of those that did not participate in the survey. The size distribution of the participating firms turned out slightly, but non-linearly, skewed towards larger firms, which is a relatively typical outcome in this type of survey.

The reason for choosing the food industry, shipbuilding and the media sector for the population of the INNOCAS survey was three-fold. First, these sectors are not traditionally considered high-tech, highly R&D-intensive sectors, and have not been at the core of research on innovation or organisational capabilities (Easterby-Smith et al., 2009). In such industries, the capability to change and to innovate is more likely to distinguish firms from their competitors. Second, these sectors represent different types of industries, giving a broader perspective on the aspects of interest. Third, the three industries each face unique challenges regarding both long-term development and economic fluctuation. The maritime industry is the most open in terms of exporting the final product. The value of one purchase is hundreds of millions of U.S. dollars, which makes demand very volatile. The business environment of the media sector has witnessed a strong influence from the internet and ICT boom: new business opportunities have arisen, while, on the other hand, technology has made some traditional printing services obsolete. In the food-processing industry the international trend of concentration in the retail sector drives industry agglomeration, but, at the same time, health issues and preferences for local food leave room for

small innovative local players. Overall, the reasoning behind the choice of population did not affect the generalisability of the results to the whole population of Finnish firms, and was based on the need to distinguish the theoretical relationships in question.

In chapters 6 and 7, the INNOCAS survey is supplemented with the Orbis database (www.bvdinfo.com) which contains comprehensive information on the financial statements of companies worldwide. In the studies, the data are used for computing the relative growth rates of the individual companies. One important reason for using these data is to get objective information that was not gathered by the survey, in order to diminish the potential bias due to the common method variance related to the survey indicators.

3.2 Methods applied

Naturally, since the data gathering approach was based on surveys, analytical methods are quantitative and chosen to exploit the full potential of the data. Altogether, the methods range from different multivariate methods to panel regression and different combinations of these. An exception to the strict quantitative analysis is made in chapter 6 where a "mixed methods" approach is used to analyse how dynamic capabilities and innovation affect the performance of firms facing a dramatic economic downturn. Methodologically the six studies can be grouped into two categories. First, chapters 2 and 3 utilise merged CIS surveys, and thus mainly rely on panel methods. Second, chapters 4 to 7 utilise the INNOCAS survey and use structural equation modelling to test the posited hypotheses. In chapter *6*, qualitative case study methods are applied in addition.

Chapters 2 and 3 use the same basic estimation method. Namely, the studies estimate a dynamic random effects probit model for handling the initial conditions problem (the so-called Wooldridge method). When estimating dynamic non-linear models, i.e. models where lagged dependent variables are used as explanatory variables, it is important to take into account the unobserved heterogeneity, so as not to overestimate the past effect on the outcome. Wooldridge (2005) suggested that initial observation be included in the model to control for the firm specific unobserved heterogeneity. Together with innovation activity information from CIS2, in chapter 3, this method is extended by exploiting information about the firms in the initial period by utilising principal component and cluster analysis. In this way, it is possible to group the firms into different categories based on their innovation strategies and to further analyse the reasons innovation is persistent.

In chapters 4 and 5, we estimate group moderation models comparing the effects of innovation activity on different outcomes. These studies utilise confirmatory factor analysis, ordinary least squares regression, and structural equation modelling. The

empirical analysis in chapters 6 and 7 is based on hierarchical confirmatory factor analysis and structural equation modelling.

4. Summary of the studies

4.1 Innovation persistence

As described above, three specific topics of innovation on the organisational level are addressed. These are innovation persistence, innovation in family firms, and organisational capabilities.

The first theme focuses on the dynamics of innovation output, namely the persistence of innovation, which has recently received substantial academic interest. Innovation is generally said to be persistent if an innovation in the past positively and significantly predicts current innovation (Peters, 2009). Persistent innovation implies that the development of an innovation at one point in time constitutes an important source of knowledge that enables future innovations by the same organisation. Studies of innovation persistence address the question of whether there exists true state-dependence in innovation. True state-dependence means that a causal behavioural effect exists, in the sense that innovation in one period in itself enhances the likelihood of innovation in the subsequent period. A second source of persistence is the fact that firms may possess certain unobservable characteristics, which make them more likely to innovate continuously. To the extent that such characteristics themselves show persistence over time, they will induce persistence in innovation behaviour. If not controlled for, previous innovation may appear to affect future innovation merely because innovation picks up the effect of the persistent unobservable firm characteristics. Empirically, to control for this spurious state-dependence, the Wooldridge method is applied.

Previous research has been rather vague in addressing the theoretical reasons behind the phenomena and simply posited three types of possible explanations for innovation persistence. These explanations are “success breeds success”, “learning by doing”, R&D sunk costs. The first explanation refers to the idea that firms innovate again if previous innovations are successful, thus alleviating the financial and other constraints related to innovation activities. Learning by doing refers to the cumulative nature of knowledge, which makes firms more efficient in their innovative efforts over time. Third, the sunk cost explanation argues that innovation persistence is due to the fact that R&D activities are not easily discontinued on a yearly (or short-term) basis, resulting in continued innovation activity. The innovation persistence literature has been particularly atheoretic, focusing only on the empirical question of whether or not firms persist in their innovation activities over a long time period. Thus, the

studies in this dissertation are heavily motivated by theory. The first study, chapter 2, draws on recent advances within the technology and innovation management literature, addressing the importance of distinguishing between different types of product innovation, namely incremental or breakthrough. The second study on innovation persistence, chapter *3,* shifts the focus to a topic which has previously received little attention in the literature. This is the sources and determinants of innovation persistence. In this study it is proposed that differences in innovation strategies across firms are an important driving force behind innovation persistence.

The general finding in the literature is that product innovation is persistent. To further our understanding of the persistence of innovation, chapter *2* addresses a rather typical research question within the literature, i.e. is product innovation persistent or not. However, previous literature on innovation persistence has not made the distinction between incremental and radical innovation. Therefore, this study examines whether and to what extent breakthrough and incremental product innovation is persistent at the firm level. This is an important addition, because, if the distinction is not made, it hinders our understanding of the processes underlying the innovation activities of firms (Damanpour & Wischnevsky 2006).

The study shows that radical innovation is persistent, but that incremental innovation is not. This leads to the important conclusion that not addressing the type of product innovation gives a misleading view of the role of persistency in innovation. The study also shows that there exist persistent behavioural effects from past breakthrough innovation outputs, but not necessarily from innovation investments nor merely the adoption of technology and products developed by others. The results suggest that innovation persistence is driven by firm internal learning, or dynamic learning effects, and that these are manifest mainly when firms internally generate new product innovations that previously did not exist in the market.

The innovation studies literature has identified a number of different inputs that lead to increased innovation performance. Instead of focusing on one innovation or a few, in chapter 3 they are captured jointly by using the notion of an innovation strategy. The study proposes that the degree of innovation persistence observed in a particular firm depends on the specific mix of innovation inputs or sources the firm uses. This proposition, together with a novel empirical strategy for identifying the innovation strategies, is the key element of the study. The study suggests that the long-term nature of these innovation strategies accounts for differences in innovation and innovation persistence across firms. By utilising the variables available from the CIS dataset, five innovation strategies are identified by means of factor and cluster analysis. These are ad-hoc, supplier-based, market-driven, R&D intensive and science-based strategies.

The result also confirms the general finding in the literature that innovation is persistent at the firm level. The most interesting result in this study is that observed and stable firm heterogeneity in the form of initial strategic differences across firms

constitutes a key driving force behind a firm's likelihood to innovate. The results support the idea that the differences in innovation strategies across firms are an important determinant of the firms' likelihood to repeatedly innovate. The study shows that firms pursuing the strategies "market-driven," "R&D intensive" and "science-based" were more likely to be persistent innovators. The study also looked separately at both process and product innovation. The results show that – in the low-tech sector – persistent innovation is found mainly in terms of process innovation. In general, the results suggest that innovation strategies provide an additional, and important, source of innovation persistence in addition to the previously suggested theoretical reasons.

4.2 Innovation in family firms

The second topic focuses on innovation in a specific type of organisation, namely the family firm. Innovation has long been recognised as one of the key drivers of company success, but its role in family firms has been mostly neglected in existing academic research. Previous research on family firms has mostly focused on the question of how they differ from public corporations, describing family firms as being less entrepreneurial than their non-family counterparts. The extant literature also criticises the lack of innovation in family firms. In addition to the lack of research, innovation in family businesses is an interesting research topic for innovation studies. Organisations with different structural forms vary in their patterns of learning and knowledge creation, giving rise to different types of innovative capabilities (Lam 2005).

Within this topic, two studies focus on the determinants and consequences of innovation, and whether and to what extent family firms differ from non-family firms. The first study, chapter *4,* looks at the determinants of product innovation. The aim is to further the understanding of the determinants of innovation output by comparing family firms with non-family firms. The focus is on the possible differences in the effects of entrepreneurial orientation in these two types of firms. Two entrepreneurial orientation (EO) dimensions are set as determinants of the third, innovativeness. First, the study considers the propensity to aggressively and proactively compete with industry rivals, i.e. proactivity. Second, the study considers the tendency of the top management of firms to take risks regarding investment decisions and strategic choices in the face of uncertainty, i.e. risk-taking. The study explicitly focuses on the effects of the two dimensions on innovation output, although realising that traditionally they are analysed as a combination. In this way, the study follows recent work on entrepreneurial orientation, where it is recognised that the three dimensions occur in different combinations and represent different independent aspects of the multidimensional concept of EO (e.g. Covin & Slevin 2006, Pérez-luño et al. 2011,

Tang et al. 2008). The choice is also based on the underlying research goal of the dissertation: the focus on the organisational determinants of innovation output.

The study shows that, although family and non-family firms do not differ concerning product innovation intensity, they differ in how risk-taking and proactivity influences their product innovation intensity. The general finding is that proactivity is more important for family firms while risk taking is more important for the non-family firms. It is found that risk-taking does not increase innovation output, whereas product innovation increases through proactivity in the subsample of family firms. On the other hand, non-family firms gain from an inclination towards risk-taking. The findings also show that proactive family firms can more positively influence their innovation output than can proactive non-family firms.

Chapter 5 considers management innovations and their effect on product innovation and firm performance. Management innovations are an important – yet rarely studied – part of the innovation activities of firms (Birkinshaw et al. 2008). They are linked to both business model and product innovations and are an important source of renewal for firms. In the study, management innovations are divided into managerial innovation and organisational innovations. Organisational innovation refers to the organisation of work, management structure or relationships with external partners. Managerial innovation refers to innovations in management systems, knowledge management and supporting activities.

The aim of the chapter is to study the role of managerial and organisational innovation in family firms compared to non-family firms. In a similar vein to the previous chapter, the aim is not to determine whether family firms are as innovative as non-family firms, but whether there are important differences between family and non-family firms that have an effect on how firms innovate and what role innovations play in their organisation.

The study shows that the effects of management innovations on corporate success differ to some extent between family and non-family firms. For family firms, organisational innovations seem to be more important than managerial innovations. They have a positive relationship with overall success as well as product innovation intensity. This means that if a family firm rebuilds, for example, its organisation of work, its management structure, or its relationships with external partners, it is more likely to produce innovative new products and to grow. Organisational innovations were important antecedents for both family and non-family firms, although in the latter there was no direct relationship with corporate success, but only with increasing amount of product innovations. Managerial innovations again were only important in non-family firms, where they have a direct positive relationship to corporate success. This means that, for example, innovations in management systems, knowledge management, or supporting activities seem to be less important for family firms.

4.3 Innovation and organisational capabilities

In the third topic, covered in Chapters 6 and 7, the focus is on the intra-organisational elements of innovation and innovativeness, particularly the 'dynamic' organisational capabilities, and their relationship to firm performance.

The first study addresses the adaptive behaviour of organisations weathering the economic turmoil from the financial crisis of 2008. Thus, it addresses the core issues of the dynamic capabilities literature: how firms are able to adapt to the changes in their operational environment. The study contributes by giving a detailed analysis of dynamic capabilities and the environment in which firms operate. It approaches the relationship between dynamic capabilities and environmental instability from the perspective of the financial crisis of 2008, which led to a drastic economic downturn. Firms differ in how they experience crisis and the role of organisational capabilities is important in this. The paper also contributes to the literature by reporting an empirical analysis of both quantitative and qualitative data, testing for an indirect link to evolutionary fitness and investigating the relationship between dynamic capabilities and its mediating elements as well as organisational change and innovation. Studying how firms utilise and deploy dynamic capabilities in a financial crisis furthers the understanding of this multidimensional construct and the relationships between the different capability sub-dimensions.

The study has several interesting findings. First of all, a better evolutionary fit comes through sustainable renewal that positively affects an organisation's innovative performance, and not because of dynamic capabilities in themselves. Second, different dynamic capabilities may have different effects, depending on the competitive environment in which a firm operates. In particular, firms facing diminished business opportunities due to a financial meltdown benefit from renewing capabilities, whereas the results suggest that the effect is the opposite for regenerative capabilities. Third, the relative significance of the various capabilities seems to differ according to the level of turbulence. Higher-order dynamic capabilities, especially those related to observation and evaluation, seem to have a positive effect on firm performance in industries in which business opportunities have diminished due to turbulence in the business environment. On the other hand, firms in industries in which new business opportunities continue to arise – despite the economic environment – seem to benefit from both dynamic regenerative and renewing capabilities. Fourth, the qualitative case studies expose the longitudinal features of dynamic capabilities, which continuously enable and create a platform for a healthy business and evolutionary fitness during a period of financial crisis.

The findings show that a company can manage its fit with the environment, and that a better fit means better performance. However, the continuous process of identifying potential opportunities and threats, and the reconfiguring of the organisational resource base to exploit the opportunities and avoid the threats, is not

easy. The company must first overcome the structural inertia that inhibits the process and promotes stability. In particular, firms facing a lack of business opportunities due to economic uncertainty in the economy benefit from renewing capabilities, whereas the effect is the opposite for regenerative capabilities. A fair conclusion is that changing operational capabilities may not be beneficial to a firm in situations in which business opportunities suddenly disappear.

The following study tests more explicitly the characteristics of the various higher-level capabilities and their relationship to performance. Chapter *7* focuses on organisational capabilities and their relationship to firm performance in general, addressing the conceptual and theoretical issues raised in previous research. The study of the capability hierarchy has mainly attracted conceptual theorising, while empirical evidence about the complex relationship between the different levels and firm performance remains scarce. Therefore, the goal of the second paper in this section is to more directly address the hierarchical nature of dynamic capabilities and the relationship between the different capability dimensions and firm performance.

The findings of Chapter 7 reveal the complex relationships between dynamic capabilities and the evolutionary fitness of the firm. The results show that higher order, regenerative and renewing capabilities have an indirect positive influence on a firm's evolutionary fitness. Furthermore, the results show that regenerative capabilities are negatively associated with evolutionary fitness in the short run. The incremental capabilities also have a positive direct effect on the evolutionary fitness of firms, which supports the assumed mediating role of incremental capabilities in the relationship between higher order capabilities and a firm's evolutionary fitness. The results show that higher order capabilities enable a firm to increase its evolutionary fitness, especially when they are aligned with lower order incremental capabilities. Instead of resulting directly in increased performance, the study suggests that regenerative capabilities will enhance the use of dynamic capabilities on other levels. From this perspective, higher order capabilities are employed to utilise incremental capabilities to the fullest in the pursuit of better performance.

Table 1.3. Summary of the objectives, research questions and contributions

Topic	Chapter	General objective	Research question	Results
Innovation persistence	2	To further our understanding of the persistence of different types of product innovation	Whether and to what extent is breakthrough and incremental product innovation persistent at the firm level?	Innovation persistency varies according to the type of product innovation. Breakthrough innovations are persistent, but incremental innovations not, suggesting that it is driven by dynamic learning effects.
	3	To clarify the sources of persistent innovation output	Do firm specific innovation strategies explain innovation persistence?	Observed and stable firm heterogeneity in the form of initial strategic differences across firms constitutes a key driving force behind a firm's probability to innovate over time.
Innovation in Family business	4	The aim is to further the understanding of the determinants of innovation output in family firms.	Do family firms differ from nonfamily firms regarding proactivity and risk taking as determinants of innovation output?	The processes leading to product innovation differ between family and nonfamily firms. Family firms benefit more from proactivity and not from risk taking, while the opposite is true for nonfamily firms
	5	To further our understanding of management innovations in family firms.	Does the role of management innovations differ between family and nonfamily firms?	Product innovation intensity is positively related to corporate success. However, family firms gain from organisational innovation, while nonfamily firms from managerial innovation.
Organisational capabilities	6	To empirically analyse and develop our understanding of the relationship between DCs and the operational environment.	Are organisations able to adapt their behaviour when facing a financial downturn and if so, how do they do that?	Companies are able to manage their fit with the environment, even in turbulent economic settings, through the deployment of dynamic capabilities. However, the relative significance differs according to the type of capability.
	7	Introduce and develop a new measurement model for dynamic capabilities.	Whether and to what extent do dynamic capabilities lead to better evolutionary fit?	The results show that higher order capabilities enable the firm to increase its evolutionary fitness especially when they are aligned with lower order incremental capabilities.

CHAPTER 2: PERSISTENCE OF PRODUCT INNOVATION - COMPARING BREAKTHROUGH AND INCREMENTAL PRODUCT INNOVATION

1. Introduction[5]

An important research tradition within Innovation Studies (IS) has focused on understanding the sources of innovation at the firm level (e.g. Von Hippel, 1988; Chesbrough et al, 2006; Nelson & Winter, 1982; Lundvall, 1992). Empirical research has for instance focused on the role of R&D departments in the innovation process (e.g. Cabello-Medina et al, 2011), the role of different types of knowledge sources (e.g. Paananen, 2009), the role of R&D cooperation (with different types of partners) (e.g. Kang & Kang, 2010) and the influence of non-R&D based strategies for explaining innovation (e.g. Barge-Gil et al, 2011). In this paper we add to this line of research by analyzing whether or not the development of an innovation in one point in time constitutes a source of innovation that enhance firms' ability to develop an innovation at a later point in time. Our research thus differs from the traditional "determinants of innovation" research within IS that has adopted a cross-sectional approach to the study of the sources of innovation at the firm level (Damanpour et al, 2009). We follow the argument that by taking time into account, new issues can be examined and new research questions can be answered that can add to our knowledge about innovation at the firm level (Damanpour et al, 2009).

In this paper we focus on comparing breakthrough product innovation – defined as product innovations that are new and previously unknown to the market the firms operate in – and incremental innovation – defined as innovation that are new to the firm but *not* new to the market and whether these types of innovations are persistent at the firm level. Innovation is generally said to be persistent if an innovation in the past (i.e. lagged innovation) positively and significantly predicts current innovation (Peters, 2009). Hence, persistent innovation implies that the development of an innovation at one point in time constitutes an important source of innovation that enables future innovations by the firm. Recently, the issue of whether or not innovation is persistent at the firm level has generated substantial academic interest

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(e.g. Peters 2009; Antonelli, Crespi & Scellato 2010; Raymond et al. 20010; Clausen et al, 2011).

Studies of innovation persistence are oriented towards the discovery of what is called true state-dependence. True state-dependence means that a causal behavioral effect exists, in the sense that innovation in one period in itself enhances the probability to innovate in the subsequent period. A second source of persistence besides lagged innovation is that firms may possess certain characteristics which make them more likely to innovate, such as firm size. To the extent such characteristics themselves show persistence over time, they will induce persistence in innovation behavior. If not controlled for in a regression analysis, past innovation may appear to affect future innovation merely because it picks up the effect of the persistent unobservable firm characteristics. In contrast to true state dependence this phenomenon is therefore called spurious state dependence (Peters, 2009). The literature on innovation persistence has subsequently analyzed to what extent innovation in firms is driven by true state-dependence.

Several recent empirical studies on the topic of innovation persistence have been conducted. The general finding among the recent studies in the literature on innovation persistence is that previous innovation significantly and positively predicts current innovation (e.g. Flaig & Stadler 1994, Peters 2009, Raymond et al. 20010; Clausen et al, 2011). In this paper we aim to add to the innovation persistence literature by comparing the possible difference in persistence between breakthrough and incremental product innovation. Examining this issue is important and addresses a gap in the current literature on innovation persistence at the firm level: One shortcoming in the innovation persistency literature is that no study (to the authors' knowledge) has compared different types of product innovations when examining persistency. Instead, prior studies have grouped different types of innovations under the overall heading of "product innovation" when examining persistence.

The previous literature has shown that innovation output, in particular, is driven by this persistency effect, for both product and process innovation (e.g. Clausen et al, 2011). However, differences between the types product innovation have been studied to a lesser extent, although research in the innovation studies tradition would suggest that we are likely to find these differences due to their different nature. As argued by recent studies, the inability to distinguish between types of innovation hinders our understanding of innovation (Damanpour & Wischnevsky, 2006). In order to increase our knowledge about the possible persistent nature of breakthrough and incremental product innovation this paper asks the following research question: Whether and to what extent is breakthrough and incremental product innovation persistent at the firm level?

This paper is organized as follows: In the next section we discuss theory and prior empirical studies related to innovation persistence. The methodology, data and variables used in the analysis are discussed in section 3. The empirical analysis is

conducted in section 4, which is accompanied by a discussion of the empirical results. We draw some conclusions and implications for further research in section 5.

2. Innovation persistence

Joseph Schumpeter (1934) was one of the first to provide an analysis of the importance of innovation for economic change. He devised a "model" where endogenous technological change is an outcome of investments made by business firms to compete and beat their rivals (Nelson, 1995). According to this view, economic growth occurs through a process of creative destruction where the old industrial structure – its product, its process, or its organization – is continually changed by innovation (Link, 1980). Inspired by Schumpeter's work, research within evolutionary economics and strategic management has highlighted innovative activity as a major source of innovation and economic progress (Nelson & Winter, 1982; Nelson, 1991).

Drawing on Schumpeter's seminal work, recent research within strategic management and evolutionary economics argue that companies need to be entrepreneurial and put innovation at the forefront of the firms' competition strategy (Teece, 2007). Reasons are that new products are a central driving force behind firm performance and profitability (Teece, 2007; Amara et al, 2008) and that such innovations are central to organizations' ability to adapt themselves to changing market conditions (Nijssen et al, 2005; Bessant et al, 2005). Hence, strategic management research argues that firms need to innovate on a continuous basis in order to survive and prosper in an increasingly tougher competitive environment.

2.1 Theoretical perspectives on persistent innovation

Three broad theories have been discussed in the literature and which may account for why innovation may become persistent within firms (Peters 2009, Raymond et al. 2010). The unifying idea between these theories is that there exists an effect, due to the prior innovation efforts that have resulted innovation output, which leads to a higher probability of innovating compared to the instance where a firm did not innovate.

A first line of reasoning is based on the idea that "success breeds success" (Nelson and Winter 1982, Flaig and Stadler 1994). This idea stresses that prior commercial success in the form of a successful innovation creates profits that can be invested in current and future innovation activities. Because of financial constraints related to the risky nature of R&D and innovation (see Hall 2002a;b for a survey of the literature that addresses this issue), retained profits and past commercial success in previous

innovative activities are considered particularly important to finance innovation projects.

A second line of reasoning argues that some firms become persistent innovators due to dynamic economies of scale and "learning-by-doing" (Arrow 1962, Nelson and Winter 1982, Dosi 1988). This may result from the very nature of knowledge itself, which is cumulative and used as an input to generate new knowledge. It is often argued (see, e.g. Malerba and Orsenigo 1996) that this is particularly important in some sectors where the knowledge base is very cumulative, implying that experience in R&D makes firms more efficient at innovating. But learning-by-doing may also take the form of 'procedural knowledge'. This, for example, refers to the management of relationships with external partners such as universities. Assuming that the depreciation rate of these acquired abilities is small (Raymond et al, 2006), innovation will become persistent.

The third and final line of reasoning argues, based more or less implicitly on a linear view of innovation, that innovation persistence at the firm level can be explained by the largely sunk nature of R&D costs (Sutton 1991, Cohen and Klepper 1996). In this perspective, R&D is not an activity that is easily discontinued one year, and started again the next year, mainly because knowledge is embodied in the human capital of researchers. Thus, the decision on whether or not to invest in an R&D lab is one for the long run. Once that decision has been taken, the firm is expected to have a constant flow of innovations, rather than a one-off innovation. Thus, innovation becomes persistent.

2.2. Innovation persistence in decisions and outcomes

After the first studies appeared in the 1990s, the issue of whether or not innovation is persistent at the firm level has been addressed in many quantitative papers, especially recently. Although the basic empirical setting and econometric models used have differed across studies, innovation persistence has always been examined by including lagged innovation as a predictor of current and/or future innovation (e.g. Peters, 2009; Clausen et al, 2011).

A problem with the past literature on innovation persistence is that several different indicators have been used when discussing and analyzing persistence of innovation. Previous research has used a several indicators of innovation in their analysis of persistence such as "R&D expenditures" (Peters, 2009; Castillejo et al. 2004; Crepon & Duguet, 1997), "innovation expenditures (not-including R&D)" (Peters, 2009), "product innovation (Clausen et al, 2011; Raymond et al, 2010), patents (Geroski et al, 1997; Malerba and Orsenigo, 1999; Cefis and Orsenigo, 2001; Cefis, 2003)), process innovation (Antonelli et al. 2010; Clausen et al, 2011) and "significant innovation" (Geroski et al, 1997). Prior studies have thus also gotten – at least in part

– different results when it comes to the question about whether or not innovation is characterized by true state-dependence. As a consequence, it is possible to criticize this literature for lacking coherence[6].

A fruitful distinction can, however, be made between whether or not innovation is persistent in terms of the investments going into the input side of the innovation process, such as R&D spending, and / or persistent in terms of the outputs from the innovation process, such as patents and products (Huergo & Moreno 2011).[7] While investments are mainly decisions, patents and products are mainly outcomes (which imply, of course, a previous decision). The dynamics of innovation persistence could then very well differ across the input and the output sides of the innovation process. Our review of the literature below will reflect this and will be accompanied by a discussion of the possible sources of persistent in the innovation input and output stages.

Empirical research on innovation persistence: Investment decisions

The decision to invest in resources going into the input side of the innovation process, like R&D spending, is typically an important decision undertaken by the firm management (Nelson & Winter, 1982). By emphasizing and encouraging innovation over time in their decision-making, the firm management and their decisions' can be a source of innovation persistence in relation to the continuity and amount of resources going into the input side of the innovation process. Research, both theoretical and empirical, has for instance used investment in R&D as a proxy for firms' innovation capabilities (Nelson & Winter, 1982) and found that firms tend to persistently differ in the amount of funds they devote to R&D (Helfat, 1994). And although R&D may have a sunk cost nature, the decision to invest in it in the first place is a strategic decision undertaken by the firm management.

Decisions to invest in innovation is thus typically undertaken by the (senior) firm management and maintained over time. Scholars have therefore pointed to the role of the firm management as a key evolutionary agent that has a strong influence on firm behavior and its persistence over time (Nelson & Winter, 1982). This is in line with research within strategic management where it is argued that firms persistently differ in their innovation capabilities, and as a consequence, that there exist considerable and persistent intra-industry inter-firm differences in profitability and growth rates (Nelson, 1991; Rumelt, 1991; McGahan & Porter, 1997; Schmalansee,1985; Wernerfelt & Montgomery,1988; Powell, 1996).

Although much theorizing in strategic management builds on the idea that R&D spending, and their associated capabilities, are persistent over time, not that many studies have in fact examined to what extent the decision to invest funds in R&D is

[6] We would like to thank an anonymous reviewer for pointing this out
[7] We would like to thank an anonymous reviewer for making this highly useful distinction

persistent over time at the firm level using proper methods and data. Although some studies have correlated past and pervious R&D spending at the firm level (e.g. Helfat, 1994), this research has in general been unable to distinguish between true and spurious state dependence. The literature on innovation persistence is an exception however.

Several studies have examined innovation persistence with reference to the input side of the innovation process. Focusing on R&D activities, Castillejo et al. (2004) examined the persistence of innovation in Spanish manufacturing firms by using a dynamic probit model and panel data. They found that the influence of past R&D experience on the current decision to undertake R&D is positive and significant. Similarly, Peters (2009) focused on whether or not innovation was persistent in terms of R&D expenditures and "other innovation expenditures besides R&D" using a panel of German firms and a dynamic probit model. She concluded that innovation is indeed persistent in terms of both the decision to invest in R&D and also persistent in the decision to invest in other innovation input activities besides R&D. Focusing on R&D intensive firms in France, Crepon & Duguet (1997) found high persistence in terms of R&D spending and patenting using dynamic panel data and models.

Hence, studies on "the decision to invest in innovation" among firm over time have shown that the innovation investment behavior of firms is characterized by (strong) persistence.

Empirical research on innovation persistence: Outcomes

Although the firm management can exert a high degree of control over the firms' investment decisions, and thus constitute a source of persistent behavior, the management has less control over the outcomes and results from the innovation process. The decision to invest in innovation does not guarantee that the investment will be successful (Peters, 2009). Persistence in "innovation output" may thus be driven by other dynamics than persistence in the decision to invest in innovation input activities. In contrast to persistence in "investment decisions", "success-breeds-success" dynamics and "dynamic learning effects" may explain why innovation may be persistent also in terms of outcomes/outputs (Peters, 2009). Both "success-breeds-success" and "dynamic learning effects" are innovation outcome oriented and stress the cumulative nature of innovation and the importance of learning effects in the innovation process (Peters, 2009). They stress the successful implementation of innovation and not just the decision to invest in innovation. Positive market selection is thus an element in what may drive persistence in innovation outputs/outcomes.

In evolutionary economics, positive market selection is the key source of survival and economic success of firms. Firms which experience positive market selection tend in this framework to adopt persistent behavior aligned with the positive market feedback (Nelson & Winter, 1982). Persistent innovation in terms of "new products"

may thus stem from prior successful innovation outcomes: Prior commercial success in product innovation can make profits available for future spells of product innovation. In this situation, it is positive outcomes in the market which drives persistent product innovation, and not necessarily the decision to invest in innovation by the firm management. Related to success in the market are the "dynamic learning effects" that firms gain from being successful in the innovation process at an earlier time period. Sources of persistence in "innovation outcomes" may thus by different when compared to persistence in "innovation input", at least in part.

As in the case of R&D spending, not that many studies have examined to what extent firms are persistent in terms of "innovation outputs/outcomes" using proper methods and data. One reason is that there has been a lack of data that follow firms over time and which measures "innovation output" within Innovation Studies. Patent data is an exception and – although an outcome of the innovation process – such data has been widely criticized for being only an intermediate measure of innovation (Smith, 2005). Recent databases, drawing upon the Community Innovation Survey (CIS), has however made it possible to examine innovation persistence using direct (alas subjective) measures of product and process innovation (for a recent example see Clausen et al, 2011). But what does the empirical evidence have to say about the possible persistence among firms in terms of "innovation output".

Early studies on innovation outcome persistence mainly used patent data. These studies have found low persistence in the innovation activity of firms. Examples include Geroski et al. (1997) which used patent as well as data on "major" innovations for the UK (and a duration dependence model), and Malerba and Orsenigo (1999), Cefis and Orsenigo (2001) and Cefis (2003) which analyzed EPO (European Patent Office) patent application data for manufacturing firms in France, Germany, Italy, Japan, the UK and the US. A problem with patent data is that such data probably underestimates the number of innovative firms and the persistence of innovation. The reason is that a patent involves both to innovate and to be the first to innovate. This means that patent data measure the persistence of innovative leadership rather than the persistence of innovation (Duguet & Monjon, 2004).

The availability of innovation survey data, such as the CIS, does not confound innovative leadership and innovation. Using CIS data, recent studies tend to be more positive on whether or not innovation is persistent (see, e.g. Clausen et al. 2011, Duguet & Monjon 2004, Raymond et al. 2010).For instance, in a recent analysis of Dutch manufacturing firms, Raymond et al. (2010) examined innovation persistence separately for high-tech and low-tech sectors. They found that firms in the high-tech sector innovated persistently while this was not the case for low-tech firms. Clausen et al (2011) found in an analysis of Norwegian firms that both product and process innovation were persistent over time, but that process innovation was less persistent than product innovation. A similar result was found with Italian data (Antonelli et al.

2010). Also Duguet and Monjon (2004) have found evidence of innovation persistence using a panel of French firms and CIS data.

Innovation persistence across types of product innovations

One shortcoming in the persistency literature is that no study (to our knowledge) has examined separately the persistence of breakthrough and incremental product innovation. Instead, prior studies have grouped different types of product innovation under the overall label "product innovation" when examining persistence. In this paper we follow the argument that it is important to distinguish between different types of innovations in order to generate cumulative knowledge about innovation and its effects (Damanpour & Wischnevsky, 2006).

The focus on breakthrough product innovation may further be justified by the argument that such innovations are different from incremental product innovations that are only "new to the firm". Perhaps the largest difference between them is that the novelty and potential market impact of "new to the market" product innovations are higher when compared to "new to the firm" innovations (Garcia & Calantone, 2002). Whereas "new to the market" innovations have the capacity to create market and/or technological discontinuities at the both the industry and firm levels, "new to the firm" innovations only have the potential to create discontinuities in the firm's technological and or marketing resources (Garcia & Calantone, 2002). The main reason is that whereas firms that develop "new to the market" innovations generate entirely new products, companies that "only" develop "new to the firm innovations" mainly adopts the innovations generated by others (Pérez-Luño et al, 2010).

Although the adoption of the innovations generated by other organizations is a very important part of the innovation diffusion process, it is important to underline that one critically important starting point in the innovation diffusion process is a company that generates "new to the market" innovations that at a later point in time can be adopted by other firms.

Although past research has analyzed the persistence of product innovation in general, this research has not analyzed to what extent the "supply of entirely new product innovations into the market and business sector" is driven by persistence and / or "the adoption of product innovations developed by others" is driven by persistence.

In order to help correct this gap in our knowledge we put forth the following research question: "Whether and to what extent is breakthrough and incremental product innovation persistent at the firm level?"

3. Data and Methodology

3.1 Method

In this paper we examine whether there exists a persistency effect in product innovation. In other words, we analyse the influence of lagged innovation on current innovation over time. Such an analysis, that incorporates the role of time, and especially a lagged dependent variable, calls for an econometric method that deviates from the cross-sectional regression normally implemented when examining sources of innovation within the IS literature, by taking into account unobserved heterogeneity. Below we explain the dynamic panel data method that we use and the variables included in the analysis.

Since the dependent variable employed is binary (explained below), a probit regression model is selected. We follow the standard modelling procedure for analysing (innovation) persistence, i.e. the lagged dependent variable is included as an explanatory variable in the model in order to test the persistence hypothesis. The specific estimation model used is a dynamic random effects probit model. The probability of innovation is dependent on the past innovative history of the firm, and this can be traced back to the initial observation in the sample (wave 1). This initial observation proxies for otherwise unobserved firm's characteristics, and hence, as suggested by Wooldridge (2005), this initial observation is included, in addition to the lagged dependent variable. It is important to account for unobserved heterogeneity in this way, since otherwise the coefficient obtained for the lagged dependent variable may be biased (overestimated) (Raymond et al., 2010; Peters, 2009). Taking into account unobserved firm heterogeneity (by means of random effects), as well as the initial value of the dependent variable, provides a dynamic framework, in which a significant lagged dependent variable indicates true, not spurious, state dependence (Heckman, 1982). If the observed persistence, a significant lagged dependant variable, loses its significance, then it is not due to true state dependence, i.e. due to the fact that a firm innovated before, but unobserved permanent heterogeneity. In other words, if the source of persistence is due to permanent unobserved heterogeneity, individual choices show a higher likelihood to take a decision, in our case generate innovation output, but there would be no effect of previous outcomes and thus past innovation would have no behavioural effect (Antonelli et al. 2010; Heckman 1982). The Wooldridge (2005) method also includes the time-averages of the explanatory variables.

3.2 Data

Our research builds on a panel database created by merging four waves Community Innovation Survey (CIS) and R&D survey data collected by Statistics Norway. The database contains information about all enterprises which have participated in at least one of the CIS surveys conducted by Statistics Norway between 1997 and 2006. Due to the way CIS are conducted in Norway the panel consists of waves of two to three years. The CIS survey targets all firms with 10 employees or more. However, all firms with 50 or more employees are included in the database, while only a random – but representative – sample of firms with less than 50 employees are included. As a consequence, large firms have a higher probability of being included in several surveys rather than small firms. The panel consists of four CIS surveys, namely CIS2 (1998), CIS3 (2002), CIS4 (2005), and CIS2006 (2007). The questions on innovation in CIS refer to the past three years, for example, the CIS2 survey, the first included in our dataset, asks whether or not the firm innovated in the period between 1995 and 1997. The innovation variables that we use refer to the periods 1995-1997, 1999-2001, 2002-2004, and 2004-2006. The original panel is unbalanced in the sense that firms can enter and exit it over time due to firm failure and simply not responding to the survey. However, the Wooldridge method is developed for a balanced sample and therefore we use a balanced subsample of the original merged surveys. Altogether we have 1644 firm-wave observations. Because a lagged dependent variable is adopted as one of the regressors, the regressions uses three observations per firm. It is important to control for the fact that some firms of the original sample may have exited due to failure. For this reason we control for some of the selection bias, due to firms exits, utilizing the two-step Heckman correction procedure which is designed to correct for sample selection. The CIS data was matched to the Firm Registry in Norway and the survival status of all firms in the CIS 2 was examined in 2007. The lambda/mills ratio from the Heckman regression was extracted from the analysis and saved as an ordinary variable to our dataset and subsequently included as an independent variable in the panel data regressions.

3.3 Variables

Table 1 documents the summary statistics of the main variables used in the regressions, broken down by waves of the survey (wave 2 refers to the first observation used in the regressions, since wave 1, which is the CIS 2, is used only for lagged variables). We have two dependent variables, breakthrough and incremental product innovation. Breakthrough innovation is defined as product innovations that are not only new for the firm but also for the firms market in the CIS questionnaire (*inmar*). This variable is directly observed in the survey, and is binary. The value 1

for the breakthrough product innovation indicates that the firm had one or more respective innovations of this type during the 3-year period within each wave of the CIS survey. Incremental innovation is defined as innovations new to the firm, (*inpdt*). It is directly observed binary variable in the survey, however, firms that have given a 1 may have also replied 1 to the *inmar* variable, thus we replace the value with a 0 if that is the case. In other words, our incremental innovation variable captures those firms which only adopt innovations. To analyse whether previous innovation creates a persistency effect, we need to control for the main drivers of product innovation. Research & development investments are considered as the most important of these drivers. We include R&D intensity (*rdintensity*), measured as R&D personnel over all employees, and the share of internal of all R&D (*internalrdshare*) as explanatory variables in the model. We use the lagged values of the explanatory variables. Adding lagged R&D variables to our analysis enables us to examine to what extent persistent product innovation is driven by lagged "investment decisions" and/or outcome oriented persistence dynamics such as "success-breeds-success" and "dynamic learning effects".

Since the initial value of the dependant variable is included in the analysis (*Iinmar*), the sample used in the regressions is limited to three waves.

One additional control variable used here is firm size (from which larger firms are expected to have a higher probability to innovate, i.e. Schumpeter Mark II, 1942), and this is measured by the number of employees a firm has (as reported in the survey). We use and report only the natural logarithm of the number of employees (*size*). A dummy variable for whether or not the firm is a part of a larger group *(group)* is also added to the analysis. Research has shown that exporting firms are more innovative, thus we include a control for whether firm is an exporter or not (*expD*). We also control for year and industry fixed effects (based on NACE codes). To take into account the possible bias of the two overlapping waves we also include the time fixed effects (*wave FE*).

Table 2.1 Descriptive statistics

Variable	Type	Mean	Std. Dev.			Min	Max
			overall	between	within		
Inmar	0/1	0.232	0.422	0.287	0.310	0	1
Inpdtonly	0/1	0.227	0.419	0.239	0.345	0	1
RDintensity	0-1	0.046	0.105	0.095	0.047	0	1
Internalrdshare	0-1	0.397	0.439	0.365	0.245	0	1
Size*	Nro employees	275.63	640.91	625.80	138.50	10	12594
ExpD	0/1	0.749	0.434	0.293	0.320	0	1
Group	0/1	0.772	0.419	0.330	0.258	0	1
Mills ratio	Heckman correction	0.488	0.143	0.143	0	7.78E-12	0.997817

* In the analysis we use a log-transformed variable.

Another way to descriptively study our dataset and give a firsthand idea of the dynamics of product innovation is to look at the transition probability tables (e.g. Antonelli et al. 2010, Cefis 2003, Roper & Hewitt-Dundas 2008). On average of 46 % the firms introducing new to the market innovations at time t_{-1} introduce a new to the market innovation at time t. For incremental innovation the probability to continue as an incremental innovator is 32 %. For product innovation output in general the probability is 67 %. Already, this distinction between the two types of innovations, gives us an idea that the previous research, which have grouped breakthrough and incremental product innovation together may have missed something.

In Table 2we have the transition probabilities for both breakthrough and incremental production innovation at each period. From the tables we can see that the this value changes over the different periods to small extent, for breakthrough innovations probabilities vary between 41 - 52 % and for incremental innovation between 37 - 26 %. As noted above, between the first and second period (waves 2 and 3) there is a one year gap, while between the last two waves there is a one year overlap. For breakthrough innovation probabilities increase toward the last period, while the opposite is true for incremental innovation. This indicates that the panel construction plays a role in these probabilities. In previous research utilizing CIS based panels Raymond et al. (2010) claim that a one year overlap is a minor issue. Nevertheless, we need to take this issue into account in the analysis and thus we include wave dummies as controls. In addition, the one year gap and one year overlap average each other out in our panel.

Table 2.2 Transition probability tables

		Transition probabilities									
		Period 1 (wave 1-2)				Period 2 (wave 2-3)				Period 3 (wave 3-4)	
Incremental innovation											
		$wave_2$				$wave_3$				$wave_4$	
		0	1			0	1			0	1
$wave_1$	0	74.07	25.93	$wave_2$	0	80.41	19.59	$wave_3$	0	84.76	15.24
	1	62.93	37.07		1	67.1	32.9		1	74.22	25.78
Breakthrough innovation											
		$wave_2$				$wave_3$				$wave_4$	
		0	1			0	1			0	1
$wave_1$	0	84.58	15.42	$wave_2$	0	84.51	15.49	$wave_3$	0	86.65	13.35
	1	58.9	41.1		1	54.92	45.08		1	47.93	52.07

4. Analysis

4.1. Results

In this paper we posed the following research question: "whether and to what extent is breakthrough and incremental product innovation persistent at the firm level?" We estimate three model specifications for both dependent variables to address our research question. Standard errors are presented in the parentheses. In the first specification, we estimate a baseline random effects model where we do not add the initial condition nor the time-averages. In the second specification we estimate the model as suggested by Wooldridge (2005), and applied by for example Peters (2009) and Antonelli et al. (2010), including the initial condition of the dependant variable and time-averages of the explanatory variables. In the last specification we include the mills ratio obtained from the Heckman estimation procedure to take into account the selection bias due to firm exit and the possible non-representativity of our sample.

Table 2.3. Estimation results for breakthrough innovation

VARIABLES	(4) inmar	(5) inmar	(6) inmar
$inmar_{t-1}$	0.620***	0.319*	0.318*
	(0.0847)	(0.145)	(0.145)
$RDintensity_{t-1}$	0.784*	-0.159	-0.137
	(0.356)	(0.811)	(0.812)
$Internalrdshare_{t-1}$	0.689***	-0.352*	-0.354*
	(0.101)	(0.172)	(0.172)
$size_{t-1}$	0.0598+	-0.300*	-0.298*
	(0.0348)	(0.138)	(0.139)
gp	0.131	0.103	0.0988
	(0.103)	(0.176)	(0.176)
expD	0.305**	0.0423	0.0404
	(0.115)	(0.170)	(0.170)
Iinmar		0.226+	0.230+
		(0.130)	(0.130)
RDpersintensity_M		0.607	0.491
		(0.973)	(0.981)
internalrdshare_M		1.891***	1.895***
		(0.259)	(0.259)
size_M		0.394**	0.387**
		(0.148)	(0.149)
gp_M		0.0192	0.00454
		(0.233)	(0.233)
expD_M		0.0455	0.0809
		(0.281)	(0.283)
millsratio			0.647

			(0.581)
Constant	-1.935***	-8.052	-8.593
	(0.200)	(1,211)	(1,570)
Observations	1,644	1,644	1,644
Number of org_nr	548	548	548
Industry FE	YES	YES	YES
Year FE	YES	YES	YES

Standard errors in parentheses
*** p<0.001, ** p<0.01, * p<0.05, + p<0.10

Table 3 presents the results for breakthrough innovation. In model 1 we regress breakthrough product innovation on the lagged dependant variable and control variables. The results show that lagged innovation is highly significant and positive. R&D intensity is positive and significant supporting the view that R&D inputs are an important determinant of innovation output and, furthermore, this effect last over time (cf. Peters 2009). In addition, internal R&D share is positively linked to breakthrough innovations. New to the market innovations need internal R&D efforts - simply outsourcing R&D may not be enough. We further see that lagged firm size is a positive and significant predictor variable. Hence, larger firms are significantly more likely to develop breakthrough product innovations. Also, exporting firms are more likely to introduce new to the market innovations.

However, as mentioned above this might be a spurious result due to the nature of the firm and not an indication of true state dependence, i.e. persistent innovation. Hence, in model 2 we include the initial condition, a dummy variable of whether the firm introduced a breakthrough product innovation in the first period or not, and the time-averages of the explanatory variables.

In model2 (table 3), we see that individual heterogeneity as measured by the initial condition is positive and significant. When comparing this result to model 1 this indicates that if we did not control for the initial condition in our econometric analysis, then the influence of the lagged breakthrough product innovation variable would have been overestimated and its effect on current breakthrough product innovation would have been significantly biased. All in all, after taking into account unobserved heterogeneity we still find the persistency effect of innovation output from the previous period.

We also find that R&D intensity is not significantly related product innovation when we take into account individual heterogeneity. This suggests that, although R&D intensity in time t_{-1} is significant in model specification 1, taking into account individual heterogeneity reduces the effect of lagged R&D intensity. In other words, previous innovation output persistency effect tends to override the effect of R&D in generating new innovation output. This suggests that there exists a knowledge accumulation effect through innovation output over that of R&D investment. The positive and significant effect from the share of internal R&D expenditure supports this interpretation: knowledge accumulated internally within the firm has an effect over time.

In model 3 we further control for selection bias due to firm survival. The coefficient for the mills ratio is positive but does not differ statistically from zero. The result is as expected - surviving firms tend to be more innovative.

Our results displayed in table 3 above suggest that breakthrough product innovation is indeed persistent at the firm level. Lagged breakthrough product innovation can positively and significantly explain current breakthrough product innovation in the Norwegian context, controlling for year, industry and other important firm characteristics. Hence, this result extends prior research on innovation persistence at the firm level which hitherto has examined the persistence of product innovation in general – but not the persistence of breakthrough product innovation in particular. In this paper we have shown that breakthrough product innovation is also persistent at the firm level.

Table 2.4 Results for incremental innovation

VARIABLES	(1) inpdtonly	(2) inpdtonly	(3) inpdtonly
inpdtonly $_{t-1}$	0.140	0.0865	0.0848
	(0.116)	(0.132)	(0.132)
RDintensity $_{t-1}$	0.584	1.259	1.251
	(0.406)	(0.773)	(0.774)
Internalrdshare $_{t-1}$	0.385***	-0.312*	-0.311*
	(0.105)	(0.157)	(0.157)
size $_{t-1}$	0.0889*	0.0523	0.0490
	(0.0393)	(0.120)	(0.120)
gp	-0.162+	-0.264+	-0.262+
	(0.0978)	(0.152)	(0.152)
expD	0.217+	0.114	0.117
	(0.116)	(0.144)	(0.144)
Iinpdtonly		0.0223	0.0159
		(0.109)	(0.109)
RDpersintensity_M		-1.358	-1.304
		(0.939)	(0.943)
internalrdshare_M		1.284***	1.282***
		(0.220)	(0.220)
size_M		-0.0140	-0.00625
		(0.129)	(0.129)
gp_M		0.146	0.157
		(0.202)	(0.203)
expD_M		0.103	0.0863
		(0.239)	(0.240)
millsratio			-0.418
			(0.548)
Constant	-0.885+	-1.044*	-0.750
	(0.470)	(0.496)	(0.627)
Observations	1,644	1,644	1,644
Number of org_nr	548	548	548
Industry FE	YES	YES	YES
Year FE	YES	YES	YES

Standard errors in parentheses
*** p<0.001, ** p<0.01, * p<0.05, + p<0.10

Table 4 presents the results for incremental product innovation. The estimation procedure is similar for that explained above. Model specification 1 already indicates that persistency effect of past innovation is not prevalent in incremental innovation. Even without taking into account unobserved heterogeneity it seems that lagged innovation does not increase the probability of present innovation. This result is further confirmed in the following specifications, which show that, although the coefficient of lagged dependent variable is positive, it is not statistically significant. However, share of internal R&D has a positive effect on average, which tends to support the idea that previous R&D investments, when focused internally, have a long lasting effect on innovation output. The initial condition of the dependent variable is significant and positive implying there is a substiantial correlation between it and permanent unobserved heterogeneity. However, it is smaller than the lagged dependant variable showing that the behavioral effect of past innovation is more important. In model specification 3 the mills ratio, again, does not differ statistically from zero, but is negative.

Overall, our results show that persistence in terms of breakthrough product innovation is driven not by past investment but rather by "dynamic learning effects". It is further interesting to note that incremental product innovations were not significantly influenced by neither the lagged dependent variable nor the lagged R&D spending variables. We thus find, within the context of our Norwegian data, that past investment in innovation do not constitute a persistency effect on innovation output (controlling for lagged innovation).

At the general level, our results show that the dynamics of innovation persistence differ across types of innovations. So far, the literature on innovation persistence has been very close to empirical data and not in general heeded the call from the more theoretical and theory building studies in the IS tradition which calls for the use of taxonomies to build cumulative knowledge about innovation types, their nature and effects (Damanpour & Wischnevsky, 2006). This paper has taken one small step in this direction, although also the present paper has a strong empirical orientation. Future studies should arguable pay even more attention to the persistence of innovation across different types of innovation.

5. Conclusion

In this paper, we draw new insights in the literature on innovation persistence by comparing two types of product innovation outputs, namely breakthrough and incremental product innovation. Framed within the context of product innovation and the literature on innovation persistence, the following research question was asked:

Whether and to what extent is breakthrough and incremental product innovation persistent at the firm level? Supporting the literature, which makes a distinction between incremental and breakthrough innovation, our results show that breakthrough product innovation is persistent at the firm level, but incremental innovation is not. When generating breakthrough innovations firms introduce internally created new technology, which is previously unknown to the market while incremental innovation is based on knowledge and technologies adopted by the firm but developed by others (Perez-Luño et al. 2011). The results in this paper show that such internally created breakthrough innovations tend to have long term effects on firm behaviour, through, for example, knowledge accumulation that result in persistent innovative behaviour.

Our finding extends prior research in two important ways. First, we have shown that not addressing the type of product innovation gives a misleading view of the role persistency in innovation. We added to the literature on innovation persistence by examining whether or not breakthrough and incremental product innovation are persistent at the firm level. This issue has not been examined before in this literature. Second, we have contributed to the research tradition within Innovation Studies on the determinants of innovation by showing that there exist persistent behavioral effects from past breakthrough innovation outputs but not necessarily from innovative investments nor merely the adoption of technology and products developed by others. Our results suggest that innovation persistence is driven by firm internal learning – dynamic learning effects – and that these are manifest mainly when firms internally generate new breakthrough product innovations that previously did not exist in the market.

One important implication of our finding is that the generation of new to the market innovations that can enter the innovation diffusion process and potentially be adopted by other firms is driven by a group of firms that continuously develop breakthrough product innovations. The generation of breakthrough innovations over time seem to be driven by a reinforcing circle of learning and knowledge accumulation dynamics where firms that innovate in one point in time gain valuable learning experiences and capabilities to create new spells of breakthrough product innovation. What is clear is that the development of a breakthrough product innovation creates a strategic commitment to the pursuit of additional breakthrough innovations by firms. This suggests that, in practice, firms' ability to develop a breakthrough product innovation has long term implications on its future innovation performance.

A policy implication of this finding is that policymakers may want to pay particular attention to those organizations that either have experience in generating - and particular those firms that aim for the first time to generate - breakthrough, new to the market, product innovations. One important reason for this is that the innovation diffusion process starts with breakthrough product innovations. Without the generation of such types of innovations, other firms have few innovations to adopt.

Another reason is that breakthrough product innovations and their financial costs are far from being randomly distributed in the firm population. Policy support of the rather small cluster of firms that generate breakthrough product innovations over time may as such be warranted.

Our paper has some limitations, which might constitute opportunities for further research. One shortcoming is that we do not have information about the strategies etc firms pursue within the context of the innovation process and whether or not these are more or less correlated to persistent breakthrough product innovation. Previous literature has suggested that this is the case (see Clausen et al. 2011). A further analysis of whether or not different strategies as pursued by firms lead to more or less persistent breakthrough product innovation represents an interesting avenue for further research.

Two limitations of our study are related to the source of data. First, we do not have all the possible covariates that may have an effect on our dependant variables. Research on breakthrough innovation has shown that there exists different innovation strategies, which may affect the likelihood of generating these innovations (e.g. Vásquez-Urriago et al. 2011). However, this is because of the nature of the Community Innovation Survey. In CIS most of the innovation activity and input related variables are only asked from the respondents, which have replied that they have generated innovation output during the survey period. In addition, a specific limitation of the CIS data, when merging it to panel form, is that the questionnaires have changed over time, which reduces the number of common variables over the different waves. Another shortcoming in this paper is that we have data on only four waves of CS data which has enabled us to create only a short panel. Adding more data from more recent surveys as they come available and, thus creating a longer panel, is another interesting research opportunity.

CHAPTER 3: INNOVATION STRATEGIES AS A SOURCE OF PERSISTENT INNOVATION

1. Introduction[8]

An important issue in the recent literature on firm-level innovation is whether, and to what extent, firms that innovate once have a higher probability of innovating again in subsequent periods. This phenomenon, which may be referred to as 'innovation persistence', has been addressed by a number of empirical studies using data from the Community Innovation Survey (CIS) (for example, Duguet and Monjon, 2004; Peters, 2009; Raymond et al., 2006), as well as other types of data (mainly patents, for example, Geroski et al. 1997; Malerba and Orsenigo 1999; Cefis 2003). Innovation persistence is usually specified in the econometric sense by a model in which the probability of a firm to innovate is explained by a variable that measures whether or not the firm innovated in a previous period (i.e. the lagged dependent variable), as well as a number of control variables. If the lagged innovation variable has a positive and significant sign, which is indeed the case in many studies, this is interpreted as innovation persistence.

Our study deviates somewhat from the existing literature on innovation persistence in the sense that it is not primarily interested in the traditional question of whether or not, and to what extent, innovation is persistent. Instead, we strive to answer why some firms (do not) persistently innovate. The variables that influence this, such as whether or not a firm has an R&D department, or whether or not it maintains cooperative relationships for innovation, are affected by the long-run strategic choices made by the firm (see, for example, Nelson and Winter 1982; Teece et al. 1997). These factors are referred to as the 'innovation strategy' of the firm. To our knowledge, none of the prior studies in the innovation persistence tradition has explicitly analysed the strategic factors behind innovation persistence at the firm level. Therefore, the question we pursue is to what extent differences in innovation

[8] This is a pre-copy-editing, author-produced copy of an article accepted for publication in *Industrial and Corporate Change* following peer review. The definitive publisher-authenticated version *Clausen, Pohjola, Sapprasert, and Verspagen.* Innovation strategies as a source of persistent innovation *Ind Corp Change (2012) 21 (3): 553-585* is available online at: http://icc.oxfordjournals.org/content/21/3/553.

strategies across firms can explain why some firms persistently innovate. This research question fits nicely with the conclusion from a recent review of the capabilities literature (Hoopes and Madsen, 2008:394), which argues that prior studies have not, in general, analysed the relationship between the capabilities and resources of firms, nor have they evaluated how these influence "the persistence of above average performance."

Following evolutionary theory and strategic management research, it is a central tenet of our approach that there are important differences between firms in terms of how they innovate, and that this leads to different innovation probabilities at the firm level. Empirically the innovation strategies, which we discuss below in more detail, are measured using the European-wide harmonised Community Innovation Survey (CIS) questions on innovation activities (for example, R&D, marketing or design), information sources (for example, internal or external to the firm) and the major goals a firm seeks to achieve by innovating (for example, gaining market share or saving labour costs).

The CIS survey builds on decades long research efforts to understand the sources and effects of innovation. Therefore, we feel confident in using them in our empirical approach that is somewhat akin to that found in the literature on technological regimes, and which may otherwise appear to the reader as somewhat inductive. The questions in the CIS reflect underlying concepts that are widely recognized in the innovation studies literature. For instance, the questions on internal and external "information sources for innovation" can be related to the concept of innovation search, which is central in evolutionary theory of the firm (Nelson & Winter, 1982). Research on information sources for innovation is also central to innovation research on external knowledge sourcing and user-producer interactions (e.g. Von Hippel, 1988; Chesbrough et al, 2006) and questions about this have been used to predict innovation performance at the firm level by for instance Laursen & Salter, (2006). Another group of variables that we use deals with "innovation goals" and can be related to the concept of technological trajectories introduced by Dosi (1982) where it is argued that the goals that firms have in the innovation process are formed by the technological regime and trajectory that the firm is embedded in. Leiponen and Helfat (2010) have used these questions as predictors of successful innovation. Yet another group of variables that we use deal with the inputs to innovation, such as R&D spending and expenditures on training and the acquisition of external knowledge and machinery. Such variables have been used by research aimed at capturing differences among firms and industries in their underlying technological regimes and sectoral patterns of technical change (e.g. Pavitt, 1984). Hence, the variables that enter our methodology to measure innovation strategies are based upon cumulative theoretical research within innovation studies to understand innovation, its sources and its effects.

Using these variables in a taxonomic exercise over innovative firms in Norway, we identify five innovation strategies that capture the main differences of the innovation activities and processes between firms. The "least strategic" innovators are a group labelled as the *ad hoc* group, since these firms seem to regard innovation in a sporadic manner. Firms that rely mostly on suppliers of machinery and equipment as knowledge sources for their innovations belong to the *supplier-based* strategy. The *market-driven* innovation strategy consists of firms that focus on customer-driven innovation and seek knowledge from industry sources, such as competitors and clients. The fourth innovation strategy we identify is *R&D intensive*. These firms tend to have a broad spectrum of goals and sources for innovation, but especially tend to focus on internal and external R&D. The last group are the *science-based* innovators, which rely heavily on scientific sources of knowledge, such as patents, universities and research institutes, in their innovation process.

These strategies are similar to other taxonomies identified in the literature, such as the Pavitt taxonomy (1984), which has been modified and tested in the literature (Marsili & Verspagen, 2002; Castellacci 2008). However, an important difference is that our taxonomy is derived using data at the firm – and not industry – level. Hence, we do not impose an "industry representative innovation strategy" upon our firms, but rather allow industries to consist of firms that follow different innovation strategies. This has been recommended in the literature (Archibugi 2001), and supported by an exercise similar to ours by Srholec and Verspagen (2008). Consistent with the taxonomy literature (e.g. Pavitt, 1984; Marsili & Verspagen, 2002), we expect that innovation persistence at the firm level will differ across the five groups due to underlying differences in technological opportunities and challenges that characterise technological regimes and trajectories that firms innovation strategies address. For instance, firms pursuing the innovation strategies "ad hoc" and "supplier based" are expected to have lower innovation persistence as compared to the other strategies. Following on logically from the desire to measure firm characteristics in a rather precise way, two major types of innovation are distinguished here, i.e. product and process innovation. Although some prior studies have examined the persistence of product and process innovation, none of them has examined the driving forces behind innovation persistence within these two categories. This is our main contribution to the literature.

Our focus on the strategic driving forces behind persistent innovation is in line with the recent literature, which has begun to use a longitudinal firm perspective in order to identify persistent heterogeneity and its causes (Dosi et al., 2008). Such research has an interesting parallel in management research, which has been occupied with unravelling whether the sources of persistent firm performance reside at the industry or firm levels. Research on this issue has found that industry membership accounts for roughly 20% of the total variance in firm performance. The remaining residual variance is found elsewhere, the majority at the firm level (Rumelt, 1991;

McGahan & Porter, 1997; 2003; Powell, 1996). While this part of the management literature has focused on profit and productivity persistence (see Bottazzi et al., 2008, for an example), our focus is on persistent innovation and its driving forces, which is considered to be a key factor of profit and productivity persistence.

We use a panel dataset, constructed on the basis of R&D and CIS surveys from Norway,[9] and adopt a dynamic random effects probit model (Wooldridge, 2005). This model is similar to that used in most recent studies which address innovation persistence based on CIS data (for example, Peters, 2009; Raymond et al., 2006). However, we extend the Wooldridge model in a simple way, which enables an examination of whether, and to what extent, different types of innovation strategies relate to innovation persistence. Our econometric specification including innovation strategies nests the specification used in previous studies as a special case.

Following this introduction, Section 2 firstly provides a short overview of the previous empirical literature on innovation persistence, and subsequently looks at the particular mechanisms for the persistence of innovation at the firm level suggested by the literature. The section also discusses how this leads to the theoretical perspective used here. Section 3 presents the data and analytical method, and the empirical approach to measure a firm's innovation strategies is explained in Section 4. Section 5 presents the econometric results. The last section provides a summary, and ends by proposing some recommendations for further research.

2. Theoretical Background and Prior Literature

2.1. Prior empirical research on innovation persistence

After the first studies appeared in the 1990s, the issue of whether or not innovation is persistent at the firm level has been addressed by many quantitative papers, especially recently. Although the basic empirical setting and econometric models used differ across studies, innovation persistence has always been examined by including lagged innovation as a predictor of current and/or future innovation.[10] The literature uses two different types of indicators of innovation. On the one hand, some prior studies apply patent data and R&D data, and on the other hand, more recent studies focus on

[9] Innovation and R&D survey data are widely used in innovation studies. See Laursen and Salter (2006), Reichstein and Salter (2006), Vega-Juardo et al. (2009), for recent examples.

[10] We define persistence based on whether or not firms innovate. An alternative definition of innovation persistence based on variations in the level of innovativeness over time is also possible. Future research could examine whether and to what extent innovation strategies are important driving forces also behind this alternate definition of innovation persistence.

questionnaire-based measures of innovation (for example, the CIS and the like). In a somewhat simplified way, survey questions about product and process innovation can be considered as output-based measures of innovation, while R&D is an input, and patents are a measure of invention. Early studies on innovation persistence mainly used patent data, and these studies found low, or no clear-cut, persistence of innovation (Geroski et al., 1997; Malerba and Orsenigo, 1999; Cefis and Orsenigo, 2001; Cefis, 2003). More recently, panel datasets based on the CIS have been made available to researchers, and studies using these tend to be more positive about whether or not innovation is persistent.

Using a dynamic panel count data model to link past and current innovations (in terms of the number of patents and/or R&D expenditure), Crepon and Duguet (1997) reported a high persistence of innovation among R&D intensive firms in France. Duguet and Monjon (2004) and Rogers (2004) both estimated a cross-sectional probit model and found strong innovation persistence in French and Australian firms, respectively. Focusing on R&D activities, Castillejo et al. (2004) examined the persistence of innovation in Spanish manufacturing firms by using a dynamic probit model and panel data. They found that the influence of past R&D experience on the current decision to undertake R&D was positive and significant. In a recent study of firms in the German service and manufacturing industries, Peters (2009) used a dynamic random effects binary choice model and panel data to examine the persistence hypothesis. Her findings showed a high persistence of innovation activities in both manufacturing and services. In the service sector, however, the effect of innovation in the previous period on innovation in the current period was smaller than it was in manufacturing. In another recent analysis of Dutch manufacturing firms, Raymond et al. (2006) examined innovation persistence separately for high-tech and low-tech sectors. They found that firms in the high-tech sector innovated persistently, while this was not the case for low-tech firms.

When patents, R&D expenditure or innovation expenditure are used as the main data source, it is hard (or impossible) to differentiate between process and product innovation. However, to do so seems important, because these two types of innovation are of a quite distinct nature. Process innovation often requires less technological advancement and strategic decision-making (Rosenberg, 1982; Tushman and Rosenkopf, 1992). It is also often related to learning-by-doing, and linked to innovation strategies which are believed to be less developed compared to strategies for product innovation (Cabral and Leiblein, 2001; Pisano, 1997). This is why process innovation and product innovation may be expected to show different levels of persistence. In literature which addresses the evolution of industries, process innovation is usually regarded as being persistent in relatively mature industries where the focus is more on creating new, more efficient production processes than on introducing new products (Klepper, 1997; Utterback, 1994). In other words,

persistence is likely to vary between the two types of innovation according to different industries.

To our knowledge, only one previous study, by Flaig and Stadler (1994), has examined whether, and to what extent, process and product innovation are persistent at the firm level. They used a dynamic random effects probit model and found that firms were persistent in both product and process innovation, but that there was no dynamic cross effects between these types of innovation. In other words, innovation of one type in the previous period did not explain the current innovation of the other type.

Some studies have found low persistence in the innovation activity of firms. Examples include Geroski et al. (1997) who used data on patents as well as "major" innovations for the UK (and a duration dependence model), and Malerba and Orsenigo (1999), Cefis and Orsenigo (2001) and Cefis (2003) who analysed EPO (European Patent Office) patent application data for manufacturing firms in France, Germany, Italy, Japan, the UK and the US. However, in many cases, patents are not the same as innovations (Smith, 2004).[11] Our reading of the literature suggests that persistency studies that have used patents as a proxy for innovation tend to identify a low degree of innovation persistence, while studies using either R&D or output-based measures of innovation tend to find a higher degree of innovation persistence within firms. Altogether, it is clear that innovation persistence is not a clear-cut phenomenon, and that it requires an in-depth research setting which can facilitate an analysis of the driving forces of persistent innovation.

2.2. Why is innovation persistent at the firm level?

Some theoretical interpretations of innovation persistence

Previous research has identified three broad theories to explain why some firms are persistent innovators (and why others do not persistently innovate). The first line of reasoning is based on the idea that "success breeds success" (Nelson and Winter, 1982; Flaig and Stadler, 1994). This idea stresses that prior commercial success in the form of a successful innovation creates profits which can be invested in current and future innovation activities. Because of financial constraints related to the risky nature of R&D and innovation (see Hall, 2002a, b for a survey of the literature which addresses this issue), retained profits and past commercial success in previous

[11] To use only patent data to analyse innovation persistence may lead to a bias, since in many cases patents are only an intermediate measure of innovation. With only some exceptions, such as in the biotechnology industry, it would be more appropriate to treat a patent as an invention since to patent does not necessarily mean to innovate.

innovative activities are considered to be particularly important for the financing of (new) innovation projects.

A second line of reasoning argues that some firms become persistent innovators due to dynamic economies of scale and "learning-by-doing" (Arrow, 1962; Nelson and Winter, 1982; Dosi 1988). This may be the result of the very nature of knowledge itself, which is cumulative and used as an input to generate new knowledge. It is often argued (see, for example, Malerba and Orsenigo, 1996) that this is particularly important in some sectors where the knowledge base is very cumulative, implying that experience in R&D makes firms more efficient in innovating. In addition, learning-by-doing may take the form of 'procedural knowledge', because a firm may simply learn from dealing with the various tasks or problems it faces. This method of learning also refers to the management of relationships with external partners, such as universities, which is closely related to the notion of learning by interacting (Lundvall, 1988; Jensen et al., 2007). Assuming that the depreciation rate of innovative abilities is small, Raymond et al. (2006) explain that knowledge which has been used to produce past innovations can be used again in the making of current, or even future, innovations.

Based more or less implicitly on a linear view of innovation, the third and final line of reasoning argues that innovation persistence at the firm level can be explained by the largely sunk nature of R&D costs (Sutton, 1991; Cohen and Klepper, 1996). From this perspective, R&D is not an activity that can be easily discontinued one year, and started again in the next year, mainly because knowledge is embodied in the human capital of researchers. Thus, whether or not to invest in an R&D laboratory is a long-term decision, and once that decision has been taken, the firm is expected to have a constant flow of innovation, rather than a one-off.

Nevertheless, R&D is not the only innovation source of innovation (Arundel et al., 2008; Leiponen and Helfat, 2010). Other inputs include external knowledge (for example, in the form of cooperation, alliances, or licensing; see Bodas Freitas et al., 2008; Laursen and Salter, 2006), and internal activities like design, marketing, training, etc. Intuitively, not all of these innovation sources are associated with the same strong level of persistence as R&D. For example, buying a license could be a one-off activity, leading to a single innovation, and the training of employees could relate to a single innovation project. When innovation or knowledge can be bought in the marketplace (Arora et al, 2001), persistence may also be low. On the other hand, strategic alliances in which knowledge is jointly developed between firms (Duysters and Hagedoorn, 1996; Vonortas, 1997), user-producer interactions (Von Hippel, 1988; Jensen et al., 2007), or cooperation with universities and public research institutes (Mowery and Sampat, 2004; Nelson, 1993) may have important sunk costs and may, therefore, be more durable.

In this study, we apply a broader approach to analyzing innovation persistence than in the previous research tradition. Instead of focusing on a single, or a few of the

factors outlined above, we attempt to capture them jointly by using the notion of an innovation strategy. From this perspective, the degree of innovation persistence observed in a particular firm depends on the specific mix of innovation inputs or sources the firm uses. This proposition, together with a novel empirical strategy for identifying the innovation strategies, is the key element of our contribution. The long-run nature of these differences between firms is the main reason for referring to them as 'strategic' differences, i.e. innovation strategies are operationalized as the (long-run) factors which may account for differences in innovation and innovation persistence across firms.

The justification for this approach comes from two related fields of literature which have influenced the recent discourse on innovation, namely, evolutionary economics and strategic management. Evolutionary economics deals with the processes of variation, selection and retention (Aldrich, 1999; Nelson and Winter, 1982). It argues that firms possess a set of semi-stable routines in which they store factors which affect innovation, as well as other strategic factors of the firm's behaviour. Although these routines are subject to change, this does not often occur, and generally, any such changes are not radical (Nelson and Winter, 1982; Cyert and March, 1963; Levitt and March, 1988). Because the routines are not based on a decision-making model with rational expectations or full information, and because firms differ in respect of their pre-determined knowledge and resources, they imply a relatively large degree of firm heterogeneity which evolves only slowly under the pressure of market selection. In the words of Nelson and Winter (1982:14), "... routines play the role that genes play in biological evolutionary theory. They are a persistent feature of the organism and determine its possible behaviour".

The strategic management literature identifies the notion of competencies or capabilities as explaining innovation and innovation persistence at the firm level (for example, see Penrose, 1959; Grant, 1996; Winter, 2003). Existing literature on competencies addresses the resources or capabilities firms need in order to successfully create and sustain a competitive advantage. Competencies related to innovation and change within a firm are sometimes referred to as dynamic capabilities (Teece et al., 1997). The theory states that firms need to create or acquire these dynamic capabilities in order to be able to successfully innovate in a changing competitive environment. Dynamic capabilities are higher level competencies which enable the firm to continually renew its resource and knowledge base in order to keep up with the demands of the market, and persistently innovate (Winter, 2003). What this discussion simply suggests is that firms have dynamic capabilities, and dynamic capabilities lead them to pursue different innovation strategies.

The notion of inertia also plays an important role in the strategic management literature (see also organisational ecology research on this concept, e.g. Hannan and Freeman, 1984; Carroll and Hannan, 2000). Similar to the idea of semi-stable routines, the concept of inertia is that a firm's strategy is stable, hard-to-change and

persistent at the firm level (for example, see Helfat, 1994; Stuart and Podolny, 1996). Winter (2003) argues that firms may innovate even without a strategic focus, or develop innovations in a non-routine way by *ad hoc* problem solving. However, theory predicts that persistent innovation is not likely without a clear strategy backed up by the relevant capabilities, and this is reinforced, for example, by the interaction between the firm's knowledge base and its absorptive capacity. Firms with more (relevant) knowledge and a better developed absorptive capacity are in a better position to innovate (Cohen and Levinthal, 1989, 1990), but innovation itself reinforces absorptive capacity. This latter aspect is sometimes referred to in the literature as double loop learning (Argyris and Schon, 1978), and can be extended to the Open Innovation model (Chesbrough et al., 2006), which has recently been influential in strategic management literature. Firms which are more open in the innovation process reap higher sales and profits from new innovations (Laursen and Salter, 2006)[12] which, in turn, may enable future innovation (i.e. the proposition of success breeds success, as discussed above).

From an empirical perspective, the discussion above suggests that it is important to include variables which measure these inputs in a regression framework aimed at identifying or explaining innovation persistence. However, whether or not such an approach is feasible depends, to a large extent, on the degree to which these innovation inputs themselves can be considered to be exogenous at the level of the regressions. In other words, whether or not there is merit in attempting to explain innovation persistence depends on what is known about the background of the differences between firms which may relate to a varying degree of innovation persistence.

Given that the data used has, at most, three observations (on innovation) per firm spanning a decade in total (see below), the differences between firms in terms of the choice of innovation inputs can indeed be considered as being largely exogenous. These differences will be measured at the outset of the 10-year period observed, and then it will be assumed that these observed differences explain innovation and persistence over the next observations.

The role of innovation strategies

The long-run differences in the innovation processes between firms have been addressed previously in the innovation literature. The literature of technological regimes and sectoral patterns of innovation is especially relevant to our case as it studies the variety of innovation processes and (related) industrial dynamics observed across sectors (Nelson & Winter 1982, Pavitt 1984, Marsili & Verspagen 2002,

[12] Laursen and Salter (2006) suggest that searching more widely and deeply for ideas or knowledge from external sources increases the benefits of open innovation. However, over-search (in terms of breadth and depth) may result in decreasing returns.

Castellacci 2008). Technological regimes are the manifestations of technological trajectories and mechanisms of market selection, which shape the environment firms innovate in (Dosi 1982). An extension of this argument suggests that firms will choose to pursue innovation strategies that they perceive to be most aligned with the dominant technological regime in which it is embedded. Hence, technological opportunities and the intensity of market selection which characterize technological regimes will have an effect on the incentives and possibilities to (persistently) innovate. Thus, we expect that innovation (persistence) at the firm level will differ across regimes.

Similar to the literature on technological regimes, our methodological approach to define innovation strategies is somewhat inductive and data-based (see below). However, our approach differs from this strand of literature by focusing on the level of the firm, not sector. This is important because it allows us to capture firm heterogeneity and its implications for innovation persistence, as measured by the influence of innovation strategies, within industrial sectors, which has been recommended in the literature (Archibugi 2001). To further address the possible differences stemming from the selection environment, we study the persistence in both high-tech and low-tech industries.

In conclusion, we argue that the finding that firms that innovate once tend to innovate again in the future, can be linked to the conceptual notion of innovation strategies, which brings together theoretical ideas from a range of literature. On the one hand, the notion of innovation strategies captures of sunk costs, "success breeds success", and learning-by-doing, which are all factors that previous innovation persistence studies have used to interpret their findings. On the other hand, the idea of technological regimes and (sectoral) systems of innovation also underpins our notion of innovation strategies, by pointing out that the environment in which a firm is embedded influences its strategic choices.

Similar to the literature on technological regimes, we identify a taxonomy of five innovation strategies based on how intensively firms use a number of innovation related input factors, and pursue a number of innovation goals. The least strategic innovators in the taxonomy are the *ad hoc* group, which may be expected to be among the least persistent innovators. The reason is that firms in this group have not invested much financial resources in R&D (i.e., absence of sunk costs), do not have firm commitments to other inputs (knowledge sources), which induces less strong learning dynamics, and to the extent that this strategy generates relatively minor innovations, they are also less able to invest the profits from prior innovations in subsequent innovative activity.

Firms that rely mostly on suppliers of machinery and equipment as knowledge sources for their innovations belong to the *supplier-based* strategy. This may be seen as an incremental approach to innovation where the firms do not invest much resource in-house to pursue innovation. Because of this, again, neither "sunk cost dynamics"

nor "success-breads-success dynamics" may be in place to allow for persistent innovation.

The *market-driven* innovation strategy consists of firms that focus on customer driven innovation and seek knowledge from industry sources, such as competitors and clients. These are relations that firms invest in, and which are also matched by significant internal funds, indicating that this strategy requires more log-run commitment than the previous two. Thus, pursuing this strategy may be expected to be persistent innovators because of sunk costs associated with the strategy.

The fourth innovation strategy that we identify is the *R&D intensive* strategy. These firms tend to have a broad spectrum of goals and sources for innovation, but especially tend to focus on internal and external R&D. Thus, firms pursuing this strategy may especially be expected to be persistently innovative due to sunk-costs. To the extent that this strategy yields more radical innovations, "success-breads success dynamics" and "learning effects" from prior innovations will also induce higher persistence in this group.

The last group are the *science-based* innovators, which rely heavily on scientific sources of knowledge, such as patents, universities and research institutes, in their innovation process. Firms pursuing this approach to innovation may be expected to be persistent innovators as basic science holds many technological opportunities (Klevorick et al., 1995). Further, it is now well established that companies that draw heavily on universities and research institutes have a high developed absorptive capacity which is believed to enable (persistent) innovation (Rosenberg, 1982; Cohen & Levinthal, 1990; Laursen & Salter, 2004). Learning-by-doing is arguably a key driving factor behind the expected persistent innovativeness of the firms following the "science" strategy. All these factors lead us to expect that innovation persistence is high in this strategy.

3. Data and Methodology

Our research builds on a panel database created by Statistics Norway. The main objective of creating this database has been to track firms over time on key variables such as innovation, R&D, employment and sales. The database contains information about all enterprises which have participated in at least one of the R&D surveys conducted by Statistics Norway since 1993. The R&D survey is conducted every second year, and thus, the panel consists of waves of two years. The surveys target all firms with 10 employees or more. However, all firms with 50 or more employees are included in the database, while only a random – but representative – sample of firms with less than 50 employees are included. As a consequence, large firms have

a much higher probability of being included in several surveys rather than small firms. Hence, for small firms (less than 50 employees), we do not know whether firms that exit the database over time do so because they are not sampled, or because they exited. This might lead to an attrition bias, especially if exit is correlated with innovation strategies. We cannot control for such a bias because we do not know the reason why a firm exited from the database, but we expect that this bias is not large because firm exit is not large in Norway.

We use a part of the R&D panel. The first year of the dataset used is 1997, in which the R&D data were combined with data from the Community Innovation Survey for year 1997 (so called CIS2). The CIS2 questions on innovation applied here refer to the past three years, i.e., the CIS2 survey asks whether or not the firm innovated in the period between 1995 and 1997. Because the surveys are conducted every two years, the innovation questions have an overlap of one year, and this may introduce an element of spurious persistence which is a potential significant problem (potentially much larger than the 10% which Raymond et al. 2006 suggest). Therefore, we find it necessary to create a sample without any overlap in the measurement period. The innovation variables that we use refer to the periods 1995-1997, 1999-2001, and 2002-2004. A survey covering the period between1998 and 2000 does not exist, which is why we are forced to leave a one-year gap between the first and second wave in the dataset. Because a lagged dependent variable is adopted as one of the regressors, the regressions use two observations per firm at most (this is the case for firms which are present in all 3 waves). Moreover, since the initial observation (data from the CIS 2) is used to measure the innovation strategies, the sample used in the regressions is limited to those firms which were present in the initial wave (the CIS 2). And because the questions about innovation in services are incompatible between the waves, the service sector is excluded from the dataset, i.e. the sample is limited to industry (mining, manufacturing, public utilities and construction).

We employ two dependent variables, namely, product innovation and process innovation, one at a time. These variables are directly observed in the survey, and are binary. The value 1 for the product or process innovation variable indicates that the firm had one or more respective innovations (either product or process) during the 3-year period. According to the definition of the Oslo Manual a product innovation is a product whose technological characteristics or intended uses differ significantly from those of previously produced products. Such innovations can involve radically new technologies, can be based on combining existing technologies in new uses, or can be derived from the use of new knowledge. The broad definition of innovation also includes improved products whose performance has been significantly enhanced or upgraded. A simple product may be improved through use of higher-performance components or materials, or a complex product which consists of a number of integrated technical sub-systems may be improved by partial changes to one of the

sub-systems. Process innovation, on the other hand, is defined as the adoption of technologically new or significantly improved production methods, including methods of product delivery. These methods may involve changes in equipment, or production organisation, or a combination of these changes, and may be derived from the use of new knowledge.

Table 1 documents the summary statistics of the main variables used in the regressions, broken down by waves of the survey (wave 2 refers to the first observation used in the regressions, since wave 1, which is the CIS 2, is used only for lagged innovation variables). One of the control variables used here is firm size (from which larger firms are expected to have a higher probability to innovate, i.e. Schumpeter Mark II, 1942), and this is measured by the number of employees a firm has (as reported in the survey). Both employment and ln(employment) are documented, but only the latter is used in the regressions. With an average number of 183 employees, the firms in this sample seem fairly large by Norwegian standards. This is a result of the fact that larger firms have a higher probability of being included in the sample, because of the aforementioned sampling method used by Statistics Norway. Also because of this sampling method, the average firm size in wave 3 is larger than in wave 2, i.e. those (larger) firms which are present in wave 3 are also present in the two previous waves (as opposed to the firms present in wave 2, which need not be present in wave 3). In addition, the statistics in Table 1 demonstrate that the employment variable has a high standard error, which is the result of the skewed nature of this variable. In fact, there are a few very large firms in the sample, the largest of which has more than 11,000 employees.

Table 1 also reports that product innovation is more frequent (about 41% of all observations) than process innovation (about 34%). Moreover, both forms of innovation are more frequent in wave 2 than in wave 3, although this difference is much larger for process innovation (a drop from 38% to 26%) than for product innovation (42% to 39%).

Table 3.1. Descriptive statistics

	total			*wave=2*			*wave=3*		
	valid n	Average	St. error	valid n	Average	St. error	valid n	Average	St. error
Employment	1510	183.4	490.0	905	170.6	435.4	605	202.6	561.6
ln(Employment)	1509	4.423	1.137	904	4.368	1.133	605	4.505	1.140
Product innovation	1476	0.409	0.492	905	0.420	0.494	571	0.391	0.488
Process innovation	1510	0.335	0.472	905	0.383	0.486	605	0.263	0.441

Table 2 illustrates the transition probabilities for the innovation status of firms for both types of innovation. The sums of the values on the diagonal are an indication of persistence, as they indicate the fraction of firms which stay in the same class, being persistent innovators or persistent non-innovators (Cefis, 2003). These values are all high (above 0.5, with one exception), which suggests that persistence is indeed prevalent in the sample (but of course, this needs to be further tested in a regression model which includes control variables). However, process innovators seem to be less persistent. In both periods, firms which were initially process innovators have a relatively low probability of staying that way (compared to product innovators). In the second period (wave 2 – 3), process innovators have an even larger probability of being non-process innovators in the next wave than remaining as process innovators (0.6 versus 0.4).

The difference between the two cells in the second column of each matrix indicates the 'bonus' enjoyed by an initial innovator over an initial non-innovator in terms of innovation probability. Although these observed differences do not control for variables such as firm size and other (observed or non-observed) heterogeneity, they can serve as a rough benchmark of what to expect in the regressions. The observed differences range from 22% (process innovation in the first period) to 42% (product innovation in the second period).

Table 3.2. Transition probabilities

Period 1 (wave 1 – 2)				**Period 2 (wave 2 – 3)**			
Product innovation		*wave =2*				*wave =3*	
		No	Yes			No	Yes
wave =1	No	0.73	0.27	*wave =2*	No	0.80	0.20
	Yes	0.34	0.66		Yes	0.38	0.62
Process innovation		*wave =2*				*wave =3*	
		No	Yes			No	Yes
wave =1	No	0.71	0.29	*wave =2*	No	0.83	0.17
	Yes	0.49	0.51		Yes	0.60	0.40

Note: The transition probabilities in each matrix are calculated for the firms that are present in the two successive waves considered (wave 1 – 2, wave 2 – 3).

Since the dependent variables employed are binary, a probit regression model is selected. We follow the standard modelling procedure for analysing (innovation) persistence, i.e. the lagged dependent variable is included as an explanatory variable in the model in order to test the persistence hypothesis. The specific estimation model used is a dynamic random effects probit model. Obviously, in such a model, the probability of innovation is dependent on the past innovative history of the firm, and this can be traced back to the initial observation in the sample (wave 1). This initial

observation proxies for otherwise unobserved firm's characteristics, and hence, as suggested by Wooldridge (2005), this initial observation is included, in addition to the lagged dependent variable. It is important to account for heterogeneity in this way, since otherwise the coefficient obtained for the lagged dependent variable may be biased (overestimated) (Raymond et al., 2006; Peters, 2009). Taking into account unobserved firm heterogeneity (by means of random effects), as well as the initial value of the dependent variable, provides a dynamic framework, in which a significant lagged dependent variable indicates true, not spurious, state dependence (Heckman, 1982).

We propose a simple extension to the Wooldridge method (Wooldridge, 2005), to enable an analysis of the influence of innovation strategies on persistent innovation. Principally, the Wooldridge method incorporates an initial condition dummy variable which is coded 0 if firms did not innovate in previous period (t1) and 1 if firms innovated at t1, and this initial condition variable is fixed throughout the panel data analysis. The extension to this method is simply that subgroups of firms which innovated at t1 will be distinguished by using factor and cluster analyses. The CIS2 data used, which represents the time period t1 in the panel, contains various details about innovation in firms, and latent firms' strategies will be identified based on this information, by utilising a factor analysis. A cluster analysis will then categorise innovative firms at t1, based on how they score on the latent factors obtained from the factor analysis. This is important, because the results of the cluster analysis will help to identify subgroups of innovative firms which differ in their approach to innovation at t1. The identified clusters will be represented in the analysis by cluster dummies, where value 1 signals that an innovative firm at t1 belongs to the respective cluster (and not to the others). As the cluster analysis is undertaken using data of only innovative firms at t1, the cluster dummy variables can simply be combined and transformed back into the original dummy variable measuring the "initial innovation condition". Thus, factor and cluster analyses are two essential steps to be taken in order to examine whether, and to what extent, innovation strategies influence persistent innovation at the firm level over time.

4. Measuring innovation strategies by factor and cluster analyses

This section conceptualises innovation strategies, and categorises firms based on their strategies. The review in Section 2 suggests that firms use various knowledge sources and engage in a range of learning activities (for example, through different routines) in the innovation process. Thus, a first step is to identify latent variables or principle components which capture a variety of sources, objectives and activities related to

innovation in firms. For this purpose, a factor analysis is undertaken on the relevant groups of variables extracted from the CIS2 questionnaire. The structure of the questionnaire is such that firms which do not report any product or process innovation are not allowed to answer the questions concerned, and these firms are excluded from the factor analysis. Therefore, the results reported in this section are based only on firms which have carried out some innovation activities.

4.1. Results of factor analysis

Table 3 reports the results of the factor analysis on the set of CIS2 questions which indicate the extent to which the sampled firms were active in different types of innovation activities. The particular factor pattern identified in the table suggests two broad innovation approaches, similar to the "make versus buy" option in technology sourcing. The "make" strategy includes a combination of internal and external R&D, and the market introduction of innovation. The "buy" strategy incorporates reliance on machinery and equipment procurement, external technology, and training related to innovation. This result is in line with that of Veugelers and Cassiman (1999), which demonstrates that firms differ in how they use "make" and "buy" strategies.

Table 3.3. Innovation activities

	Make	*Buy*
▪ Research and experimental development within the enterprise (intramural R&D)	**0.88**	-0.05
▪ Acquisition of R&D services (extramural R&D)	**0.82**	0.00
▪ Acquisition of machinery and equipment linked to product and process innovations	-0.18	**0.72**
▪ Acquisition of other external technology linked to product and process innovations	0.09	**0.65**
▪ Market introduction of technological innovations	**0.52**	0.32
▪ Training directly linked to technological innovations	0.12	**0.71**

Note: 57 % of total variance explained by the two factors; principal components factoring with oblique oblimin rotation, chi^2 (15) = 828.71, Prob. >chi^2 = 0.00, Numbers in bold indicate moderate to high factor loadings.

Table 4 illustrates the results of a second factor analysis, which aimed to identify latent factors in relation to the objectives of firms for innovation. It is assumed that firms differ in terms of innovation goal setting, and that this difference will enable the estimate to detect the factors which account for firm heterogeneity in the innovation process. According to the results, the common goals can be broadly categorised into a "production" dimension (reducing inputs and costs, while improving quality and satisfying standard requirements), and a "market" dimension (competing with better and more products).

Table 3.4. Innovation Objectives

	Production	*Market*
▪ Replace products being phased out	0.20	**0.53**
▪ Improve product quality	**0.46**	0.32
▪ Extend product range	-0.06	**0.82**
▪ Open up new markets or increase market share	-0.01	**0.81**
▪ Fulfil regulations, standards	**0.59**	0.05
▪ Reduce labour costs	**0.72**	-0.11
▪ Reduce materials consumption	**0.75**	0.13
▪ Reduce energy consumption	**0.83**	0.01
▪ Reduce environmental damage	**0.77**	-0.11

Note: 53 % of total variance explained by the two factors; principal components factoring with oblique oblimin rotation, chi^2 (15) = 828.71, Prob. >chi^2 = 0.00, Numbers in bold indicate moderate to high factor loadings.

Following the discussion in Section 2, different types of knowledge sources used in a firm's innovation process are also of interest. Therefore, a factor analysis was undertaken on the set of CIS2 variables which provide such information. The results indicated in Table 5 suggest the presence of three main characteristics or functions of sources of information used by the firms for innovation. The first is labelled "Science", and captures information from universities, research institutes, patents and, to a lesser extent, from computer networks and consultants. The second is labelled "Industry", and includes many sources within industry (including the firm's internal sources, customers, and competitors). The third is labelled "Opportunistic", and refers to the fact that this factor includes a number of sources which require relatively little effort on behalf of the firm which adopts them (suppliers of equipments, journals, professional conferences, fairs and exhibitions).

Table 3.5. Sources of information for innovation

	Science	*Industry*	*Opportunistic*
▪ Sources within the enterprise	0.15	**0.58**	-0.26
▪ Competitors	-0.05	**0.67**	0.23
▪ Clients or customers	-0.02	**0.81**	-0.06
▪ Consultancy enterprises	**0.41**	0.12	0.24
▪ Suppliers	-0.02	-0.15	**0.81**
▪ Universities	**0.86**	-0.04	-0.02
▪ Non-profit research institutes	**0.86**	-0.12	0.01
▪ Patent disclosures	**0.64**	0.24	-0.08
▪ Professional conferences, journals	0.34	0.07	**0.55**
▪ Computer information networks	**0.53**	0.23	0.21
▪ -Fairs, exhibitions	-0.00	0.38	**0.60**

Note: 55 % of total variance explained by the three factors; principal components factoring with oblique oblimin rotation, chi^2 (15) = 828.71, Prob. >chi^2 = 0.00, Numbers in bold indicate moderate to high factor loadings.

4.2. Identifying innovation strategies by means of hierarchical cluster analysis

In order to identify the innovation strategies of the sampled firms, the results obtained from the factor analysis were used in a subsequent cluster analysis. Clustering was undertaken on the factor scores for the seven principal components documented in the previous three tables. The clustering procedure used was a hierarchical clustering, in which each firm is initially located in a separate cluster (so that the initial number of clusters is simply the total number of firms), and then the two most similar clusters were joined together sequentially at each step. Ward's method was adopted as the linkage function. Empirical validation was based on the agglomeration schedule of the hierarchical cluster process. The Calinski/Harabasz pseudo-F stopping rule was used, which indicated the solution to be between 2 to 5 clusters. Although the general custom is to report only a single cluster solution, in order to decrease the subjectivity of the analysis, and because there is no theoretical reason for expecting a single solution, a range of cluster solutions was opted for use. The four cluster solutions are reported in descending order, from five to two (as mentioned above, two of the most similar clusters were combined at each step). Table 6 documents the average factor scores in each of the clusters in different cluster solutions. Since the factor scores are standardised variables with a mean of zero and a standard deviation of one, a positive (negative) number in the table indicates an above (below) average result.

Table 3.6. Hierarchical Cluster Analysis

	Make	Buy	Produc-tion	Market	Science	Industry	Oppor-tunistic	N (%)
5-Clusters								
Strategy 1/5								271
Supplier-based	-0.71	0.34	0.11	0.04	-0.47	0.01	0.54	(28.3)
Strategy 2/5								85
Ad Hoc	-0.84	-0.36	-0.68	-1.70	-0.76	-1.67	-0.34	(8.9)
Strategy 3/5								240
Market-driven	0.09	-0.47	-0.55	0.35	-0.55	0.17	-0.91	(25.1)
Strategy 4/5*								129
R&D intensive	1.17	1.15	0.52	0.67	0.83	0.71	0.46	(23.5)
Strategy 5/5*								231
Science-based	0.39	-0.43	0.41	-0.11	0.95	0.09	0.20	(24.2)
4-Clusters								
(5-Clusters with 1 restriction)								
Strategy 1/4*								271
Supplier-based	-0.71	0.34	0.11	0.04	-0.47	0.01	0.54	(28.3)
Strategy 2/4*								85
Ad hoc	-0.84	-0.36	-0.68	-1.70	-0.76	-1.67	-0.34	(8.9)
Strategy 3/4								240
Market-driven	0.09	-0.47	-0.55	0.35	-0.55	0.17	-0.91	(25.1)
Strategy 4/4								360
High-profile	0.67	0.14	0.45	0.17	0.91	0.31	0.29	(37.7)
3-Clusters								
(5-Clusters with 2 restrictions)								
Strategy 1/3*								356
Supplier-based	-0.74	0.17	-0.08	-0.38	-0.54	-0.40	0.33	(37.2)
Strategy 2/3*								240
Market-driven	0.09	-0.47	-0.55	0.35	-0.55	0.17	-0.91	(25.1)
Strategy 3/3								360
High-profile	0.67	0.14	0.45	0.17	0.91	0.31	0.29	(37.7)
2-Clusters								
(5-Clusters with 3 restrictions)								
Strategy 1/2								596
Low-profile	-0.41	-0.09	-0.27	-0.08	-0.54	-0.17	-0.17	(62.3)
Strategy 2/2								360
High-profile	0.67	0.14	0.45	0.17	0.91	0.31	0.29	(37.7)

* denotes the two strategies/clusters that join together in the subsequent stage.

In the 5-cluster solution, the Supplier-based strategy has high scores specifically on "buy" and "opportunistic", which suggests that these firms mainly rely on suppliers (of machinery and equipment) for their innovation. The Ad hoc strategy refers to the group of firms which has below-average (negative) scores on all factors. This strategy refers to undertaking innovation on an *ad hoc* basis (Winter, 2003), without particular reference to the strategic factors identified. The Market-driven group scores positive on "market" and "industry", and, to a lesser extent, on "make", which implies that firms in this group tend to seek knowledge from the industry for their innovation process, aiming to make more and better products to compete in the market. The R&D intensive strategy represents a group of firms which are active in all of the aspects of innovation considered, but especially stand out with higher scores on both external and internal R&D factors, "make" and "buy". The fifth group is called Science-based innovation strategy, since this group scores particularly high on "science" and "make", i.e. they are firms which utilise scientific knowledge and undertake internal R&D.

In the 4-cluster solution, the Science-based and R&D intensive groups are merged. This combined group (High-profile) still scores higher than average on all factors, but now more substantially on "science". In the next phase (the 3-cluster solution), the Ad hoc group is combined with the Supplier-based group, which, at this point, turns to have negative scores on all factors, except "buy" and "opportunistic". Here, the Supplier-based group seems to refer to firms which depend very little on themselves, but heavily on their suppliers. Finally, the 2-cluster solution distinguishes the High-profile and Low-profile groups of firms. The move to this stage merges the Supplier-based and Market-driven group into one with low scores on all factors, i.e. Low-profile (similar in meaning to the Ad hoc strategy identified above, but not in scale or membership).

The hierarchical nature of the clusters (i.e. at each transition between two levels, two clusters are combined) can, in the econometric context, be represented as a set of restrictions on the coefficients in the estimated model. For example, the five strategies (clusters) will be represented by five dummy variables (the non-innovators being the reference category). The move to four strategies (clusters) can then be represented by the restriction that two of these dummy variables (R&D intensive and Science based) carry the same coefficient. A similar logic applies to each "transition" to a lower number of strategies (e.g. four clusters is equivalent to five clusters with one restriction, and three clusters is equivalent to five clusters with two restrictions).

To demonstrate the sectoral patterns of our innovation strategies, Table 7 shows the distribution of some broad industry categories in terms of the above described innovation strategy clusters. One observation that is quite clear is that each sector has a substantial part of each strategy, i.e., the strategies and sectors are different dimensions of the data. The *supplier-based* strategy is dominant in what may be called traditional industries, such as fishing, manufacturing of food and beverages, as

well as manufacturing of furniture, and wood products. These industries also have a higher share of *ad hoc* innovators, with also construction, and utilities related industries showing up. *Market-driven* strategies are prominent in construction, manufacturing of machinery, electrical and optical equipment, but also manufacturing of textiles and leathers. The *science-based* strategy is prominent in the recycling and utilities sectors and mining and quarry industry. Somewhat surprisingly, fishing has a large share of science-based innovators (this needs to be seen in light of the Norwegian context, where salmon farming is a big business). *R&D intensive* innovation strategies are found in manufacturing petroleum and chemicals, but also electronics and optical equipments. However, these industries also represent a relatively even distribution of innovation strategies. Altogether, the descriptive statistics of the sectoral distribution of our clusters are in line with previous taxonomies of technological regimes (e.g. Pavitt 1984). On the other hand, it shows that innovation strategies are relatively evenly distributed within many sectors. This indicates that, as evolutionary theory predicts, there exists heterogeneity of innovation strategies within sectoral categories.

Table 3.7. Sectoral distribution of innovation strategies

	Supplier-based	Ad Hoc	Market-driven	R&D intensive	Science-based	Total	N (%)
Sector (2-digit NACE)							
Fishing	38.5 %		7.7 %	7.7 %	46.2 %	100	13
(5)							(1.4)
Mining & quarrying	6.5 %	9.7 %	16.1 %	12.9 %	54.8 %	100	31
(10-14)							(3.2)
Manuf. of food, bev. &	37.3 %	14.7 %	19.3 %	8.0 %	20.7 %	100	150
tobacco (15-16)							(15.7)
Manuf. of text. & leather	37.5 %	5.0 %	30.0 %	15.0 %	12.5 %	100	40
(17-19)							(4.2)
Manuf. of wood prod.	42.6 %	15.6 %	19.2 %	7.1 %	15.6 %	100	141
pulp & publish. (20-22)							(14.8)
Manuf.petrol., chem., & nonmetals	25.0 %	4.3 %	21.6 %	21.6 %	27.6 %	100	116
(23-26)							(12.1)
Manuf. basic & fabr. Metals	22.5 %	9.2 %	29.6 %	16.3 %	22.5 %	100	98
(27-28)							(10.3)
Manuf.mach., elect. & opt.eq.	15.9 %	6.0 %	33.0 %	21.4 %	23.6 %	100	182
(29-33)							(19.0)
Manuf. transp. equipm.	22.5 %	3.8 %	33.8 %	13.8 %	26.3 %	100	80
(34-35)							(8.4)
Manufacturing n.e.c.	47.2 %	1.9 %	24.5 %	17.0 %	9.4 %	100	53
(36)							(5.5)
Recycling; Electricity, gas & water supply	18.9 %	13.5 %	18.9 %		48.7 %	100	37
(37-41)							(3.9)
Construction	20.0 %	13.3 %	33.3 %		33.3 %	100	15
(45)							(1.6)
Total	28.4 %	8.9 %	25.1 %	13.5 %	24.2 %	100	956

5. Econometric Results

The econometric exercise estimates a probit model for two dependent variables, namely, product innovation and process innovation. Besides firm size and the innovation variables, industry dummy variables and time dummy variables, are always included as additional controls. The first model (Table 8) examines the persistence of innovation by taking into account the lagged dependent variable and initial innovation as a way to account for firm heterogeneity, but does not yet include the innovation strategy variables. This is the model which has been used in the literature so far (e.g. Peters, 2009).

Table 3.8. Basic model

	Product innovation			**Process innovation**		
	Coeff.	St. Error		Coeff.	St. Error	
Initial innovation (Innovation at t_1)	0.551	0.248	**	0.166	0.162	
Lagged innovation	0.436	0.213	**	0.323	0.171	*
Size	0.277	0.053	***	0.212	0.041	***
Industry dummies		Yes			Yes	
Rho	0.266	0.143	**	0.106	0.134	
BIC	1782.2			1871.6		
No. of Observations	1475			1509		
No. of firms	910			910		
average observation per firm	1.6			1.7		

*, **, *** denote significance at the 10, 5 and 1% level, respectively.

Both forms of innovation appear to be persistent, as indicated by the positive and significant sign of the lagged innovation variable in both cases. In the case of product innovation, the persistence effect is stronger and more significant, and the initial innovation is also significant, which further adds to the persistence result. In terms of process innovation, the initial innovation variable is not significant, and the lagged innovation has a lower estimated coefficient, which is only significant at the 10% level. Firm size is strongly significant in both cases, although the effect of size is weaker (but still sizable and very significant) in the case of process innovation**.** The contribution of unobserved firm heterogeneity to the total variance (rho) is significant in product innovation, in which case it accounts for about a quarter of the total variance.

We proceed by including the innovation strategy dummy variables in the equation instead of the initial innovation, in an attempt to account for the strategic differences between the firms which were argued (in Section 2) to be related to innovation probability and innovation persistence. It should be noted that the model of Table 8

is nested in this new specification, since firms which do not engage in innovation activities (at t = 1) will show a zero value on all innovation strategy variables. Therefore, they are the baseline group, as they were in Table 8. One dummy is used for each innovation strategy, so that the specification of Table 8 corresponds to a case in which all of the coefficients of the innovation strategy dummy variables are equal to each other. It should also be noted that, as discussed above, the set of restrictions on the coefficients (applied to the results in Table 9 – 12) is related to the different levels in the hierarchical cluster analysis which was used to identify innovation strategies. In this sense, using less innovation strategies corresponds more closely to the basic specification in the literature.

The choice about which level of the hierarchical cluster analysis to use in the regression, is approached by using the interpretation of the hierarchical levels as econometric restrictions. We tried all cluster solutions (in the range of 2 – 5 clusters), and then chose the one which minimised the Bayesian Information Criterion (BIC) statistic. The BIC is a common criterion used when selecting one from a range of models with a different number of explanatory variables. The results of the "best" model (i.e. with the lowest BIC) are documented in Table 9.

In terms of product innovation, the 5-cluster solution (without any restrictions, i.e. incorporating all of the strategies 1 – 5) minimised the BIC. In other words, the maximum heterogeneity allowed by the model used was found to provide the best fit. This suggests that differences between strategies are an important determinant of product innovation. Such differences appear to have less influence in the case of process innovation, where the model with two strategies (i.e. three restrictions: strategy 1 equals strategy 2; strategy 1 equals strategy 3; strategy 4 equals strategy 5) best fits the data. Nevertheless, by comparing the BIC of this model (for process innovation) with the BIC of that in Table 8, two strategies are better than no strategies at all (four restrictions).

Table 3.9. Model with innovation strategy intercepts instead of initial innovation

	Product innovation				**Process innovation**		
5-clusters (with no restriction)	Coeff.	St. Error		*5-clusters with 3 restrictions*	Coeff.	St. Error	
Lagged innovation	0.423	0.207	**		0.320	0.169	*
Size	0.234	0.050	***		0.191	0.040	***
Strategy 1/5 *Supplier-based*	0.109	0.23					
Strategy 2/5 *Ad Hoc*	-0.951	0.475	**		0.035	0.158	
Strategy 3/5 *Market-driven*	0.621	0.266	**				
Strategy 4/5 *R&D intensive*	1.205	0.341	***		0.331	0.184	*
Strategy 5/5 *Science-based*	0.564	0.270	**				
Industry dummies		Yes				Yes	
Rho	0.226	0.145			0.093	0.134	
BIC	1771.2				1869		
No. of observations	1472				1506		
No. of firms	908				908		
Average observation per firm	1.6				1.7		

*, **, *** denote significance at the 10, 5 and 1% level, respectively.

The results in Table 9 illustrate that both of the estimated coefficients for lagged innovation are still significant. Their value does not differ much from that in Table 8, which implies that the persistence results in Table 8 are robust to the inclusion of strategy variables which measure more firm heterogeneity than does the initial innovation. Despite the inclusion of the innovation strategies, the parts of the total variance explained by unobserved firm heterogeneity (rho) do not decline much. However, unobserved firm heterogeneity no longer contributes significantly to the product innovation equation.

In the case of product innovation, which uses the 5-cluster solution without restrictions, the coefficient of the Supplier-based innovation strategy (mode 1/5) is not significant. Therefore, the firms in this group appear to be at the same baseline innovation probability as the firms which did not innovate in the initial period. The coefficient of the Ad hoc strategy (strategy 2/5), which includes the firms which innovate with minimal inputs, is negative and significant (in the case of product innovation). The negative coefficient indicates that these firms, ceteris paribus, are less likely to innovate than those identified as non-innovators in the initial period. This seems to suggest that this innovation strategy is a one-off innovation, i.e. once these firms innovate, they will not do it again in the next couple of years, because

innovative activity is not a strategic element of their behaviour. This could be termed anti-persistence.

The other three strategies for product innovation all show significant and positive coefficients, which indicates that firms with these innovation strategies are more likely to be innovators than those which did not initially innovate. Interestingly, the coefficients for these three innovation strategies differ from each other, with strategy 4/5 (R&D intensive) yielding the highest one. This result supports the point made in the theoretical discussion, i.e. R&D activity was positively related with innovation persistence due to the nature of sunk costs or the increased absorptive capacity related to this type of activity. Overall, the results clearly confirm the hypothesis that different types of innovation strategies lead to different probabilities of innovation, and that this tendency is persistent over the time-scale of the regressions in this exercise. Moreover, a weaker emphasis on the different dimensions of innovation strategies leads to less persistent innovation behaviour.

In terms of process innovation (applying the 5-cluster solution with 3 restrictions), the baseline innovation probability of the first three strategies (Supplier-based, Ad hoc and Market-driven) is not significant (i.e. statistically identical to non-innovators), and for the other two strategies, R&D intensive and Science-based, it is positive, but not very high (the marginal effects will be presented and discussed later). This less-clear persistence in the case of process innovation is consistent with the results in Table 8 (basic model with no innovation strategies).

Table 3.10. Estimations for high- and low-tech separately (only results with strongest persistence)

	Product innovation, high-tech					
	(Basic Model)			*(5-clusters with 2 restrictions)*		
	Coeff.	St. Error		Coeff.	St. Error	
Initial innovation	0.593	0.319				
Lagged innovation	0.656	0.277	**	0.400	0.280	
Size	0.321	0.093	***	0.292	0.095	***
Strategy 1/5 *Supplier-based*						
Strategy 2/5 *Ad hoc*				-0.156	0.345	
Strategy 3/5 *Market-driven*				0.988	0.384	***
Strategy 4/5 *R&D intensive*				1.120	0.363	***
Strategy 5/5 *Science-based*						
Industry dummies		Yes			Yes	
Rho	0.258	0.100	*	0.271	0.088	**
BIC	397.3			391.4		
No. of observations	325			323		
No. firms	192			191		
Average observation per firm	1.7			1.7		
	Process innovation, low-tech					
	(Basic Model)			*(5-clusters with 3 restrictions)*		
	Coeff.	St. Error		Coeff.	St. Error	
Initial innovation	0.059	0.177				
Lagged innovation	0.437	0.189	**	0.432	0.186	**
Size	0.214	0.046	***	0.190	0.044	***
Strategy 1/5 *Supplier-based*						
Strategy 2/5 *Ad hoc*				-0.097	0.170	
Strategy 3/5 *Market-driven*						
Strategy 4/5 *R&D intensive*				0.283	0.207	
Strategy 5/5 *Science-based*						
Industry dummies		Yes			Yes	
Rho	0.028	0.162		0.014	0.158	
BIC	1416.4			1414.2		
No. of observations	1175			1174		
No. firms	720			719		
Average observation per firm	1.6			1.6		

*, **, *** denote significance at the 10, 5 and 1% level, respectively.

To test whether the selection environment plays a role in the persistency of innovation we follow Raymond et al. (2006) and estimate separate specifications for high-tech and low-tech sectors.[13] Table 10 reports the core of our estimations in which the model is estimated separately for high-tech and low-tech sectors. The full set of models is not documented (both types of innovation in both sectors), but instead, emphasis is placed on the cases which demonstrate a stronger persistence than those in Tables 8 and 9. These are product innovation in high-tech, and process innovation in low-tech. This is in line with Raymond et al. (2006) who found different results for persistence in high-tech and low-tech sectors.

Product innovation in the high-tech sector appears to be very persistent if the innovation strategy variables are excluded (i.e. in the 'basic model'). In this case, a coefficient of about 0.66 was found for lagged innovation, which is higher than any coefficient in the previous tables. However, this appeared to be largely spurious, since the coefficient became non-significant and dropped to 0.4 when innovation strategies were included. In terms of process innovation, which is most persistent in the low-tech sector, no such spurious persistence was found. In fact, the innovation strategy variables all appeared to be non-significant in this case. The coefficient for lagged process innovation is about 0.1 higher than in Table 9.

What do these results imply for the relevance of innovation strategies in explaining observed differences in the propensity to innovate between firms? In order to respond to this question, the implied marginal effects of the variables included in the estimates reported above need to be examined. The marginal effects, which were calculated using the predicted probit probabilities, are documented in Tables 11 and 12.

The overall impression is that the (observed) heterogeneity between firms (innovation strategies) plays an important role in explaining innovation probability, especially in explaining product innovation (see Tables 11 & 12). In the case of product innovation in all sectors (Table 11), firms which were initially in innovation strategy 4/5 (R&D intensive) have a 45% higher probability of innovation than those which did not innovate initially, across the entire time span of the regression. The effect of lagged innovation, i.e. the level of innovation persistence which is unexplained by differences in innovation strategies, is 16% (in the innovation strategies model), which is much lower than the innovation strategy 4/5 effect. The 16% effect related to lagged innovation is comparable to the difference between the marginal effects of innovation strategy 4/5 and either innovation strategies 3/5 (Market-driven) or 5/5 (Science-based). However, it is smaller than the effect of either innovation strategies 3/5, 4/5 or 5/5 individually, and also smaller than the

[13] High-tech and low-tech are defined along the lines of OECD (1999) classification. High-tech consists of chemicals, electrical products, machinery and equipment, plastics and vehicles industries. On the other hand, Low-tech consists of food, metals, non-metallic products, textiles, products not classified elsewhere, and wood.

absolute value of the innovation strategy 2/5 effect (Ad hoc, which is -28%). Only in the case of process innovation is the effect of lagged innovation comparable in size to that of the innovation strategies (mode 4/5 and mode 5/5 in Table 11). In the low-tech sector (Table 12), the effect of lagged process innovation (about 15%) is even larger than the effect of innovation strategies. As discussed earlier, this difference between the persistence of product and process innovation may be explained by the fact that process innovation is often undertaken based on learning-by-doing, which may involve less strategic decision-making and technological advancement.

Table 3.11. Marginal effects of the main variables in the model (initial innovation, innovation strategies)

	Marginal Effect	St. Error		Marginal Effect	St. Error	
Basic model	**Product innovation**			**Process innovation**		
Initial innovation	0.210	0.092	**	0.059	0.057	
Lagged innovation	0.166	0.082	**	0.115	0.063	*
Size	0.105	0.020	***	0.075	0.014	***
Innovation Strategies model						
Lagged innovation	0.162	0.080	**	0.114	0.062	*
Size	0.090	0.019	***	0.067	0.014	***
Strategy 1/5 *Supplier-based*	0.042	0.090		0.012	0.056	
Strategy 2/5 *Ad hoc*	-0.281	0.091	***			
Strategy 3/5 *Market-driven*	0.244	0.102	**			
Strategy 4/5 *R&D intensive*	0.445	0.103	***	0.122	0.069	*
Strategy 5/5 *Science-based*	0.221	0.105	**			

*, **, *** denote significance at the 10, 5 and 1% level, respectively.

Table 3.12. Marginal effects of the main variables in the model (high-tech, low-tech)

	Product innovation, high-tech					
	Marginal Effect	St. Error		Marginal Effect	St. Error	
Initial innovation	0.223	0.12	*			
Lagged innovation	0.245	0.104	**	0.148	0.105	
Size	0.118	0.034	***	0.106	0.034	***
Strategy 1/5 *Supplier-based* Strategy 2/5 *Ad hoc*				-0.058	0.131	
Strategy 3/5 *Market-driven*				0.290	0.083	***
Strategy 4/5 *R&D intensive* Strategy 5/5 *Science-based*				0.369	0.102	***
	Process innovation, low-tech					
	Marginal Effect	St. Error		Marginal Effect	St. Error	
Initial innovation	0.02	0.06				
Lagged innovation	0.151	0.069	**	0.15	0.068	**
Size	0.072	0.015	***	0.064	0.014	***
Strategy 1/5 *Supplier-based* Strategy 2/5 *Ad hoc* Strategy 3/5 *Market-driven*				-0.032	0.056	
Strategy 4/5 *R&D intensive* Strategy 5/5 *Science-based*				0.101	0.075	

*, **, *** denote significance at the 10, 5 and 1% level, respectively.

6. Conclusions and Implications for Future Research

An important issue in the recent literature on firm-level innovation is whether, and to what extent, firms which innovate once have a higher probability of innovating again in subsequent periods. Although this phenomenon, which is called 'innovation persistence', has been confirmed by many recent studies, none of them has systematically investigated why some firms (do not) persistently innovate, and this gap in knowledge is what motivates us. Based on evolutionary theory and strategic management research, we propose that firm heterogeneity in the form of stable strategic differences across firms can explain why they (do not) persistently innovate.

Accordingly, the research question asked was, to what extent do differences in firms' innovation strategies affect their persistence of innovation?

Based on a methodology which combines factor analysis, cluster analysis, and a dynamic random effects probit model, and which extends the Wooldridge method (Wooldridge, 2005) normally used to examine innovation persistence, we set out to explore this important question in a panel data framework. The results confirm the general finding in the literature that innovation is persistent at the firm level. The most interesting result in this paper is that observed and stable firm heterogeneity in the form of initial strategic differences across firms constitutes a key driving force behind a firm's probability to innovate over time. The econometric results suggest that the effects of innovation strategies are, in many cases, larger than the 'pure' effect of lagged innovation. This seems to suggest that innovation strategies provide an additional, and more important, source of innovation persistence than lagged innovation.

In addition, we found that, although there appears to be a sign of persistence of product and process innovation, its significance and scale differ between these two types of innovation. This difference is along the lines of previous research, which has pointed out a distinction between the innovation characteristics of the two types. Differences were also found with regard to innovation persistence in high-tech and low-tech sectors. The results show that the low-tech sector is also persistent in innovation, but mainly in terms of process innovation.

Our main contribution to the literature is that it has extended prior research on innovation persistence with the argument that firms have different innovation strategies, and that such strategies constitute an important source of persistent innovative behaviour. Future studies may advance this line of research by showing how the effects of innovation strategies on innovation persistence differ across countries and industries. Future research could also try to better understand why and how firms innovate in one time period but not in subsequent time periods, and why and how firms are able to innovate at one point in time if they have not innovated in the past. We find that initial innovation strategies have a long lasting effect on the way firms conduct innovation. Exploring these and similar questions holds a premise to better understanding firms' heterogeneity and sources of (persistent) innovation.

CHAPTER 4: EXPLORING RELATIONSHIPS AMONG PROACTIVENESS, RISK-TAKING AND INNOVATION OUTPUT IN FAMILY AND NON-FAMILY FIRMS

1. Introduction

Family firms (FFs) account for a large percentage of all organizations worldwide. As many as 85% of all companies in OECD nations (Rößl et al., 2010) and 35% of companies listed on both S&P 500 and Fortune 500 are family owned (Anderson & Reeb, 2003; Lee, 2006). Morck and Yeung (2003) notably claim that family-based initiatives account for the majority of new entrepreneurial enterprises. Given these observations it is not surprising that interest in this sector is increasing and the phenomena being explored are diverse (Craig & Salvato, 2012). While a considerable amount of the extant literature on FFs revolves around issues related to performance differences between these tightly-held private companies and their widely-held public equivalents (Anderson & Reeb, 2003; Kraus et al., 2011), other recurrent themes include their entrepreneurial behavior or orientation, including risk-taking propensity. In these studies, FFs are typically viewed as being more conservative, less likely to be risk-takers, and less entrepreneurial in their behavior. We contribute to this discourse by comparing relationships among risk-taking, proactivity, and innovation output in family and non-family firms (NFFs).

Though there is consensus that firms benefit from innovation (Baumol, 2002; Cefis & Marsili, 2006), relationships among innovation output and its determinants are nuanced by (among other factors) the type of organization (Damanpour, 1991). For many reasons, FFs are a distinct organizational type that would be expected to exhibit different innovation output-linked characteristics than NFFs (Rößl et al., 2010; De Massis et al., 2013). Though still the subject of debate, research has begun to demonstrate where and how these differences are manifested. For example, research has categorized FFs as being less innovative than NFFs as a result of their conservative nature (Habbershon et al., 2003), having more limited access to capital markets (Kets de Vries, 1993), being risk averse (Naldi et al., 2007), and being less eager to grow (Poza et al., 1997). Conversely, other studies have found that being a FF positively influences innovation and growth (Margaret, 2008; Casillas & Moreno, 2010). Although "the degree to which extended families are an important source of the oxygen that fuels the fire of entrepreneurship" (Rogoff & Heck, 2003, p. 561) has

become clearer, a considerable gap remains in the understanding of innovation output in FFs (Gudmundson et al., 2003; Craig & Moores, 2006).

In this study, we further the understanding of the pre-determinants of innovation output by comparing FFs versus NFFs using two entrepreneurial orientation (EO) dimensions as our determinants (Harms & Ehrmann, 2009). Specifically, the propensity to proactively compete with industry rivals (i.e. proactivity) and the tendency of the top management of firms to take risks regarding investment decisions and strategic choices in the face of uncertainty (i.e. risk-taking) (Covin & Slevin, 1991) are used to empirically determine where differences exist in FFs and NFFs' ability to generate innovation output (i.e. the share of sales originating from products new to the firm developed within the past three years) (e.g. Smith, 2005; Laursen & Salter, 2006). The third dimension of the EO tripartite (i.e. innovativeness) is notably not considered as an independent variable in this study due to the use of innovation output as our performance proxy.

Two identifiable contributions to the extant literature are claimed. First, we extend the understanding of innovation in family businesses by demonstrating how proactivity and risk-taking influence product innovation output differently in FFs relative to NFFs (Gómez-Mejía et al., 2007; Chrisman & Patel, 2012). By showing that FFs gain more from proactivity than risk-taking, we provide new insights into how the influence of two of the widely accepted EO dimensions differs when compared to NFFs. Second, we contribute to the literature on EO related to the relationship among its different dimensions. While EO research has established that innovativeness is positively associated with proactivity and risk-taking, a distinction of this paper is that we establish proactivity and risk-taking as determinants of innovation output (e.g. Richard et al., 2004; Avlonitis & Salavou, 2007).

The following will take a look at the relevant literature around which our arguments are framed and present the hypotheses distilled from this work. Our methodology precedes a discussion of the main theoretical and applied contributions of our research.

2. Previous Literature

Family firms dominate the majority of commercial global activities. Regardless of country and cultural context, the overlap of the family system with the business system presents unique advantages and challenges. Family ownership can provide advantages due to its unique bundles of resources that lead to distinct capabilities (Habbershon & Williams, 1999). Included in these are commitments to the long-term (Lichtenthaler & Muethel, 2012), family-influenced organizational culture (Litz & Kleysen, 2001; Zahra et al., 2008), and efficiency in terms of decision making (Sciascia et al., 2013; Siu & Martin, 1992). Despite the perceived advantages, family

firms still need to operate in the face of growing competition (Zahra et al., 2008). Accordingly, family firms are increasingly looking at innovation as a way to stay competitive (Lichtenthaler & Muethel, 2012). However, there is a dearth of evidence related to the antecedents to innovation output in family firms (Souder & Thomas, 2003; De Massis et al., 2013).

In their 53-study meta-analysis, Rauch et al. (2009) show a positive correlation between the combined EO dimensions of a firm and its performance. Further, taking all the dimensions of EO together, Zainol and Ayadurai (2010) conclude that FFs' performance is enhanced by higher levels of EO. In a more refined approach, Zellweger and Sieger (2012) argue that long-lived successful FFs show low to moderate levels of EO. Thus, high levels of all dimensions of EO are not a necessary condition for success. Interestingly, when FFs do in fact embrace risk, it is associated with a lower level of performance (Naldi et al., 2007; Zahra, 2005; Zellweger & Sieger, 2012). Further justification for isolating discrete EO dimensions comes from Miller (2011) who encourages studies to focus not only on EO as a unified construct, but also on the separate sub-components of risk-taking, proactiveness and innovativeness.

Directly related to this research, Short et al. (2009) show that FFs differ from NFFs on some of the sub-dimensions, but not on the overall EO measure. More specifically, they find that while FFs do use language consistent with EO on all dimensions, they nevertheless use less language than NFFs on the dimensions of risk-taking, proactiveness, and autonomous behavior. A distinguishing characteristic that could explain these findings is the long-term orientation of FFs and their related goal of protecting family wealth for future generations (Cruz & Nordquist, 2010; Gómez-Mejía et al., 2007).

3. Hypotheses Development

Evidence shows that FFs are entrepreneurially orientated when the dimensions of risk-taking and proactivity exist in the firm, with the caveat that FFs are generally less risk embracing. Further, studies support the idea that the control and level of involvement-related characteristics of FFs influence the separate dimensions of EO, which also affects the relationship between EO and firm performance. However, it is still largely unclear how the separate dimensions of EO influence innovation output, or more specifically, how FFs can actively manage innovativeness-inhibiting and innovativeness-supporting facets to stimulate the successful implementation of innovations (Llach & Nordquist, 2010; Rößl et al., 2010). Irava and Moores (2010)

shed some light on this through their findings that family influence enhances long-term entrepreneurial success when certain unique-to-family resources are leveraged.

Many EO studies employ financial performance as an outcome metric. However, research analyzing the impact EO has on innovation output in FFs compared with NFFs is rare. A noted exception is Avlonitis and Salavou (2007) who reveal that it is proactive and risk-loving entrepreneurial firms that produce new products and performance improvements as a result. These authors emphasize that all the FFs in their sample acknowledged that innovation was essential to thrive, but only the proactive and risk-taking firms were able to generate products that were also positively related to performance. Their results show that proactivity directly influences new product performance whereas risk-taking does not. This finding is confirmed by Pérez-Luño et al. (2011) who suggest that proactivity and risk-taking positively influence innovation generation, but not adoption. Upton et al. (2001) revealed that successful FF innovators pursue a first-mover or an early-follower strategy. Kets de Vries (1993) describes FFs as being flexible and capable of making quick decisions. Similarly, Leenen (2005) acknowledges the capability of FFs to make quick decisions. As such, due to the absence of hierarchies and a less bureaucratic structure, FFs have a potential advantage over NFFs in terms of their ability to be proactively responsive to opportunities (Irava & Moores, 2010; Kellermanns et al., 2011). Following this reasoning, we hypothesize that proactivity will positively relate to innovation output more frequently in firms with family ownership than in those without family ownership. Formally stated:

Hypothesis 1. The positive relationship between proactivity and innovation output is greater in FFs than NFFs.

Our interest also concerns the role of another EO dimension, i.e. risk-taking, as a determinant of innovation output in FFs and NFFs. Traditionally, family firms are considered conservative and less eager to take risks (Kraus & Harms, 2011). And when FFs do in fact take risks, such actions have been found to be negatively related to performance (Naldi et al., 2007). The multiple goal structure of FFs influences how risk is embraced as, for example, FFs are committed to the long-term health of the business and the non-economic metrics of success (Gómez-Mejía et al., 2007). Hence, we propose the following hypothesis:

Hypothesis 2. The positive relationship between risk-taking and innovation output is greater in NFFs than FFs.

4. Methodology

We used data from a stratified sample of 2,227 firms provided by the Business Register of Statistics Finland to test our hypotheses. The data represents Finnish firms operating in the food industry (NACE 10–11), the media (NACE 18, 58-61), and the shipbuilding cluster, including ship construction (NACE 301) and any of its related sub-contracting sectors (e.g. furnishing and maintenance). The sample included the full population of all firms with five or more employees and a random sample of the smaller firms. The data collection was conducted in the late spring of 2009. The survey targeted members of the top management teams of the firms (e.g. chief executive officer, owner-manager) using computer-aided telephone interviews. Respondents were also given the option to participate through an internet-based questionnaire. The researchers approached the targets in random order, and contacted each non-responding target multiple times on different weekdays at various times of the day.

The official Finnish definition of an FF is one having more than 50% of its shares in the hands of a family, and where the chief executive officer or owner-manager believes that he or she is working for an FF. A total of 532 responses, 224 FFs (42.1%) and 308 NFFs (57.9%), representing a response rate of 23.9% were received. Responses represented a cross section of industries with 127 food industry firms (24%), 246 media firms (46%), and 159 shipbuilding firms (30%). Tests for response bias showed no significant differences between respondents and non-respondents, the number of employees, annual revenue, and age of the firm between the two groups. To remedy possible common method variance (CMV) ex ante, we operationalized the dependent variable in a different format than the independent variables (Chang et al., 2010). Harman's single factor test was applied ex post. The items of the main independent variables were loaded into an exploratory factor analysis, which generated a two-factor result where neither of the factors accounted for the majority of the variance (under 46%). Both of these remedies suggest that possible bias due to the CMV does not substantially influence the results.

5. Measures

Dependent Variable: Product Innovation Output

Consistent with the Oslo Manual (OECD/Eurostat, 2005) and other studies (see e.g. Smith, 2005; Laursen & Salter, 2006; Makkonen et al., 2013) the product innovation output variable measured the share of total revenue created by new products. A new product is defined as an innovation if it has been introduced during the last three-year

period. This figure was log-transformed to achieve normality. An innovation output measure was used rather than the innovativeness dimension of the EO scale (Covin & Slevin, 1989) in order to (1) focus explicitly on achieved innovation output, and (2) lessen problems of CMV.

Independent Variables: Proactivity and Risk-taking

Proactivity and risk-taking were determined using Covin and Slevin's (1989) six-item instrument, supplemented with one additional indicator of proactivity, as suggested by Lumpkin and Dess (2001). We modified the original semantic differential scale (Covin & Slevin, 1989) into a seven-point Likert-type scale anchored by "strongly disagree" to "strongly agree." Opposing interpretations and findings exist in the literature on the dimensionality of EO, which has been considered either a uni-dimensional or a multidimensional construct (Rauch et al., 2009). We analyzed the constructs separately in order to focus on their interrelationship (e.g. Naldi et al., 2007; Pérez-Luño et al., 2011). We tested the suitability of the latent constructs for the two groups of firms (family and non-family) using confirmatory factor analysis (CFA) (see the Appendices).

Control Variables

We included six control variables in the analysis: R&D intensity, primary market, environmental uncertainty, firm size, firm age, and industry. R&D intensity was measured as a sum variable consisting of four items related to the extent of R&D activities within the firm (Cronbach's alpha 0.88). These four items are *"We seek to increase R&D investments"*, *"Our firm has specific plans for R&D activity"*, *"Our management is involved in R&D processes"*, and *"Our firm is developing routines for firm R&D"*. We included a dummy control measuring whether the firm operates on the national/international level or only in the local market. Research in innovation studies has shown that firms operating in an international environment are more likely to innovate (e.g. Roper & Love, 2002). We also controlled for environmental economic uncertainty, i.e. the extent to which the environment can support sustained growth (Dess & Beard, 1984; Bstieler, 2005). Environmental uncertainty was established using a sum variable consisting of three items (Cronbach's alpha 0.60). These items are *"The environment causes a great deal of threat to the survival of our firm"*, *"We are operating in a declining industry, where dwindling markets for products are a very substantial threat"*, and *"New business opportunities have radically diminished in our industry due to global recession."* Finally, we controlled for firm size and firm age. While larger firms tend to have more resources to innovate and thus are generally considered more innovative (e.g. Schumpeter, 1934; Galbraith, 1952), empirical research has shown that small firms engage in product innovation

(Acs & Audretsch, 1988; Hansen, 1992). Younger firms are generally more innovative (Hansen, 1992; Huergo & Jaumandreu, 2004).

6. Results

Descriptive statistics

In our sample, FFs and NFFs do not differ to a large extent from each other (Table 1). NFFs are on average much larger, slightly older and have a higher innovation output. The mean of both the risk-taking and proactivity measures are also marginally higher for the NFFs. Interestingly, the difference between the groups is not statistically significant on any variables. When considering innovation output, this finding supports the view that FFs do not necessarily innovate less than the NFFs. However, the mean of R&D intensity, an innovation input measure, is larger for the NFFs.

Table 4.1. Descriptive statistics and correlation table

Full sample

	Variable	Obs	Mean	Std. Dev.	Min	Max
1.	Innovation output[1]	500	21%	0.214	0	100%
2.	Risk-taking	533	3.59	1.243	1	7
3.	Proactivity	532	4.45	1.278	1	7
4.	R&D intensity	532	4.30	1.484	1	7
5.	Primary market	531	62%	0.485		
6.	Environmental turbulence	532	3.71	1.361	1	7
7.	Firm size[1]	521	1842.58		1	35000
8.	Firm age[1]	530	31.96	32.878	1	190

	Correlation	1.	2.	3.	4.	5.	6.	7.	8.
1.		1							
2.		0.185*	1						
3.		0.200*	0.378*	1					
4.		0.117*	0.295*	0.452*	1				
5.		0.160*	0.102	0.168*	0.170*	1			
6.		-0.13*	-0.075	-0.075	-0.123*	-0.056	1		
7.		-0.071	0.148*	0.164*	0.308*	0.135*	0.062	1	
8.		-0.211*	0.071	0.009	0.130*	0.143*	0.054	0.373*	1

Pairwise correlation table with significance levels. * p<0.01

Non-family firms

	Variable	Obs	Mean	Std. Dev.	Min	Max	Pr(|T| > |t|)
1.	Innovation output[1]	284	22%	0.23	0	100%	0.27
2.	Risk-taking	308	3.63	1.26	1	7	0.31
3.	Proactivity	308	4.50	1.24	1.33	7	0.26
4.	R&D intensity	308	4.40	1.47	1	7	0.07
5.	Primary market	307	64%	0.48			0.31
6.	Environmental turbulence	308	3.66	1.25	1	7	0.32
7.	Firm size[1]	298	2381.07		1	35000	0.22
8.	Firm age[1]	307	32.48	36.81	1	190	0.67

	Correlation table	1.	2.	3.	4.	5.	6.	7.	8.
1.		1.000							
2.		0.214*	1.000						
3.		0.133*	0.423*	1.000					
4.		0.076	0.311*	0.417*	1.000				
5.		0.184*	0.146	0.165*	0.182	1.000			
6.		-0.160*	-0.104	-0.084	-0.209*	-0.073	1.000		
7.		-0.066	0.120	0.091	0.290*	0.113	0.077	1.000	
8.		-0.222*	0.114	0.007	0.181	0.176	0.062	0.378*	1.000

Pairwise correlation table with significance levels. * p<0.01

Family firms

	Variable	Obs	Mean	Std. Dev.	Min	Max	Pr(|T| > |t|)	Correlation table							
									1.	2.	3.	4.	5.	6.	7.	8.
1.	Innovation output[1]	216	19%	0.19	0	100%	0.27	1.	1.000							
2.	Risk-taking	224	3.52	1.21	1	7	0.31	2.	0.136	1.000						
3.	Proactivity	224	4.38	1.33	1	7	0.26	3.	0.295*	0.315*	1.000					
4.	R&D intensity	224	4.16	1.50	1	7	0.07	4.	0.173	0.267*	0.492*	1.000				
5.	Primary market	224	60%	0.49			0.31	5.	0.122	0.038	0.168	0.147	1.000			
6.	Environmental turbulence	224	3.78	1.50	1	7	0.32	6.	-0.089	-0.037	-0.061	-0.022	-0.033	1.000		
7.	Firm size[1]	223	111	589.45	1	8000	0.22	7.	-0.085	0.182	0.257*	0.326*	0.160	0.053	1.000	
8.	Firm age[1]	223	31.25	26.6	1	159	0.67	8.	-0.181	0.023	0.055	0.075	-0.077	0.032	0.412*	1.000

[1]log-transformed variables used in estimations

Pairwise correlation table with significance levels. * p<0.01

Analysis

To test our hypotheses, we followed the standard hierarchical ordinary least squares estimation procedure, estimating five different specifications. First, we estimated the model including only the control variables related to the firm and the operating environment. In the second specification, we focused on the direct effects of our model by entering our main explanatory variables of proactivity and risk-taking. The third specification (our baseline model) included the family firm dummy variable, which takes into account the difference in the intercept between the two groups. After the baseline model we estimated the interaction specifications to test our hypotheses. The interaction terms were first entered separately and then together.

Table 2 presents the results of our estimations. From specification (0) we see that the control variables have the expected sign. R&D intensity is positively related to innovation output, as is the primary market dummy. Firm age and environmental uncertainty both have a negative and significant effect. Only firm size does not have a significant effect on the dependent variable of innovation output. To take into account the difference in the sector distribution, the industry effects are also included in the analysis, but not included in the table for the sake of brevity. No statistical differences were found in the specifications testing the hypotheses.

Table 4.2. Estimations results for hypothesized and baseline models.

Estimation results

VARIABLES	(0) Controls	(1) Main Effects	(2) Baseline	(3) Interaction 1	(4) Interaction 2	(5) Full model	(6) R.check	(7) Full model w/ R.check
R&D intensity	0.013**	0.003	0.003	0.003	0.003	0.003	0.003	0.002
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
Primary market	0.038**	0.036**	0.036**	0.036**	0.036**	0.036**	0.036**	0.037**
	(0.015)	(0.015)	(0.015)	(0.015)	(0.015)	(0.015)	(0.015)	(0.015)
Environmental turbulence	-0.012*	-0.010*	-0.011*	-0.011*	-0.010*	-0.010*	-0.011*	-0.010*
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
Size (log)	-0.003	-0.005	-0.005	-0.005	-0.005	-0.006	-0.005	-0.005
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
Age (log)	-0.029***	-0.026***	-0.026***	-0.026***	-0.026***	-0.025***	-0.024**	-0.023**
	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.008)	(0.008)
Family firm			0.005	-0.074†	0.026	-0.044	0.022	-0.023
			(0.014)	(0.048)	(0.041)	(0.053)	(0.046)	(0.068)
Proactivity		0.018**	0.018**	0.010	0.018**	0.007	0.018**	0.007
		(0.006)	(0.006)	(0.008)	(0.006)	(0.008)	(0.006)	(0.008)
Risk taking		0.013*	0.013*	0.014**	0.016*	0.021**	0.013*	0.021**
		(0.006)	(0.006)	(0.006)	(0.008)	(0.008)	(0.006)	(0.008)
Family firm * Proactivity				0.018*		0.023*		0.024*
				(0.010)		(0.011)		(0.011)
Family firm * Risk taking					-0.006	-0.015†		-0.015†
					(0.011)	(0.012)		(0.012)
Family firm * Age							-0.006	-0.007
							(0.014)	(0.014)
Constant	0.213***	0.126**	0.125**	0.162***	0.115**	0.150***	0.119**	0.144**
	(0.035)	(0.040)	(0.040)	(0.046)	(0.043)	(0.046)	(0.042)	(0.048)
Industry fixed effects	YES	YES	YES	YES	YES	YES	YES	YES
Marginal effects for Family firm								
Proactivity				0.027**		0.030***		0.030***
				(0.008)		(0.009)		(0.009)
Risk taking					0.010	0.006		0.006
					(0.009)	(0.009)		(0.009)
Age							-0.030**	-0.030**
							(0.016)	(0.013)
Observations	491	491	491	491	491	491	491	491
R-squared	0.097	0.132	0.132	0.137	0.132	0.140	0.132	0.140

Unstandardized coefficients, standard errors in parentheses
*** p<0.001 ** p<0.01, * p<0.05, †
p<0.1

From the next column in Table 2, we see that the direct effects of proactivity and risk-taking are (as expected) positive and significant. In the next step, we estimated the baseline model, in which the family firm dummy variable is added to the estimation. The insignificant result indicates that the intercept does not statistically differ between the two groups.

In specifications (3) and (4), we focus on our main research question and estimate the effects of the two main explanatory variables for the two groups. Because our primary interest lies in the group moderation effect in the relationship between the two dimensions and innovation output (i.e. how do the effects of the explanatory variables of proactiveness and risk-taking behave in the two groups), we focus on the marginal effects of these variables on innovation output (Brambor et al., 2006). The interaction term in the estimation gives the size of the difference between the marginal effects of proactivity between FFs and NFFs. In specification (3), the interaction term is positive and significant (0.018, $p<0.05$) using a one-tailed t-test. The coefficient for proactivity in column (3) is the marginal effect for the NFF group. Here we see that, although positive, it is insignificant and thus does not statistically differ from zero. At the bottom of the table under the heading "Marginal effects for family firm" we computed the marginal effects for the explanatory variables of interest for the FF group. Again, from column (3) we see that for the FFs it is positive and significant (0.027, $p<0.01$). The difference in R2 between this specification and the baseline was also statistically (although marginally) significant ($F(1,479) = 2.91$, prob > F = 0.089). These findings suggest that FFs benefit more from proactivity than the NFFs, supporting Hypothesis 1.

A closer examination of the coefficient for the NFFs indicates that the standard error is relatively high. In other words, the relationship is not uniform for all of the firms in the group, which helps explain the small statistical difference between the groups.

In specification (4), we conducted a similar analysis for risk-taking. The results indicate an almost opposite effect for the two groups, i.e. NFFs have a positive and significant effect from risk-taking in their innovation output (0.016, $p<0.01$), while the effect for the FFs is not significant and hence does not differ from zero (0.010, $p>0.10$). This highlights that NFFs benefit more from risk-taking in their innovation output than the FFs. However, the interaction term for risk-taking is not significant in specification (5) and, similarly, the increase in R2 is statistically insignificant. Hypothesis 2 is therefore partially supported.

In specification (5), we estimated the full model including both of the interaction terms at the same time. This does not change the results, but strengthens them by increasing the differences between the groups. Notably, the difference increases to 0.023 for proactivity while the difference between the groups' risk-taking increases

(-0.015). However, the latter is statistically significant at $p<0.10$. In addition, the difference in R2 between specification (2) and (5) is not statistically significant. The marginal effects indicate unambiguous results, namely that FFs benefit more from proactivity and less from risk-taking, while the opposite is true for the NFFs. In sum, as we hypothesized, family firms gain more in terms of innovation output from proactivity than the NFFs, while risk-taking is less influential for FFs than NFFs.

As a robustness check, we also estimated the interaction effect of firm age and family firm status. Since the study does not include variables for generational involvement, the purpose of this check was to see whether a generational involvement effect exists for the FFs. In other words, if the family firms were to benefit from a generational involvement effect, the marginal effect of firm age on innovation output for family firms would be positive, or at least significantly less negative, than for the non-family firms. Columns (6) and (7) report the results for the robustness check. We find that for both groups, the effect of firm age is negative and significant and the marginal effects do not differ statistically between the groups.

7. Discussion

This article set out to understand the relationship among proactivity, risk-taking and innovation output in FFs and NFFs using a sample of 532 Finnish firms. We find evidence that, in innovation output terms, FFs gain more from proactivity than NFFs, while risk-taking is less influential for FFs than for NFFs. Our results therefore indicate that the determinant processes leading to innovation output differ between the two types of firms.

That FFs benefit more from their proactivity than NFFs provides support for Hypothesis 1 and is consistent with previous findings examining similar relations, albeit with different performance metrics (e.g. Avlonitis & Salavou, 2007). This finding contributes to previous work such as the study by Pérez-Luño et al. (2011) which emphasizes that proactivity is positively related to innovation *generation* but not to innovation *adoption*. Innovation generation requires tacit knowledge, an aspect usually associated more with FFs than with NFFs (Stewart, 2003; Pérez-Luño et al., 2011). A possible explanation is that the knowledge in FFs is handed down through social interaction (Nonaka, 1994) between family members. In addition, the level of trust is potentially higher in FFs than in NFFs, while trustworthiness plays an important part in the transfer of knowledge (Szulanski et al., 2004). Thus, tacit knowledge is potentially easier to share in FFs. In addition, FFs are associated with a more long-term orientation (e.g. Lumpkin et al., 2010), which equips them with the capability to provide long-term managerial support and reap the benefits of being proactive.

The importance of non-financial performance focus for FFs (Gómez-Mejía et al., 2007) also helps explain the positive relationship between proactivity and innovation output. Related to this, FFs' higher levels of human, social, and marketing capital (Llach & Nordquist, 2010) are indicators of a proactive stance. FFs are also associated with lower levels of hierarchy, less formality, and higher flexibility (e.g. Kets de Vries, 1993; Leenen, 2005; Carney, 2005; Kraus et al., 2011), which enables them to respond swiftly. Our data indicates that proactive FFs can potentially generate more innovation output, which can be linked to their long-term and organizational learning orientations. This is partially supported by Zahra's (1996) finding that organizational learning is positively related to the speed and breadth of learning in FFs, but negatively related to the depth of learning. The findings that proactivity is more positively related to innovation output in FFs than it is in NFFs helps to further understand the EO determinants that distinguish these organization types.

Hypothesis 2 examined the differences between FFs and NFFs with respect to the relationship between risk-taking and innovation output. Our data revealed partial support for this hypothesis. The finding that NFFs benefit from risk-taking can, to some extent, be explained by the differences between the firms' culture. NFFs are generally characterized as more willing to take risks, more competitive, and more achievement oriented than FFs (Duh et al., 2010). However, FFs have a different perception of risk than NFFs and will take considerable risk if faced with threat of losing the company (Gomez-Meija et al. (2007). Thus, NFFs can be said to have a more uniform risk profile and, as such, they can use risk-taking as a calculated part of their strategy whereas FFs use risk-taking as a measure to try to prevent the loss of non-economic capital.

Previous literature proposes that the overlap of ownership and management in FFs makes them more sensitive to self-control problems. As external pressure becomes less, the pressure for internal and external monitoring is reduced. As such, this may decrease agency-related costs while at the same time increasing self-control problems (Carney, 2005). Many owner-managers make decisions intuitively, resulting in situations whereby "managers in FFs have less control and understanding of the risk that they are taking" (Naldi et al., 2007, p. 37). Thus, for different reasons than those posited for our proactivity-innovation output results (e.g. the different, typically shorter-term motivations of the NFF decision makers and the need for FF decision makers to be cognizant of future stakeholder generations as well as the influence of non-financial metrics such as the family's reputation), the findings that risk-taking is more positively related to innovation output in NFFs than in FFs also furthers the understanding of the EO determinants that distinguish FFs and NFFs.

For those in business, the findings showing that proactiveness matters more than risk-taking in FFs when it comes to innovative output performance have interesting implications. For FFs to improve innovation output, their focus should be on proactiveness rather than risk-taking. This is emphasized by the observation that FF managers have different decision making criteria than NFF managers (Chrisman &

Patel, 2012). So whether in the form of scenario planning or other planning tools, focusing on proactiveness would be advisable here.

Another issue also related to risk deals with the business service providers that work with FFs needing to understand the individual FFs' perception of risk. The notion that FFs are more risk averse than NFFs is open to interpretation and is individual family-specific. As a collective, FFs are risk averse, although this potentially changes in the case of idiosyncratic aspects such as when reputational capital is threatened.

8. Limitations

A first limitation of this research is that we did not use a longitudinal study, so the results do not reflect a causal relationship. The necessary but insufficient time precedence could be identified with a longitudinal and in-depth study, which recent family business literature has emphasized (e.g. Benavides-Velasco et al., 2013).

A second limitation of this study is its use of product innovation as the dependent variable. Here, it might be valuable to maintain separation between the different types of innovation. Family firms tend to prefer incremental innovation (Leenen, 2005), since discontinuous change in terms of product innovations has been found to conflict with the essential goals and values of the family system (König et al., 2013). Kraus et al. (2012) argue that FFs benefit more from organizational innovations than from management innovations. It thus appears valuable to analyze product and process innovations and their relationship to proactivity and risk-taking.

A third limitation of the study regarding the entrepreneurial orientation literature is the replacement of the original innovativeness measure of the EO construct with a direct measure of innovation output. While acknowledging that this differs from most traditional approaches to operationalizing the EO dimensions, it follows more recent work in EO literature (e.g. Covin et al., 2006; Pérez-Luño et al., 2011) and is appropriate for this study for two reasons. First, since we aim to address the differences in innovation performance, an objective measure of innovation output is more suitable. Second, in doing this, the common method is reduced.

A further limitation relates to the use of a dichotomous distinction between FFs and NFFs. Though common in existing family literature, this does not reflect that FFs are heterogeneous (e.g. Sharma, 2004; Westhead & Howorth, 2007). Finally, the national culture and traditions of Finland might have influenced the results. Any inferences to other countries should be made with care.

9. Conclusion

This paper highlights that the relationship among EO dimensions and innovation output is complex. Future EO research in family businesses should continue to study the reasons for, as well as the consequences of, the differences among the different EO dimensions and various performance relationships. We encourage further research that investigates these relationships and which would extend our efforts to e.g. the influence of non-financial performance metrics in FFs.

APPENDICES

Table 4.A1. CFA group comparison

Model fit measures					Model differences			
Model tested	**χ2**	**df**	**p**	**RMSEA**	**CFI**	**Δχ2**	**Δdf**	**p**
separate groups								
non-family	19.619	8	0.012	0.069	0.977			
family	6.722	8	0.567					
baseline model	26.336	16	0.049	0.035	0.988			
conjectural invariance	33.29	20	0.031	0.035	0.984	6.954	4	0.138
scalar invariance	39.339	26	0.045	0.031	0.984	6.049	6	0.418

Table 4.A2. CFA validity assessment

Group	Construct	Item	std. factor loadings	GOF stat.	Composite reliability	Discriminant validity		
Non-family								
	EOPRO	EOPRO1	0.721		0.75		EOPRO	EORISK
		EOPRO2	0.52	**χ2=19.619**		EOPRO	*0.72*	
		EOPRO3	0.867	df=8		EORISK	0.55	0.71
	EORISK	EORISK1	0.738	p=0.012	0.75			
		EORISK2	0.766	RMSEA=0.069		Off diagonal: construct correlation		
		REORISK3	0.6	CFI=0.977		Along diagonal: square root of AVE		
Family								
	EOPRO	EOPRO1	0.753	**χ2=6.722**	0.79		EOPRO	EORISK
		EOPRO2	0.656	df=8		EOPRO	*0.75*	
		EOPRO3	0.826	p=0.567		EORISK	0.41	*0.67*
	EORISK	EORISK1	0.769	RMSEA=0	0.70			
		EORISK2	0.77	CFI=1		Off diagonal: construct correlation		
		EORISK3	0.411			Along diagonal: square root of AVE		

CHAPTER 5: INNOVATION IN FAMILY FIRMS: AN EMPIRICAL ANALYSIS LINKING ORGANIZATION AND MANAGERIAL INNOVATION TO CORPORATE SUCCESS

1. Introduction[14]

Family firms play a significant role in national economies worldwide, and strongly contribute to their growth and stability (Klein, 2000; Tio & Kleiner, 2005). Widely recognized, family firms account for 85% of all enterprises in the OECD countries as well as for ca. 70-80% of all enterprises in Europe (Van den Berghe & Carchon, 2003; Mandl, 2008) as well as in the USA (Potts et al., 2001; Astrachan & Shanker, 2003). In Finland, 80% of all companies are considered family firms (Finnish Family Firm Association, 2010).

Previous scholarly research on family firms has mostly focused on the question of how they differ from public corporations. Family firms are often described as being conservative (Habbershon et al., 2003; Ward, 2004); less risk-raking (Morris, 1998); more long-term oriented (Sharma & Irving, 2005); reluctant to grow and slow-growing (Taiguiri & Davis, 1992; Poza et al., 1997); slow in decision-making; and unable to react or change in accordance with markets (Schulze et al., 2003; Lubatkin et al., 2007). In sum, they are often considered to be less entrepreneurial than their non-family counterparts. Similarly, the existing literature often criticizes the lack of innovation in family firms (Cabrera-Suárez et al., 2001; Carney, 2005).

Innovations are a major driving force for entrepreneurship and (firm-level as well as economic) growth. Entrepreneurial firms are characterized by their commitment to innovation (Miller, 1983; Covin & Slevin, 1991). A marketplace that is more and more competitive continues to see increased interest in understanding the factors associated with innovation (Llach & Nordquist, 2010). After all, the management of innovation, continual change, and generation-spanning corporate development are widely considered to be and discussed as the recipe for economic growth and long-term success. Because most companies in the western world are SMEs, with the majority of these being family firms, continuous innovation is seen as a primary element of company success. Against the background of global competition for

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technologies and markets, innovation management is seen as a core challenge for European companies. A deeper understanding of the influence of families on innovation in their firms can deliver important insights to help elaborate more widely on the potential of countries to remain as leaders in the global innovation context (Bergfeld & Weber, 2011). Although innovation's role has been studied in large and publicly traded firms (e.g. Zahra, 1993) or high-tech ventures (e.g. Koberg et al., 1996), it's those firms in particular that have remained in the hands of families which continue to be ignored by innovation researchers (Craig & Moores, 2006). In their recent article, Rößl et al. (2010) even constitute a general "lack of research regarding the innovative activity of family firms" (p. 368).

The objective of this article is therefore to increase the – until now – limited understanding of the role of innovation in family firms. In this study the aim is not to study whether family firms are more, or less, innovative than the non-family firms, as has been addressed in the literature previously. Instead, as the family-business research has shown, we posit that there are important differences between family and non-family firms, which have an effect on how the firms innovate. Taking this as our point of departure, we aim to study the role of *management innovations* between these two groups of firms. We will especially focus on *organizational* and *managerial innovation* and how they affect corporate success. We are especially interested whether and to what extent the relationship between managerial and organizational innovation differs between family and non-family firms. For this, we present the assumption that organizational and managerial innovations lead to higher success in family firms, especially through their role as antecedents of successful product innovation (Damanpour et al., 1989; Armbruster et al., 2008) . Innovations in turn lead to an improved overall competitive position (Damanpour et al., 1989; Zahra et al., 2004). This potential relationship was investigated on the basis of a large-scale quantitative empirical survey of 533 Finnish firms which will be analyzed using the help of the structural equation modeling technique.

2. Definitions and delineation of subject

2.1 Family firms

Family firm research as a scholarly field is still considered to be in its early stages (Craig & Lindsay, 2002). Litz (1995) calls family firms one of the most consistently overlooked organizational phenomena. Although the quantity as well as the quality of research on family firms is constantly increasing, as Chrisman et al. (2003) put it, "much remains to be done". For example, to date there is not even a generally accepted definition of what a family firm actually is (Chrisman et al., 2005; Di Toma

& Montanari, 2010; Kraus et al., 2011). What is generally agreed on is, though, that family firms can be regarded as "contextual hybrids" (Naldi et al., 2007), being the combination of two institutional influence systems, the family and the business (Gersick et al., 1997).

A definition has to distinguish family firms from public corporations, sole proprietorships, or generally from business partnerships, as well as from small and medium-sized enterprises (SMEs) which typically share many, if not even most, but not necessarily all characteristics of family firms. Many definitions thus do not succeed in delineating family firms from sole proprietorships or SMEs. In fact, most family firms are SMEs (Fletcher, 2005). Except for a few large international family firms (Hennerkes, 2004), a majority of family firms can in fact be regarded as SMEs. Following e.g. Reimers (2004), we regard the term "family firm" as independent of company size.

A range of attempts to narrow down this term are based on qualitative characteristics for the explication of family firms. Accordingly, Habbershon and Williams (1999) define family firms as unique bundles of resources and capabilities which result from interactions between the family and the company. According to Klein (2004), a company is a family firm if one of the three factors of equity capital, management and control is dominated entirely by the family, or if the lack of influence on one of the three factors is compensated by another factor. However, it is assumed that a stake in equity capital is a necessary requirement. From this perspective, family firms are defined as companies in which ownership belongs to one family or is distributed among several families and their members, and in which (apart from the entrepreneur) at least one supplemental family member actively participates in the company through his or her collaboration (Covin, 1999; Carsrud, 2006; Rutherford et al., 2006). The will to retain the company in the family on a long-term basis also should be added as a necessary prerequisite, along with the distribution of control among several family members (Sharma et al., 1997; Astrachan & Shanker, 2003).

For this study, we follow the definition by Rößl et al. (2010), and define a family firm as a company 1) of which several family members hold capital shares, 2) whose major business capital is held by one or more members of this family, 3) in which the strategic decisions are made by several family members based on the importance of their capital shares and/or are based on informal authority, whereas it is irrelevant if the entrepreneurial family itself constitutes the management or if it controls the company through a management appointed by the family, 4) on whose economic development several people in the family are directly financially dependent, since their individual capital incomes and/or their individual work incomes in the company generate a majority of their income, and 5) which, due to this importance for the family, is intended to be retained in the family's sphere of influence.

2.2 Innovativeness of entrepreneurial firms

An innovation can be defined as the successful implementation of the processes where new creative ideas are put into practice within an organization (Rickards, 1985; Schaper & Volery, 2004). Specifically, innovation is the establishment of new concepts, procedures and/or technologies in an organization. For something to be understood as an innovation, it requires novelty; tangible qualities; must be the result of a deliberate action and not a coincidence; should aim to produce benefit; and be recognizable as something other than just a change to the typical routines (King & Anderson, 2002).

Innovations are the expression of entrepreneurial activity and may contribute to the long-term survival of a (family) business (Leenen, 2005). Innovativeness is a *strategic orientation* that many organizations require. It provides a way to adapt to technology, competition, and market changes (Dougherty & Hardy, 1996). A significant segment of the literature on innovation management emphasizes the importance of innovation as a part of corporate strategy with the goal of keeping the company competitive and in business (Hakala, 2011). Here, the assumption is always that innovation increases the uniqueness of systems, products, processes, and services, leading to higher profitability and more growth (Damanpour et al., 1989). Innovations allow a company to increase its return on investments, achieve a greater market share, and strengthen its overall competitive position. Innovations are always an indicator of corporate activity, and can be understood as an assurance that the (family) firm will not only continue operating but also grow for years to come (Leenen, 2005; Bergfeld & Weber, 2011).

According to Miller & Friesen (1983), " […] an entrepreneurial firm is one that engages in product-market innovation, undertakes somewhat risky ventures, and is first to come up with 'proactive' innovations, beating competitors to the punch" (p. 771). An important element of an entrepreneurial innovative firm is the ability to adapt to the changing market requirements (Teece et al., 1997), which often requires reinvention of the business model in order to realize the full potential of new product innovations and, more generally, enable the firm to remain innovative (Johnson et al., 2008). These business model innovations are essentially linked to new ways of organizing the company and its management systems, i.e. to managerial and organizational innovations (Doz & Kosonen, 2010; Osterwalder & Pigneur, 2010).

Management innovations work through technological product innovations. Organizational and managerial innovations (such as business model innovations) may not lead to value creation without technological product innovations (Chesbrough, 2010; Teece, 2010). Although work on non-technological innovation has existed for quite some time, most of the literature on innovation still focuses on technological product and process innovation (Birkinshaw et al., 2008). However, the need to understand administrative or management innovations is equally important. Studies

have shown that management innovations, both managerial and organizational, lead to better firm-level performance, especially when implemented together with product innovations (e.g. Damanpour & Evan, 1984; Damanpour et al., 1989; Sapprasert, 2010). As highlighted in previous literature, the adoption and creation of innovation requires adaption and change for the innovating organization as well (e.g. Fagerberg, 2003; Lorenz & Wilkinson, 2003; Lam, 2005). This literature emphasizes the combinatorial nature of innovation, put forth originally by Schumpeter (1934) where innovation requires the whole organization to be able to overcome inertia and develop new routines to appreciate the benefits of new innovations. Therefore, in order to innovate, firms are required to adapt their organization to the new products or process they wish to introduce. Firms need to adjust their organization to meet the requirements of the changing operational environment, be able to adopt new technologies, and commercialize their new products and processes. A recent example of management innovation leading the firm in becoming increasingly innovative is the open innovation model. A growing strand of research has shown that firms need external sources of knowledge and ideas to advance their technology and not only internal (Chesbrough, 2003). To make the transition from the closed innovation model to the open innovation model, the firm needs to also create or adopt a different set of managerial and organizational tools. Firms have to be able to manage their R&D networks efficiently and have an organization capable of acquiring external knowledge.

Organizations with different structural forms vary in their patterns of learning and knowledge creation, giving rise to different types of innovative capabilities (Lam 2005). Innovations are strongly associated with the readiness to innovate that is embedded in the organizational culture. Consequently, one can derive two contrary propositions: First, readiness to innovate is the starting point for innovations. And, due to the high significance of reference figures, their "spirit of innovation" continues to have generation-spanning effects in family firms.

Management innovations In this article we focus on two categories of innovations, which bring about novelty to the way firms organize, structure and manage their processes, namely *managerial innovations* and *organizational innovations*. These types of innovations both belong to the broader category of *management innovations*[15], which are elemental in the development of the firm and its products and processes. Management innovation includes the invention and implementation of a management practice, management process, management

[15] Management innovations are sometimes called *organizational innovations* (e.g. Alänge et al., 1998) or administrative innovations (e.g. Damanpour & Evan, 1984), but since we distinguish between managerial and organizational innovations, we adopt the terminology from Birkinshaw et al. (2008) to reduce ambiguity. Also, in some cases, organizational innovation has been used to refer broadly to any type of innovation created by an organization (e.g. Wolfe, 1994).

techniques, and organizational structures that is intended to further organizational goals (Birkinshaw et al., 2008). Literature on management innovations underline the fact that they are very different in nature compared to technological innovations, especially product innovations (Alänge et al., 1998). This is because management innovation represents investments in knowledge, procedures, behavior and relations and not so much in artifacts. Management innovations are typically tacit in nature and difficult to protect by patent (Teece, 1980). These characteristics allow a higher level of subjective interpretation on the part of the potential user than with technological innovations, which increases the importance of social and political processes (Birkinshaw et al., 2008). Another important feature of management innovations is that very few organizations have well established and specialized expertise in the area of management innovation. While product innovation is often specifically organized in R&D labs, this is not the case for management innovations. Due to their nature, management innovations are likely to generate uncertainty and ambiguity within the firm, with a higher impact than technological innovations. This leads to the need to establish legitimacy by validating the innovations independently from external sources, especially since the effects of management innovations are not so clear to employee or managers of the firm. To summarize, the major difference between management innovations and technological innovations lies in the role of factors internal to the firm, i.e. the cultural, social, and political aspects of the organization (Alänge et al., 1998).

The previous literature on *management innovation* has not distinguished clearly between different types of innovations (e.g. Kimberly & Evanisko, 1981; Damanpour, 1987). However, recent studies have started to analyze management innovations in a more fine grained way (Sapprasert, 2010). For example, Bodas Freitas (2008) shows differences in the diffusion of managerial and organizational innovations. We have delineated between two types of management innovations, namely *organizational* and *managerial innovation*. Organizational innovation refers to new the organization of work, management structure or relationships with external partners. Managerial innovation refers to innovations in management systems, knowledge management, and supporting activities. Following Wengel et al. (2000) we distinguish between organizational and managerial innovations the following way: organizational innovations encompass responsibilities, accountability, command lines and information flows. They focus on the divisional structure of functions, for example change the number of hierarchical levels. Managerial innovations, on the other hand, affect the operations and procedures of the enterprise such as the specifications of the responsibilities, the contents of commands and of information flows and the way they are dealt with. They concern speed and flexibility of production and the reliability of products and production processes.

3. Innovation in family firms

3.1 Literature review

There is a clear lack of scholarly research regarding the innovative activity of family firms so far (Leenen, 2005). As of January 2011, in the Family Business Review (FBR), the major family firm research journal published by SAGE Publications, only three articles in a total of 23 volumes have contained the word "innovation" in their title. According to Gudmundson et al. (2003), "research examining the relationship between innovation and ownership structure appears to be nonexistent" (p. 3). In their recent research note on the topic, Craig & Moores (2006) state that they "believe there is still limited research that has explored innovation within family firms" and that "…there is potential for further study of innovation in family firms…" (p. 8). So in recent years, the topic has fortunately started to receive increasing interest (Rößl et al., 2010).

To the knowledge of the authors, the following surveys are the only studies addressing this issue empirically:

Morck et al. (2000) show on the basis of a Canadian sample that family firms controlled by heirs were less active in R&D than their non-family counterparts of the same age and size in the same industries. Litz and Kleysen (2001) conducted a case study analyzing the entrepreneurial activity of a jazz musician with a special focus on the sustainability of the commercial innovations regarding the ensuing family generations. Gudmundson et al. (2003) examine the influence of organizational culture, ownership structure (family vs. non-family firms) and of customer types on the initiation and implementation of innovative processes in a quantitative empirical survey. In summary, they note: "The results suggest that initiation and implementation of innovation are significantly enhanced […] when it is a family-owned business. Family firms have unique characteristics positively related to implementation of innovation […]" (p. 14). However, differences in organizational culture interfere with this effect. Leenen (2005) examines the drivers of innovations in family firms, i.e. why innovative projects are initiated; whether innovations in family firms emerge incrementally rather than radically; if product or process innovations prevail; and how organizational culture, management style or the choice between family members as CEO or the use of an external CEO influence the innovative process. In their longitudinal 10-year study of 67 established Australian family firms, Craig and Moores (2006) determined that organizational structure is related to innovation within family firms. Also, firms having a greater amount of innovation have less formality and are more de-centralized. In addition, well-established family firms seem to place a high level of significance on innovation and strategy practices. The authors were also able to show strong interactions between

innovative strategy and environmental uncertainty attributed to technological change. Llach and Nordquist (2010) found differences with regard to the role of human, social and marketing capital for innovation when comparing 22 family and 22 non-family firms from Spain. These are interesting findings, because some of them stand in contrast to the conventional wisdom that sees family firms as being less innovative than non-family firms. And finally, Bergfeld and Weber (2011) just recently compared 62 family and 62 non-family "dynasties" of family firms (i.e. older than 100 years) from Germany, and found that successful dynastic families define innovation as the ability to constantly address new markets and technologies based on a clear long-term strategy.

In sum, the results of the very few existing empirical studies on the topic of innovation in family firms are still contradictory to a certain extent. And, no large scale quantitative study has emerged so far. This is where the following research takes up its work.

3.2 Development of hypotheses

In this study, we put forth the hypothesis that management innovations lead to higher corporate success, especially through their role as an antecedent of successful product innovation. Firm growth has become the major indicator for overall corporate success within entrepreneurship and SME research (Carton & Hofer, 2006). Talking about "entrepreneurial" family firms always means discussing innovation- and growth-oriented family firms. We thus we also use firm growth as an indicator for corporate success in our empirical study.

The main core of innovation study literature has focused on product innovations and the relationship between product innovativeness and corporate success. This literature stems back to the seminal work of Schumpeter (1934; 1942) who emphasized innovations as the core aspect of firm survival in the "perennial gale of creative destruction". Research has shown over and over again that firms require to develop new products if they are aiming to gain competitive advantage (e.g. Teece, 1986). In this article we do not focus on explicit product innovations but the orientation or inclination towards product innovations, which we call product innovation intensity or innovativeness[16]. We define innovation as the introduction of new products and hence product innovativeness refers to the extent to which the firm creates and is oriented to introducing new products.

[16] Jansen et al. (2006) call this exploratory innovativeness as opposed to exploitative, which refers to technology adoption and incremental improvement.

Although the performance effects of management innovations are more difficult to discern beforehand (Birkinshaw et al., 2008), which thus affects their adoption rate, earlier studies have shown that both managerial and organizational innovations lead to better firm-level performance (e.g. Damanpour & Evan, 1984; Damanpour et al., 1989; Sapprasert, 2010). Management innovations focus on the core organizational routines of firms; the way firms organize their workforce, knowledge management system, and decision making mechanisms. These routines are by nature stable and slow to change with a tendency towards inertia (Nelson & Winter, 1982; Hannan & Freeman, 1984; Dosi et al., 2000). Management innovations, by introducing change to these routines, enable the firm the escape the harmful effects of inertia. Our central argument is that in addition to product innovations, firms need also managerial and organizational innovations to achieve corporate success. Management innovations present a direct source of competitive advantage by having a significant impact on business performance with regard to productivity, quality and flexibility (Armbruster et al., 2008). Empirical research has previously shown that especially when implemented together with product innovations, management innovations are related to positive outcomes (Bodas Freitas, 2008; Damanpour & Evan, 1984; Damanpour et al., 1989; Sapprasert, 2010). Theoretical literature suggests that management innovation is a necessary precondition for technical innovation (Lam, 2005). They act as the antecedents and facilitators of an efficient use of technical product and process innovation, because the ability for firms to introduce new products depends on the degree to which the organizational structures and processes respond to the use of these new technologies (Armbruster et al., 2008). Management innovations enable the firm to become more innovative by, for example, enabling it to shift towards an open business model (Chesbrough 2010). This leads us to propose that product innovation intensity partially mediates the effects of organizational and managerial innovations on corporate success. Thus we put out the following hypotheses:

Hypothesis 1a: Managerial innovation has a positive effect on corporate success.
Hypothesis 1b: Organizational innovation has a positive effect on corporate success.
Hypothesis 2: Product innovation intensity has a positive effect on corporate success.
Hypothesis 3a: Organizational innovation has a positive effect on product innovation intensity.
Hypothesis 3b: Managerial innovation has a positive effect on product innovation intensity.

Differences in family and non-family firms with regards to management innovation are perhaps even more evident than in technological innovations due to the importance of social and political processes (Birkinshaw et al., 2008). As discussed above, the internal, and cultural, aspects of the firm are central to

management innovations. Organizational culture plays an important role in defining the innovativeness of a firm (De Brentani & Kleinschmidt, 2004; Naranjo-Valencia et al., 2010). On the other hand, family business research has shown that family firms differ in their values and attitudes, objectives, and strategic behavior from non-family firms (e.g. Donckels & Fröhlich, 1991). This leads us to hypothesize that organizational and managerial innovations have a different level of importance in family firms compared to non-family firms. A recent study focusing on the adoption of management practices points to this as well: Battisti & Iona (2009) show that managerial innovations are not adopted as likely in family firms. It is speculated that a more concentrated ownership structure reduces the need to adopt management practices. Non-family firms require more centralized management systems and thus a quicker to adopt managerial innovations. However, existing studies have highlighted the importance of organizational culture in the pursuit of competitive advantages in family firms (e.g. Zahra et al., 2004). Family firms gain from their organizational culture which, for example, tends to have fewer issues with principle agent problems and reduced reliance on formal controls and coordination. These traits make the family firm a more efficient innovator when it comes to the effects of organizational innovation. In other words, family firms gain more from organizational than managerial innovations, while non-family firms need new management systems to manage growth. As Craig & Moores (2006) point out, it is the organizational structures that enhance innovativeness in family firms. Organizational innovations align these structures to enable innovation and corporate success. This leads us to the next hypotheses:

Hypothesis 4a: The positive relationship between organizational innovation and corporate success is higher in family firms than in non-family firms.
Hypothesis 4b: The positive relationship between managerial innovation and corporate success is higher in non-family firms than family firms.

The following figure illustrates our underlying conceptual model, including the stated hypotheses:

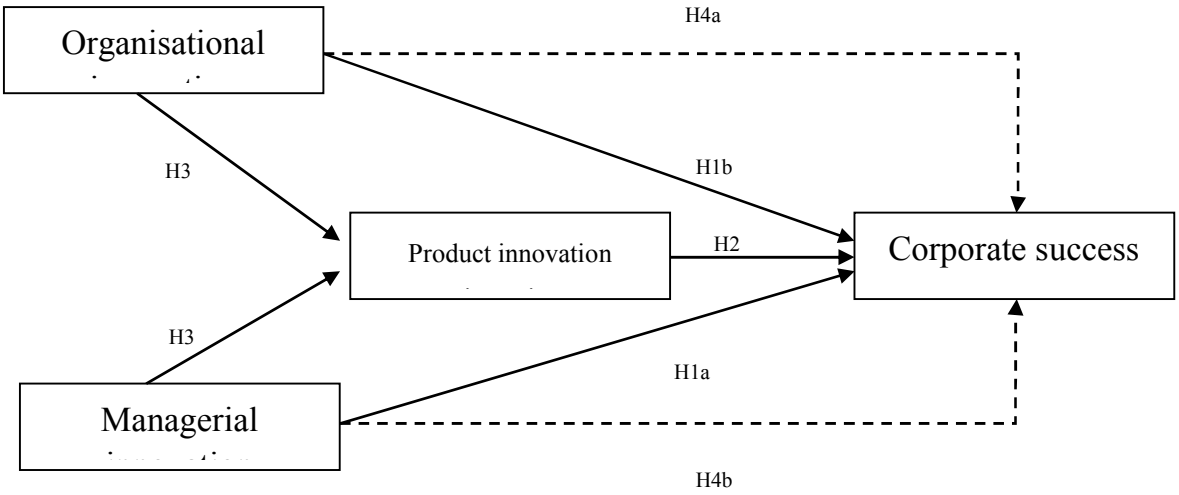

Figure 5.1 The conceptual model

4. Empircal investigation

4.1 Data

This study used a unique Finnish dataset of 533 firms to study the differences between family and non-family-owned firms in the role of organizational innovation in growth performance. We aimed to analyze how organizational and managerial innovation is associated with the growth performance of firms, and how this relationship differs in family and non-family firms.

We applied a quantitative survey data to test our hypotheses. The data was collected from Finnish firms operating in the food industry (NACE 10-11); the media (NACE 18, 58-61); and the maritime industry, including ship-building (NACE 301) and any sub-contracting sectors (furnishing, maintenance etc.). A sample of 2,227 firms was selected for the data collection by using a stratified sampling of the official business register of Statistics Finland. This data was collected through computer-aided telephone interviews in late spring of 2009. The survey was targeted at key respondents (e.g. Kumar et al., 1993; Lechner et al., 2006) in management positions (i.e. owner, CEO, general manager) as the supposedly most knowledgeable information sources. Contacting the 2,227 firms resulted in a total of 535 responses and a response rate of 24% which can be supposed as rather high for management studies (Wolff & Pett, 2007). For a non-response bias, examinations were conducted to determine differences between early and late respondents. No statistical differences were discovered between the two groups (Kanuk & Berenson, 1975; Armstrong & Overton, 1977; Newby et al., 2003).

The analysis covered the size of the 533 firms that responded and the firms that did not participate in the survey. The size distribution of the participating firms was slightly, but non-linearly, skewed towards larger firms, which is a relatively typical outcome in these kinds of surveys. The share of family firms in the entire dataset was 42% (226 firms). Distinguishing organizations by type is crucial in innovation research (Damanpour, 1991), and as a result, we expected interesting results in the comparison of the two groups.

The distribution of family firms among the sectors resulted in the following: 69% of the respondents in the food industry, 32% in the media sector, and 43% in the maritime industry considered their firms to be family businesses. Table 1 describes some descriptive statistics about the two groups of firms. The average size (measured by either the number of employees or turnover) of the family firms is somewhat smaller than the non-family firms. However, when we exclude the two largest firms from the sample, the average size of the non-family firms reduces to 128 employees and 32 MEUR.[17] The age distribution does not differ considerably between the groups.

Table 5.1 Descriptive statistics

Non-family firms	**Mean**	**std.dev.**	**Min**	**Max**
Age	33.44	36.76	1	190
No. of employees	308.72	2381.07	1	35000
Turnover/EUR 1000	128590.20	1393294.00	0	23000000
Family firms				
Age	32.25	26.59	1	159
No. of employees	110.49	589.45	1	8000
Turnover/EUR 1000	19396.29	90678.36	0.016	1000000

4.2 Measures

In building our measurement model we utilized established measures. Survey constructs for measuring organizational and managerial innovation are still scarce. We adopted items developed for the Community Innovations Surveys, which have been conducted since the mid-1990s in the European Union member states and which are coordinated by EUROSTAT. The methodology for measuring managerial and organizational innovation is described in the Oslo Manual (2005) of the OECD. All scale items were scored using a Likert-type scale with response options from 1 (“totally disagree”) to 7 (“totally agree“), with higher scores indicating higher levels of the construct in question. Corporate success: Success was analyzed by means of

[17] Removing the outliers did not change the results and therefore they were kept in the dataset in the analysis reported below.

three self-reported measures of firm growth. The respondents were asked to respond to the statements about the growth of their sales and personnel in comparison to their competitors. The corporate success construct emphasized the relative growth performance of the firm. Product innovation intensity: Product innovativeness was measured by means of three self-reported measures. The respondents were asked to respond to the statements about their relationship to product and service innovation. This measures the extent to which the firm aims to create product and service innovations. Firms scoring high on this measure are oriented towards product innovation. The product innovation intensity measure was adopted from Jansen et al. (2006). Managerial innovation: Managerial innovation was measured by means of three self-reported measures. The respondents were asked to respond to the statements about whether they have introduced new knowledge management systems during the last three-year period. Organizational innovation: Organizational innovation was measured by means of three self-reported items. The respondents were asked to respond to the statements about whether they have introduced new organizational structures, employee decision making, or networks during the last three-year period. The descriptive statistics and correlation matrices of the measures can be found in the following Table 2:

Table 5. 2 Descriptive statistics, family and non-family sample; N, mean, and correlation table

Family firms

Variable	N	Mean	INNSTR3	INNSTR5	INNSTR6	INNOPDT4	INNOORG1	INNOORG2	INNOORG3	INNOORG4	INNOORG5	PERFC2	PERFC3	PERFC4
INNSTR3	226	3.99	1											
INNSTR5	226	3.81	0.55	1										
INNSTR6	226	4.31	0.55	0.72	1									
INNOPDT4	226	3.81	0.21	0.22	0.28	1								
INNOORG1	226	3.58	0.17	0.21	0.28	0.67	1							
INNOORG2	226	4.15	0.20	0.21	0.32	0.58	0.70	1						
INNOORG3	226	4.30	0.35	0.23	0.32	0.44	0.43	0.47	1					
INNOORG4	226	3.70	0.36	0.25	0.31	0.49	0.52	0.48	0.65	1				
INNOORG5	226	3.66	0.21	0.04	0.23	0.51	0.47	0.47	0.46	0.53	1			
PERFC2	226	3.68	0.38	0.25	0.34	0.32	0.32	0.32	0.39	0.38	0.27	1		
PERFC3	226	2.89	0.20	0.17	0.18	0.23	0.23	0.23	0.25	0.31	0.24	0.63	1	
PERFC4	226	3.63	0.33	0.18	0.26	0.34	0.36	0.31	0.33	0.42	0.29	0.76	0.65	1

Non-family firms

	N	Mean	INNSTR3	INNSTR5	INNSTR6	INNOPDT4	INNOORG1	INNOORG2	INNOORG3	INNOORG4	INNOORG5	PERFC2	PERFC3	PERFC4
INNSTR3	307	4.01	1											
INNSTR5	307	3.72	0.67	1										
INNSTR6	307	4.29	0.62	0.72	1									
INNOPDT4	307	3.87	0.17	0.17	0.15	1								
INNOORG1	307	3.58	0.23	0.24	0.22	0.64	1							
INNOORG2	307	4.11	0.26	0.35	0.33	0.55	0.56	1						
INNOORG3	307	4.40	0.40	0.33	0.30	0.35	0.42	0.41	1					
INNOORG4	307	4.05	0.35	0.32	0.32	0.40	0.49	0.42	0.62	1				
INNOORG5	307	3.84	0.35	0.35	0.29	0.39	0.42	0.40	0.53	0.54	1			
PERFC2	307	3.88	0.30	0.23	0.27	0.27	0.33	0.33	0.22	0.29	0.25	1		
PERFC3	307	3.13	0.29	0.27	0.29	0.13	0.23	0.25	0.18	0.25	0.20	0.63	1	
PERFC4	307	3.81	0.41	0.33	0.36	0.23	0.32	0.33	0.27	0.33	0.27	0.78	0.69	1

4.3 Measurement model

To test our research hypotheses, we followed a two-step approach for structural equation modeling using MPlus 6 (Hair et al., 2010). To test for differences between groups we estimate a moderation model, where we divide the sample into two groups, family firms and non-family firms. First, we assessed and validated our measurement model, followed by an estimation of the structural equation model depicted in Figure 1. Since we were estimating a moderator model with two groups, we first tested whether our measurement model worked for both of the sub-samples. As the values are above the critical levels 0.9 for CFI, RMSEA values below .08, and SRMR values below .08, this proved to be the case (Table 3). The chi2 value is significant for all the measurement models. However, this is normal for models with a large number of indicators (Hair et al., 2010), and since all fit indices indicate good fit, we can safely assume that the model is appropriate for the data and proceed to examining the structural model. Then we tested the measurement model fit for the full sample estimated with the two groups. This also proved reasonable (Table 3).

Table 5.3. Test of model fit for the measurement model

	Chi-Square	**df**	**CFI**	**RMSEA**	**SRMR**	**N**
Non-family	69.942	48	0.988	0.039	0.037	307
Family	92.227	48	0.967	0.064	0.047	226
Full	301.54	180	0.967	0.050	0.051	533

We then evaluated the measurement models based on three criteria: convergent validity, discriminant validity, and reliability. Table 4 provides the figures for our evaluation. Here, it can be seen that our constructs in both sub-samples were valid and reliable. Convergent validity is summarized by average variance extracted (AVE), which is over 0.50 for all the constructs. Similarly construct reliability is over 0.70 for all the constructs. The right-hand side of Table 4 gives us a matrix, where the correlation between the constructs is compared to the square root of AVE, which is on the diagonal. From this we can see that all of the values on the diagonal are higher than their pairs, which indicates good discriminant validity.

Table 5.4. Reliability and validity assesment

Non-family firms	**Convergent validity**		**Discriminant validity**			
	Construct reliability	AVE	Product innovation intensity	Managerial innovation	Organisational innovation	Corporate success
Product innovation intensity	0.861	0.674	*0.821*			
Managerial innovation	0.809	0.586	0.363	*0.766*		
Organisational innovation	0.797	0.567	0.525	0.709	*0.753*	
Growth performance	0.877	0.706	0.442	0.417	0.407	*0.840*

Family firms

	Construct reliability	AVE	Product innovation intensity	Managerial innovation	Organisational innovation	Corporate success
Product innovation intensity	0.829	0.622	*0.788*			
Managerial innovation	0.851	0.656	0.368	*0.810*		
Organisational innovation	0.792	0.562	0.425	0.758	*0.749*	
Growth performance	0.868	0.688	0.371	0.450	0.530	*0.829*

4.4 Results

To test the hypothesized model, we split our sample into two groups and estimated a two-group structural equation model. To tests the dichotomous moderator variable we utilized the family firm moderator to divide the sample into groups and performed a Chi-square test of the significance of the difference between designated structural parameters across groups (see e.g. Hair et al., 2010). The result was, as expected, that the coefficients from product innovation intensity to corporate success were statistically non-different between the groups. Also, the coefficient from organizational innovation to product innovation intensity did not differ between the

groups. The goodness of fit statistics suggests that the structural models fit the data well (Table 5).

Table 5.5. Goodness-of-fit statistics

	Chi-Square	df	CFI	RMSEA	SRMR	N
Structural model	179.251	114	0.979	0.046	0.047	533

The results are summarized in Figure 2 for the family firms and Figure 3 for the non-family firms. Our results show that the positive influence of product innovation on corporate success exists. Organizational and managerial innovations play an important role as well. However, as hypothesized, we did not find the managerial innovation to be significantly related to corporate success for the family firms. Organizational innovations on the other hand seem to be important for family firms. They have a direct effect on corporate success, as well as an indirect effect through product innovation intensity (significant indirect effect 0.108***). In non-family firms, managerial innovation comes out as an important factor in corporate success. This is also the case for organizational innovation. Here, however, they have an effect only through product innovation. We find a significant indirect effect from organizational innovation through product innovation intensity to corporate success (0.117***).

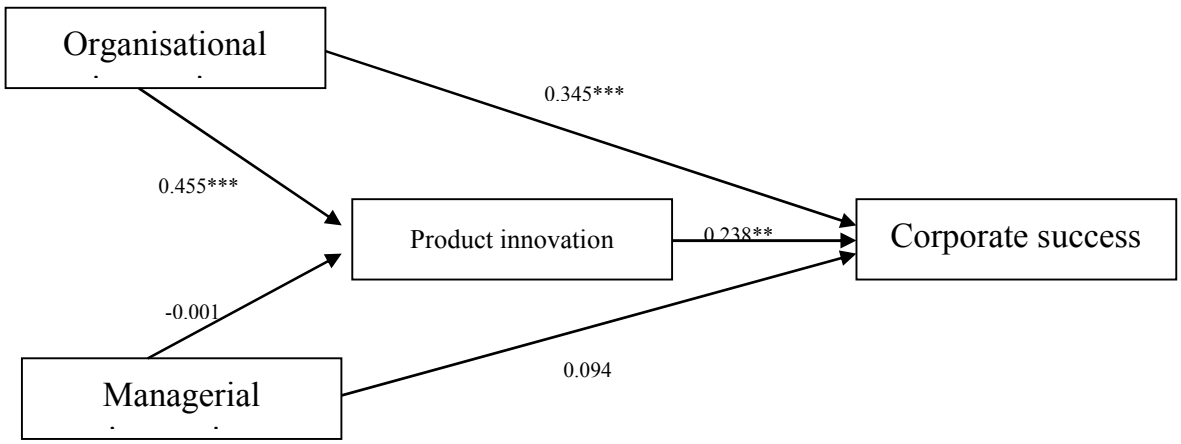

Figure 5.2. Results for family firms

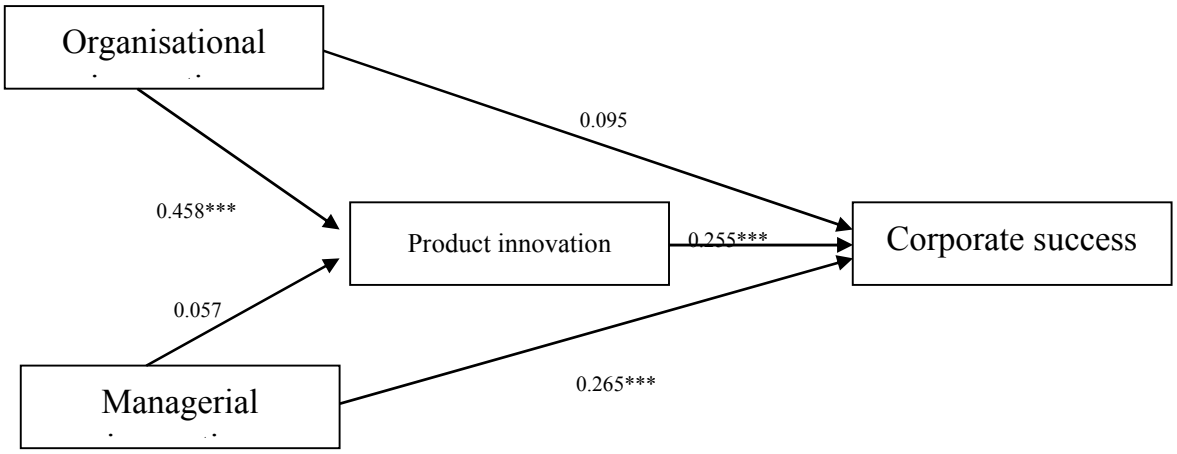

Figure 5.3. Results for family firms

From the above figures we can discern that hypotheses 1a and 1b were only partially supported. Managerial innovation was positively related to corporate success in non-family firms, but not family firms. The exact opposite applies for organizational innovation. Hypothesis 2 was supported; product innovation intensity had a positive effect on corporate success in both kinds of firms. Hypothesis 3a was not supported; we did not find managerial innovation to have a positive effect on product innovation intensity. This was a somewhat surprising finding. It may be that managerial innovations are more oriented towards making the firm cost-efficient, not necessarily more innovative (Bodas Freitas, 2008). This idea is supported by the fact that managerial innovations have a positive effect on corporate success (non-family firms). On the other hand, hypothesis 3b was supported and we found organizational innovation to have a positive effect on product innovation intensity. For the moderating hypotheses we find them both supported. The effect of organizational innovation on corporate success for family firms was higher than for the non-family firm group. Managerial innovation, on the other hand, had a larger effect on corporate success for the non-family firms. Table 6 summarizes our results.

Table 5.6. Summary of results

Hypothesis	**Result**
Main effects	
Hypothesis 1a: Managerial innovation has a positive effect on corporate success.	Partially supported
Hypothesis 1b: Organisational innovation has a positive effect on corporate success.	Partially supported
Hypothesis 2: Product innovation intensity has a positive effect on corporate success.	Supported
Hypothesis 3a: Managerial innovation has a positive effect on product innovation intensity.	Not supported
Hypothesis 3b: Organisational innovation has a positive effect on product innovation intensity.	Supported
Moderating effects	
Hypothesis 4a: The positive relationship between organisational innovation and corporate success is higher in family firms than in non-family firms.	Supported
Hypothesis 4b: The positive relationship between managerial innovation and corporate success is higher in non-family firms than family firms.	Supported

5. Discussion and conclusion

The goal of our study has been to increase our knowledge on the differences in innovative behavior that can be found between family and non-family firms. Here, the interrelations between innovation and corporate success are essential for both everyday business and research. Innovation is an entrepreneurial skill that can be applied by family firms to achieve a competitive advantage. Although some areas of family firm research have in fact begun to consider innovation, there is a general lack of empirical studies on innovation and how it is used in family businesses. Studies in the past on the innovation found in family firms have led to findings contradicting one another. Just about all researchers see family firms as conservative and stable, a result of their tradition and aversion towards risk. This is one reason why the lack of innovation in family firms continues to be a topic found in the literature.

Nevertheless, there is also research showing that family firms can be entrepreneurial as well (Naldi et al., 2007). With this in mind, we examined the innovative behavior of family firms on the basis of a large scale empirical survey from Finland, and found that the effects of management innovations on corporate success differ to some extent between family and non-family firms. In fact, for family

firms organizational innovations seem to be more important than managerial innovations. They have a positive relationship towards overall corporate success as well as on product innovation intensive. This means that if a family firm rebuilds e.g. its organization of work, its management structure or its relationships with external partners, i.e. if it "renews" itself constantly (Floyd & Wooldridge, 1999), following the logic of increasingly changing markets, it is more likely to innovate new products and to grow. Organizational innovations were important antecedents in both family and non-family firms, although in the latter there was no direct relationship towards corporate success, but only one towards increasing product innovations. Managerial innovations again were only important in non-family firms with a direct positive relationship to corporate success. That means that e.g. innovations in management systems, knowledge management or supporting activities do seem to be less important for family firms. This is in line with existing research on family firms which states longer-term planning horizons and more constant, sometimes even more conservative, leadership (e.g., Habbershon et al., 2003).

Future studies should aim to elaborate on the underlying reasons for these findings. Especially, it would be interesting to understand in more detail how the organizational culture plays a role in the innovation processes of family firms. It has been shown that the organizational culture plays an important role on the way firms innovate (Çakar & Ertürk, 2010; Naranjo-Valencia et al., 2011). However, there is still little research on the relationship between organizational culture and the different types of innovation in the family firm context.

Previous research has shown that organizational culture is responsible for the innovativeness of a family firm (e.g., Naranjo-Valencia et al., 2010), as is the management style of its leaders (e.g., Leenen, 2005) as well as a less formal and more de-centralized structure (e.g., Craig & Moores, 2006). In short, if a family firm wants to grow, to be innovative and to be entrepreneurial, it should (constantly) question itself if the culture within the firm as well as the applied leadership style of the entrepreneur is also entrepreneurial (e.g., Blumentritt et al., 2005), and if its organizational structure is still fitting to the requirements of a rapidly changing environment – in sum, if the firm is actively pursuing an entrepreneurial strategy. The complex and constantly changing interplay of these domains – strategy, entrepreneur, environment, and organizational structure – or, in other words, the "optimal configuration" (e.g., Kraus et al., 2011) of the family firm is the final influence variable of corporate success. We follow Pittino and Visintin (2009) with their conclusion in summarizing previous research that the strategic orientation of a family firm is strongly dependent on 1) the leadership's role in fostering risk-taking and entrepreneurial behavior, 2) the profile, competences and motivation of the owner(s), and 3) the characteristics and specialization of the members of the firm's dominant coalition. The most important driver for entrepreneurial behavior in family firms – as in most other (usually non-publically traded) SMEs is thus the person of the (family

firm) entrepreneur (or the entrepreneurial team). Future research on the topic of innovation in family firms should therefore concentrate on the interplay of the four named configurational domains, especially investigating the role of the family firm entrepreneur being responsible for any strategic decision within the company.

This study of course also holds several limitations. First, it only entails cross-sectional data from only one country (Finland). Further research in other countries should be undertaken in order to evaluate whether our results might be country-specific. Second, the use of objective measures does not solve the problem of the one measuring point. To analyze more thoroughly a longitudinal design should be implemented, and a follow-up study to be undertaken. Third, the use of growth as a measure of corporate success might be questioned. Albeit a generally accepted indicator for success in SME and Entrepreneurship research (see e.g. Carton & Hofer, 2006), not all enterprises want to grow. This might be especially the case for family firms. To avoid this problem it can be helpful to collect different objective measures of financial success and analyze if there are differences between the groups in performance measures. It is also possible that the performance of family firms is reflected in their growth more than in profitability. It is naturally possible that profit maximizing behavior is not present among the family firms, that is – they are financially less efficient, but they use company as a direct tool to increase the owners' welfare. This kind of behavior requires more analysis concerning the financial efficiency between these groups. Fourth, this study used CEO's and owners as respondents, which might cause a bias because these respondents may have a tendency to reply over positively to questions related to corporate success and innovation. However, since there is no reason to think that this bias differs between family and non-family firms, it is of no major concern. Last, but not least, also the question whether innovative behavior changes over time within corporate development, i.e. with a change of management due to intergenerational or external succession, might be an interesting avenue for further research.

CHAPTER 6: DYNAMIC CAPABILITIES AND FIRM PERFORMANCE IN A FINANCIAL CRISIS

1. Introduction[18]

The link between the organization and its operational environment has been a central research theme and a source of debate among organization theorists from the moment the study of organizations emerged as a discipline. There is a basic conceptual distinction between the closed-system and the open-system approaches. The former concentrates on internal organizational matters, excluding interaction with the environment, whereas the latter works on the assumption that organizations exist in order to convert external inputs through value-adding processes into outputs that go back to the environment (see Thompson, 1967). This fundamental cycle from the external to the internal evolves continuously and relates strongly to organizational performance. Different schools of thought have evolved around the internal-external relation and the performance link (see e.g., Lin & Carley, 1997, 125).

Contingency theorists (cf. Lawrence & Lorsch, 1967) emphasize that it is not the environment as such, but the fit or match between the organization and the environment that determines organizational performance. Again, there are two extremes in terms of fit, the deterministic and the voluntaristic. According to the voluntaristic view, organizations do not passively drift at the mercy of environmental changes, but actively take strategic actions in order to influence the fit (see Child, 1972; Cyert & March, 1963). Proponents of the deterministic side share this view of fit and its role in organizational performance or survival, but argue that a single organization's ability to survive is dependent on its more fixed and given characteristics: no firm can adapt to changes in its environment. For example, population ecologists (Hannan & Freeman, 1977) consider the link between the organization and the environment a one-sided mechanism similar to natural selection, which separates organizations with a better or worse fit (see Lin & Carley, 1997; Subramanian & Nilakanta, 1996).

This study assumes the open-system view, considering the organization an active actor that can adapt to the environment at least to some extent, mainly within the limits of its resources and capabilities. The literature on dynamic capabilities emphasizes the need for firms to be able to change their resource and capability base

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in order to counter the inertia inherent in routines that effectively prevent them from observing external environmental changes and adapting to them (cf. Helfat et al., 2007). In line with the theme of this special issue, "Avoiding/Responding to Global Economic-Management Disasters", this article sheds light on how organizations have adapted their behavior in order to weather the storm in the business environment that the global financial crisis of 2008 unleashed. The literature on dynamic capabilities, organizational change and innovation related to organizational performance and survival captures this kind of adaptive behavior.

The focal issue in the research on dynamic capabilities, which has remained the same since the concept emerged, is the dynamism in the competitive environment (Teece & Pisano, 1994; Teece, Pisano, & Shuen, 1997). The view in the literature is that both stable and dynamic capabilities are beneficial for the firm, and that the environment moderates the need for and the effect of these higher-order capabilities (Ambrosini, Bowman, & Collier, 2009; Eisenhardt & Martin, 2000; Zahra, Sapienza, & Davidsson, 2006). In most cases the focus is on dynamic versus stable environments, in which dynamism refers to the rate of technological change or environmental volatility in general (e.g., Ambrosini et al., 2009; Teece et al., 1997). However, instability in the market environment comes in different forms, and dynamic capabilities may have varying significance depending on the nature of the instability. This study approaches the relationship between dynamic capabilities and environmental instability from the perspective of the financial crisis of 2008, which led to a drastic economic downturn. The aim is to shed light on how dynamic capabilities affect performance in unstable environments. However, firms differ in how they experience crisis: some suffer considerably, whereas others manage to avoid the worst effects.

In addition to analyzing how dynamic capabilities operate in situations of financial distress, this paper contributes to the literature in reporting an empirical analysis based on both quantitative and qualitative data, testing whether there is an indirect link with evolutionary fitness, as the recent research suggests, and investigating the relationship between dynamic capabilities and the mediating elements (e.g., Barreto, 2010). Studying how firms utilize and deploy dynamic capabilities in a financial crisis furthers understanding of this multidimensional construct and the relationships between the underlying different sub-dimensions.

The empirical context of the analysis is the Finnish economy, specifically the maritime, media and food-processing industries, all of which are facing the recession in their own unique way. Finland is a small open economy with a strong dependency on global economic development. The three industries in question face their own challenges related to both long-term development and economic fluctuation. Furthermore, economic downturn is typically a catalyst triggering deep industrial changes. The maritime industry is the most open in terms of exporting the final product. The value of one purchase is hundreds of millions of U.S. dollars, which

makes the demand very volatile. The industry has thus been in a continuous state of crisis for the last 30 years, and most of the successful companies utilize their core competences in several related areas. Developments in ICT have changed the business environment in media industries more than in either of the other two: new business opportunities have arisen, and on the other hand technology has made some traditional printing services obsolete. The food-processing industry is somewhat bifurcated in terms of development – the international trend of concentration in the retail sector drives industry agglomeration, but at the same time health issues and preferences for local food leave room for small innovative local players.

The article proceeds as follows. The next two sections describe the theoretical background and the research model, together with the respective hypotheses. Given the aim to build a comprehensive picture of the phenomenon, the empirical study applies both quantitative and qualitative approaches in explaining and enhancing understanding of the connection between dynamic capabilities, organizational change, innovativeness and organizational performance. The focus in the fourth section is on the research methods. Structural equation modeling, group analysis and qualitative case comparisons provide the basis for the analysis and results comprising the fifth section. The final section discusses the conclusions, the implications for theory and practice, and potential avenues for future research.

2. Theoretical background

The theoretical framework builds on evolutionary economics and the Schumpeterian view on innovation, according to which capabilities and routines comprise the firm's fundamental structure, and the evolutionary fit between the firm and the environment is the measure of performance (Nelson & Winter, 1982; Schumpeter, 1934). Schumpeter (1934) describes innovation as a combination of the entrepreneur's prior knowledge and resources, and as such the most fundamental element of competition and vital to the survival of firms in the perennial gale of creative destruction.

In line with the Schumpeterian notion, more recent literature questions the capacity of firms to produce innovations in conjunction with their routine operations (cf. Fagerberg, 2003), and calls for explorative new ways of combining resources in and through organizational activities (see Eisenhardt & Martin, 2000). A growing body of literature targets the concept of capabilities and their role on the pathway from static resources and competences to innovative products or processes as outputs. This stream of literature builds on the evolutionary theory of the firm, which depicts a firm as a set of skills and capabilities that form the basis of innovation and competitive advantage (see e.g., Hodgson, 1998; Nelson & Winter, 1982; Teece et al., 1997).

According to some scholars, capability-enabled innovativeness and innovation facilitate adaptation to the environment and success on the markets (see e.g., Hill & Rothaermel, 2003).

Organizational activities aiming at value creation and crossing the boundaries between the focal organization and other actors in the business network may be exploitative or explorative (on organizational ambidexterity see e.g., Duncan, 1976; March, 1991; Raisch & Birkinshaw, 2008). Exploitation concerns the refining of existing capabilities, whereas exploration refers to the challenge of creating new ways of transforming existing ideas (e.g., March, 1991). Successful firms are usually consistent and efficient in their management of current business demands (i.e. exploitation), and at the same time adaptive to changes in the environment (i.e. exploration). This classification reflects various conceptualizations within business studies, such as organizational learning (e.g., March, 1991), technological innovation (e.g., Danneels, 2002), organizational adaptation (e.g., Zahra & George, 2002), strategic management (e.g., Burgelman, 1991), organizational design (e.g., Duncan, 1976), market orientation (Kohli & Jaworski, 1990; Slater & Narver, 1995), and entrepreneurial orientation (see e.g., Lumpkin & Dess, 1996; Miller, 1983). All these conceptualizations explicitly or implicitly build on the division between exploitative and explorative organizational activities. This distinction also provides a basis on which to categorize organizational capabilities as operational or dynamic. Operational capabilities refer to the means and practices of efficiently configuring existing resources into existing products and services, whereas dynamic capabilities reflect the explorative side of the organization (see Dosi, Nelson, & Winter, 2000; Zahra et al., 2006).

Dynamic capabilities allow the realization of new opportunities in a business environment, and the conversion of the organizational resource base in terms of both tangible and intangible assets and capabilities (Easterby-Smith, Lyles, & Peteraf, 2009). Value-creation processes exploit these opportunities through the efficient and effective development of new products and services. In this respect, dynamic capabilities reflect the organizational capacity to purposefully create, extend, and modify the existing resource base, and thereby constitute the means for changing and renewing current processes, providing a basis on which to achieve innovation and a better fit with the environment (see Eisenhardt & Martin, 2000; Helfat et al., 2007; Zollo & Winter, 2003; Winter, 2003; Zahra et al., 2006).

As population ecologists point out, firms are prone to inertia, which is a prevalent and even necessary characteristic of routine and operational capabilities (Nelson & Winter, 1982; Newey & Zahra, 2009). For example, the different innovation strategies firms utilize have a long-lasting effect on innovation outcomes (Clausen, Pohjola, Sapprasert, & Verspagen, 2011). However, inertia may be detrimental to strategic change and thus lead to the failure of the firm. Valuable organizational capabilities may become rigidities if the function to which they relate becomes

obsolete (Leonard-Barton, 1992). Dynamic capabilities are the set of resources that allow the firm to change sustainably. Their main function is therefore to govern the rate of change in operational capabilities (Collis, 1994; Winter, 2003; Zahra et al., 2006), and thus enable the firm to evolve in a sustainable manner, to overcome inertia, and to adapt to environmental change (Eisenhardt & Martin, 2000; Helfat et al., 2007; Newey & Zahra, 2009) without having to resort to *ad hoc* problem solving.

Dynamic capabilities are related to innovation-oriented organizational change, which enables the firm to become more innovative and as a result increases its evolutionary fitness. There are different types of higher-order capabilities focusing on different organizational elements and purposes (Helfat et al., 2007). The literature on dynamic capabilities distinguishes several different types or dimensions (e.g., Bowman & Ambrosini, 2003; Madsen, 2010; Teece, 2007), and more recent contributions conceptualize the construct as multidimensional (Barreto, 2010; Edwards, 2001; Protogerou, Caloghirou, & Lioukas, 2011). A construct is multidimensional if it refers to several distinct but related dimensions as a single entity (Law, Wong, & Mobley, 1998). On the other hand, there are conceptual distinctions between different levels of dynamic capabilities depending on their role in governing change in the firm (see e.g., Ambrosini, Bowman, & Collier, 2009; Collis, 1994; Helfat et al., 2007). Winter (2003), for example, describes two levels: first-order capabilities, which reflect change in the operational, zero-level capabilities and resources of a firm, and higher-order capabilities that include the capacity to modify or create new first-order capabilities. Building on Winter's (2003) study, Ambrosini et al. (2009) divide higher-order capabilities further into regenerative and renewing capabilities, thereby emphasizing the distinction between the capabilities that enable the firm to move away from previous change practices towards new forms of organizational change (regenerative capabilities) and those that modify its resource base (renewing capabilities). Regenerative capabilities are necessary for the renewal of dynamic capabilities, and represent long-term investment in the change capabilities within the organization (Winter, 2003). Renewing capabilities refresh and renew the nature of the resource and capability stock through the introduction of new product lines (Ambrosini et al., 2009), for example, and allow the firm to identify and exploit opportunities. Building on the vast literature conceptualizing the different dimensions of dynamic capabilities, this study applies a set of six different dimensions. Table 1 briefly describes the types of dynamic capability and gives the main references.

Table 6.1 Dimensions of dynamic capability

Dimensions		Definition	Selected references
Regenerative capabilities	Reconfiguration	The capability to continuously and purposefully reconfigure the existing resource base, enabling the firm to transform and exploit its existing knowledge.	Bowman & Ambrosini (2003), Eisenhardt & Martin (2000), Teece & Pisano (1994), Teece et al. (1997), Zahra & George (2002)
	Leveraging	The capability to utilize and deploy an existing resource in new a situation, allowing the firm to replicate an operational capability in a new market.	Bowman & Ambrosini (2003), Eisenhardt & Martin (2000), Pavlou & El Sawy (2006), Teece et al. (1997)
	Learning	The capability that allows the firm to adopt, acquire and create new capabilities through the learning processes of the organization.	Bowman & Ambrosini (2003); Romme, Zollo & Berends (2010); Teece & Pisano (1994); Zollo & Winter (2002), Zott 2003
Renewing capabilities	Sensing and seizing	The capability to position oneself favorably in an environment and to explore new opportunities.	Danneels 2002, Pandza & Thorpe 2009, Teece 2007, Teece et al. (1997)
	Knowledge Creation	The capability to continuously create and absorb new knowledge, and to develop new products or processes, also known as absorptive capacity.	Eisenhardt & Martin (2000), Danneels (2002), Henderson & Cockburn 1994, Mckelvie & Davidsson (2009), Pisano 1994, Verona & Ravasi (2003), Zahra & George (2002)
	Knowledge Integration	The capability to acquire and integrate new knowledge through external sources such as networks, also referring to the utilization of social capital.	Ambrosini et al. (2009), Blyler & Coff (2003), Eisenhardt & Martin (2000), Teece & Pisano 1994, Teece et al. 1997, Verona & Ravasi (2003), Zollo & Winter (2002)

According to the literature, the core dynamic capabilities are reconfiguration, leveraging, learning and knowledge creation, integration, and sensing and seizing (e.g., Ambrosini et al., 2009; Barreto, 2010; Bowman & Ambrosini, 2003; Teece, 2007; Teece et al., 1997). Reconfiguration refers to the transformation and recombination of assets and resources (Bowman & Ambrosini, 2003). In order to change the way they modify their resource base firms need the ability to leverage their existing capabilities and resources and use them as the basis of building new pathways for the future. Learning is a core higher-order capability (Teece, 2007) that enables the firm to effectively utilize and acquire the necessary knowledge to

facilitate the creation and modification of the capability and resource base (Zahra & George, 2002; Zollo & Winter, 2002). The subset of capabilities comprising reconfiguration, leveraging, and learning are regenerative, providing the basis for capability modification and development and allowing the firm to influence its renewing capabilities. Renewing capabilities, on the other hand, which comprise knowledge creation, sensing and seizing, and integration, enable the firm to create and modify changes in its current operational-capability and resource base. Being able to sense and seek opportunities is necessary for the efficient renewal of organizational capabilities according to the requirements of the external environment (Danneels, 2002; Teece, 2007), and together with the capability to generate new knowledge enable the firm to create new products and product categories in accordance with the fluctuations in demand and customer taste (Helfat & Peteraf, 2003; Verona & Ravasi, 2003). Knowledge creation involves the transformation and realignment of knowledge within the organization (Lichtenthaler & Lichtenthaler, 2009). A related capability is the ability to integrate the knowledge. It is not possible to locate or develop all the relevant knowledge within the firm, and thus the capability to absorb knowledge from outside sources is essential (Chesbrough, 2003; Lichtenthaler & Lichtenthaler, 2009), and closely resembles absorptive capacity (Cohen & Levinthal, 1990; Zahra & George, 2002).

According to previous research, dynamic capabilities serve as a means of adapting to environmental change in highly dynamic environments (Teece et al., 1997). Even though more severe environmental turbulence greatly increases their value, they are obviously also useful in other than dynamic, uncertain environments (Eisenhardt & Martin, 2000; Wu, 2010; Zahra et al., 2006). Research suggests that their value is highest when operating capabilities become rigidities through exogenous shock, as in the case of a financial crisis (Newey & Zahra, 2009). Ambrosini et al. (2009) further develop the link between the organizational environment and dynamic capabilities, arguing in their conceptual study that both regenerative and renewing capabilities are necessary in turbulent environments requiring firms to adjust to changing circumstances. In particular, regenerative capabilities allow the firm to adapt its previous dynamic capabilities to meet the requirements of the new circumstances (Ambrosini et al., 2009). This paper explores whether and to what extent regenerative and renewing capabilities increase the evolutionary fitness of the firm in situations of global financial crisis.

3. Model and hypotheses

The reason for the continuing research interest in dynamic capabilities lies primarily in its potential to shed light on the antecedents of competitive advantage or superior performance (Teece et al., 1997). According to some earlier studies, dynamic

capabilities influence performance indirectly (Cepeda & Vera, 2007; Danneels, 2002; Helfat et al., 2007; Protogerou et al., 2011; Winter, 2003; Zahra et al., 2006) in terms of enabling management to make timely decisions to change the operational routines of the firm when necessary (Ambrosini et al., 2009; Barreto, 2010; Helfat et al., 2007). The firm will then be able to introduce new innovations, for example, which may lead to better performance.

However, although dynamic capabilities enable change, they do not necessarily lead to better performance. Management may well misperceive the need for change and deploy dynamic capabilities unnecessarily or in the wrong form (Ambrosini et al., 2009). The value of a dynamic capability to an organization is context dependent – it depends on environmental needs and constraints (Helfat et al., 2007). When successful, dynamic capabilities lead to relative growth within the firm's operating environment. Thus, a proper performance measure for the analysis of their effects would be evolutionary fitness, as the core literature on evolutionary economics emphasizes (Nelson & Winter, 1982).

Figure 1 depicts the conceptual model of the focal study, in line with the above discussion.

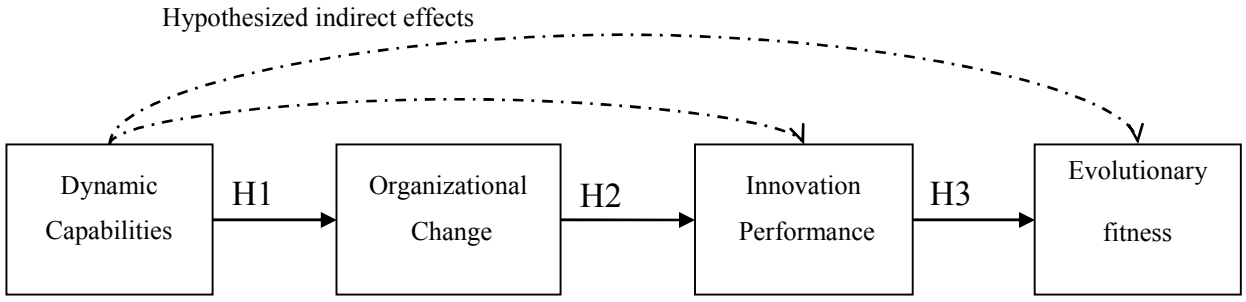

Figure 6.1 The conceptual model: the indirect link between dynamic capabilities and evolutionary fitness

The model builds on the posited indirect effect of dynamic capabilities on the evolutionary fitness of the organization under the assumption of a positive effect on its potential for organizational change, which in turn positively affects its innovativeness and increases the extent of its evolutionary fit with the environment.

In sum, dynamic capabilities enable the organization to change in accordance with its new or modified operational capabilities and resources. This, in turn, fosters innovativeness, which is necessary if the firm is to compete successfully in the marketplace.

It is necessary to align dynamic capabilities with the organizational processes that foster innovation. Their proper deployment increases the probability of generating product innovations that would attract positive feedback from customers and thus increase the firm's evolutionary fitness (Newey & Zahra, 2009). The result is modification and change in routines and capabilities leading to new organizational structures and work routines. Consequently, the first hypothesis is as follows:

Hypothesis 1: Dynamic capabilities positively affect organizational change in the firm.

According to the research on dynamic capabilities, one of the main mediators of evolutionary fitness is innovation performance (Danneels, 2002; Lichtenthaler & Lichtenthaler, 2009; Verona & Ravasi, 2003; Wang & Ahmed, 2007). Dynamic capabilities enable the firm to change its product portfolio to better match the market and customer needs, in other words to develop and refine its innovative capabilities (Lisboa, Skarmaes, & Lages, 2011). Generating and adopting innovations is a process that affects the organization as a whole (Fagerberg, 2005), requiring structural reorganization, entry into new networks and collaborative agreements, and modification of the management structures and methods. Thus, our second hypothesis is the following:

Hypothesis 2: Organizational change positively affects innovation performance.

The evolutionary theory of the firm posits that innovation is the main driver of performance (Nelson & Winter, 1982; Winter, 2006), a view that dates back to Schumpeter's (1934, 1942) seminal writing on innovation as the driving force behind market competition. There is a broad stream of literature on subjects ranging from economics (e.g., Bloom & Van Reenen, 2002; Crepon, Dugues, & Mairesse, 1998; Geroski, Machin, & Van Reenen, 1993) to management (e.g., Damanpour & Evan, 1984; Kraus et al., 2011; Simpson, Siguaw, & Enz, 2006; Teece, 1986) showing that innovation, and especially product innovation, leads to better performance. Successful innovation enables the firm to keep up with consumer tastes and

proactively to increase market share at the expense of its competitors. The third hypothesis is thus as follows:

Hypothesis 3: Innovation performance positively affects the evolutionary fitness of the firm.

4. Methods

4.1 Empirical strategy

The empirical reporting proceeds in three stages, the first two focusing on an extensive survey the authors conducted in 2009 within the three industries. The first step is to test the conceptual model by means of structural equation modeling for the full sample. The second is to consider the types of dynamic capabilities in more detail with regard to sectorial differences and changes in importance relative to firm performance. The final stage is an in-depth analysis of the key variables of interest through extensive case studies representing all three sectors.

4.2 Quantitative survey

The data for the quantitative analysis originates from two sources – a quantitative survey targeting three specific sectors for the explanatory variables, and the Orbis database (www.bvdinfo.com), which contains comprehensive information on the financial statements of companies worldwide, for computing the dependent variable. The reason for choosing the food industry, shipbuilding and the media was two-fold. First, these sectors are not traditional high-tech, highly R&D-intensive sectors, which have been at the core of research on innovation and dynamic capabilities (Easterby-Smith et al., 2009), and the capability to change and to innovate is more likely to distinguish firms from their competitors. In other words, the posited relationships and the operationalization of the dynamic-capabilities dimensions are more explicit in this kind of sample. Second, these sectors represent a broad range of industries facing financial turmoil from different perspectives. All in all, the reasoning behind the choice of population concerned not only the generalizability of the results to the whole population of Finnish firms, but also the need to distinguish the theoretical

relationships in question. The data represents Finnish firms operating in the food industry (NACE 10–11), the media (NACE 18, 58–61), and the shipbuilding cluster, including ship construction (NACE 301) and any sub-contracting sectors (e.g., furnishing and maintenance). Stratified sampling identified a sample of 2,227 firms from the official Business Register of *Statistics Finland*. The data collection took place during computer-aided telephone interviews in late spring, 2009. The survey targeted a member of the top-management team of the firm in question, preferably the CEO or the owner-manager. The researchers approached the respondents in random order, and contacted each non-responding number multiple times on different weekdays and at various times of the day. A total of 535 responses came from the 2,227 firms, a response rate of 24 percent. Chi-square tests assessed non-response bias, the analysis taking into account the size of the 535 firms that responded and of those that did not participate in the survey. The size distribution of the participating firms turned out slightly, but non-linearly, skewed towards larger firms, which is a relatively typical outcome in this type of survey. Here the focus is only on firms with five or more employees, thus restricting the sample to 452. In addition, 151 firms disappeared because the obligation to report their financial statements to the trade register, which is the original source of the dependent variable, only applies to limited-liability companies. The sectorial distribution of the resulting sample of 301 firms is as follows: 21 per cent belong to the food industry, 45 per cent to the media, and 34 per cent to the shipbuilding sector.

4.3. Quantitative measures

Dynamic capabilities. Due to the lack of generally accepted scales for measuring dynamic capabilities (McKelvie & Davidson, 2009), the authors decided to adopt and further refine a recent tailor-made measurement scale (Alsos, Borch, Ljungren, & Madsen, 2008). It was clear from previous experience that the original measurement scale required modification and thorough testing. The first stage in this process was to conduct a set of qualitative semi-structured interviews in order to test the preliminary items, the second was to pilot the scale as a survey, and the third was to further assess face validity by pre-testing the measurement among experts in the field. The changes to the original measurement scale comprised dropping out the non-functioning items or replacing them with better and clearer items. Finally, an intense pretesting phase incorporating lengthy discussions with academics and approximately 50 company respondents focused on the reliability and validity of the questionnaire.

The final scale of dynamic-capability types resulted in a set of items on a Likert scale ranging from one to seven (see Table 1A Appendix 1). It is worth pointing out that in measuring dynamic capabilities, definition of the capability level is context-

dependent (Barreto, 2010; Winter, 2003). Thus the context affects the choice of suitable items; for example, product-development R&D is a higher-order capability for a firm in the food sector, the main purpose of which is to produce and sell products, but a zero-level capability in the case of an independent R&D lab. The dynamic-capability construct we were testing included the following dimensions: *reconfiguration routines* (RECRUT), *leveraging* (RENEMP), and *learning* (RECEMP); and the following higher-order capabilities: *knowledge creation* (RENRD), *sensing and seizing* (OBS), and *knowledge integration* (ACQNW). Given the conceptualization of the dynamic-capability construct as multidimensional and superordinate, its operationalization proceeded by means of second-order confirmatory factor analysis (CFA) (Edwards, 2001). The resulting construct derives from hierarchical confirmatory factor analysis (e.g., Byrne, 2001; Neuman, Bolin, & Thomas, 2000). In other words, in terms of measurement, dynamic capability is a second-order factor, with the aforementioned dimensions as first-order factors. The first step was to conduct a confirmatory first-order factor analysis of the six constructs following the guidelines originally appearing in Fornel and Larcker (1981). Assessment of the construct reliability and both convergent and discriminant validity was in accordance with the standard means in the literature (e.g., Fornell & Larcker, 1981; Hair, Black, Babin, & Anderson, 2010; Shook, Ketchen, Hult, & Kacmar, 2004). In terms of model fit, the evaluation was on the basis of standard indexes and their cut-off criteria, again in accordance with the literature. The recommendation is to use more than one index in assessing several indexes and, given the increasing number of measures, one absolute fit measure (RMSEA), one badness-of-fit measure (SRMR), and one incremental-fit index (CFI) (e.g., Hair et al., 2010; Kline, 2011; Shook et al., 2004). The cut-off criteria are <0.07, <0.08, and >0.90, respectively (Hair et al., 2010).

The results support the construct reliability and both the convergent and discriminate validity of the constructs, and the resulting fit statistics support the model based on cut-off criteria adjusted for complexity and sample size (Hair et al., 2010; Shook et al., 2004). Table A1 in Appendix 2 presents the model and construct assessment results. The second-order confirmatory factor analysis of the final construct included the six dimensions of dynamic capability. In other words, the constructs from the first-order CFA served as indicators of the dynamic-capability construct. The resulting fit statistics supported the second-order CFA model. See Table A1 in Appendix 2 for the model and construct assessment results.

Organizational change. According to the literature and in line with the above discussion, dynamic capabilities change operational capabilities. However, due to the cross-sectional nature of the data, it is not possible to observe actual change. Thus, the resulting new organizational structure that embodies the operational capabilities serves as a proxy for change. The following three items adapted from the Community Innovation Survey (OECD 2005) served to measure the implementation of a new or

significantly different management structure, the organization of work, and relations with other firms and public institutions: 1. Significant changes in the organization of work in your enterprise that support employee decision-making and responsibility; 2. A significant change in the management structure of the enterprise, such as creating new divisions or departments, integrating different departments or activities, or adopting a networked structure; 3. New or significant changes in relations with other firms or public institutions, such as through alliances, partnerships, outsourcing or sub-contracting.

Innovation Performance. The measure of product-innovation performance comprised the percentage share of new products of the firm's total sales, thus ranging from 1 to 100 (the log-transformed version of the variable). This is a standard measure of innovation performance according to the literature (e.g., Laursen & Salter, 2006).

Evolutionary fitness (relative growth). Evolutionary fitness served to measure performance, as the recent literature on dynamic capabilities suggests (Barreto, 2010; Helfat et al., 2007; Leiblein, 2011). Measures of evolutionary fitness comprise the growth of sales relative to the mean growth in the sector, the assumption being that relative growth captures the central idea (see e.g., Helfat et al., 2007). Given the time frame of interest, in other words the global recession, the growth measurement covered the period between 2007 and 2010. The Orbis database (www.bvdinfo.com), which contains comprehensive information on the financial statistics of companies worldwide, yielded the data for the performance measure. There was also a control measure for firm size and age (log transformed).

4.4The qualitative case study

The reason for conducting a multiple case study was to demonstrate and enhance understanding of dynamic capabilities, organizational change, innovation, and performance/survival on the level of the individual firm. The qualitative case study is a particularly strong research strategy when the aim is to investigate processes in real-life contexts (Eisenhardt & Graebner, 2007; Yin, 2003), in this case shedding light on firm-level dynamics and contextual complexities before, during and after the financial crisis.

There are two effectively opposite options for case selection, namely random and purposeful sampling (Eisenhardt & Graebner, 2007, 27). *Purposeful sampling* derives from the idea of learning or understanding something on the basis of the cases. The focus is not so much on the cases themselves as on the opportunity to exploit them to serve more abstract theorizing purposes (see Patton, 1980, 100). Given that the aim in this study is to understand the research phenomenon per se, the focus here is on scrutinizing cases that best serve this aim, hence the adoption of purposeful sampling.

The target in the case selection was to achieve maximum variation according to the blocking factors of industry type, company size, and change in business opportunities (cf. Patton, 1980). The assumption was that the variance according to these factors would reveal elements and features of the research phenomenon on a company level (see Eisenhardt & Graebner, 2007). Regarding the first blocking factor, industry, the three case companies represent the maritime, media and food-processing industries. In accordance with their wishes, the companies remain anonymous here: MaritimeCo, FoodCo, and MediaCo. Secondly, the case companies vary in size: FoodCo is a small family business, MaritimeCo a medium-sized business, and MediaCo a large business. Thirdly, the influence of the crisis on these companies varied, as did the level or activation of the capabilities in different areas: the business opportunities of MaritimeCo diminished drastically and unexpectedly; the business opportunities of MediaCo diminished drastically but expectedly and the company was ready for that; FoodCo found and seized new business opportunities in that, on account of the low interest rates during the crisis, the company was able to strengthen its resource base and invested in production machinery.

Retrospective respondent accounts combined with real-time interview data describe past key events and the developmental pathway to the current situation (Leonard-Barton, 1990). The data gathering took place in personal semi-structured interviews (Hesse-Biber & Leavy, 2006) with the key personnel in the companies (three in FoodCo in 2006, 2007 and 2011; two in MaritimeCo in 2010 and 2011; and two in MediaCo in 2010 and 2011). The interview themes emanated from the theoretical framework of the study. Free descriptions of the case supplemented these theory-driven themes and topics as dialogue developed between the interviewer and the interviewee. The interviewers recorded the interviews and transcribed them into written form. Secondary data, in the form of documentary analysis, complemented the interview data (Glueck & Willis, 1979). The researchers studied the case companies for a period of time and thus had an overall picture of them and the contextual factors affecting their functioning.

The first step in the analysis was to organize the data in a chronological account of the company's development before, during and after the crisis. The next step was to analyze this chronological description in terms of the research framework of dynamic capabilities and organizational change with reference to innovation and company performance/survival. The study reports the cases in the form of case descriptions and theoretical conclusions with reference to the research focus on dynamic capabilities, organizational change, innovation and performance.

According to Lincoln and Cuba (1985), the value of a study lies in its trustworthiness in terms of credibility, transferability, dependability and confirmability for application in the assessment of qualitative research. *Credibility* refers to truthfulness in the interpretation of the data, that is, whether or not the interpretations and meanings relate to the data in line with the informants' insights.

The researchers sent the empirical analyses and interpretations to the participating companies for checking. The contact person in the organization, who in each case was the key informant due to their central role in the process, confirmed the interpretations. *Transferability* refers to the extent to which the results are transferable to other contexts, and relates closely to the explicitness of the chain of evidence or depth of description in the study. The qualitative part aimed at theoretical generalization, in other words that the explorative findings would be to some extent transferable to the theoretical level with a view to enhancing understanding of dynamic capabilities and firm performance in other types of organizations and industries. The aim was not to produce law-like generalizations on the population level of the industries in question, for example. The purpose was to provide descriptions of each case in order to contextualize the results and give an opportunity for others to evaluate the transferability of the study.

Dependability refers to the research quality and consistency throughout the process. It is to some extent parallel to *confirmability,* which in turn relates to conducting research in an unbiased way as opposed to distorting the findings or allowing the researcher's interests and motivation to influence the process. The aim in the qualitative part of the study was to complement the quantitative part in order to gain an in-depth understanding of dynamic capabilities, organizational change and innovation as linked to organizational performance. Although the qualitative case study was explorative, it reflected the theoretical background of the study, and all the interpretations focused on confronting the theoretical framework with the empirical data. In this sense the aim was to diminish the influence of the personal interests and motivations of the researchers on the results, and thus to raise the quality and consistency of the research process.

5. Results

The analysis of the hypothetical model, which we conducted by means of structural equation modeling, covered the full sample (see Figure 2). The analysis proceeded in two steps (e.g., Anderson & Gerbing, 1988). The first step was to test the measurement model in order to assess its validity, using a similar process as for the hierarchical CFA. Tests of construct reliability, and of convergent and discriminative validity confirmed the structural validity of the measurement model. The goodness-of-fit indices gave further support (see Table 2, Appendix 2 for the results). The next step was to test the three-path mediational model in accordance with the joint-significance test (Taylor, MacKinnon, & Tein, 2008). The analysis followed the suggestions regarding tests of mediation in James, Mulaik, and Brett (2006), with the complete mediation model as the baseline. Comparison of the fully mediating model

with the seven nested models involved adding a path in each one to the model from the explanatory variables, and finally in the seventh model paths including all the linking variables (see Table 3, Appendix 2 for the results). The results indicate that, first, the model fits the data, second, there is no significant relationship between the dynamic capability or organizational change and the evolutionary-fitness measure, and third, the comparison models give no better fit to the data. In other words, the data support the full mediation hypothesis. It therefore appears that, as expected, dynamic capability has a sizable positive and significant effect on organizational change. Likewise, organizational change has a positive and significant effect on product innovativeness in making the firm better able to accommodate new products. Accordingly, product-innovation performance has a positive influence on the relative growth of the firm. Firms that had been more innovative were able to create significantly more sales than their peers during the two-year period. The next step was to test statistically for the presence of possible positive indirect effects by means of bootstrap re-sampling (Mallinckrodt, Abraham, Wei, & Russell, 2006). With bias-corrected confidence intervals on a 95-percent-confidence level and one thousand bootstrap samples the results indicate a significant and positive indirect effect. All in all, the results support the underlying view that dynamic capabilities and innovation give firms competitive advantage and increase their evolutionary fitness.

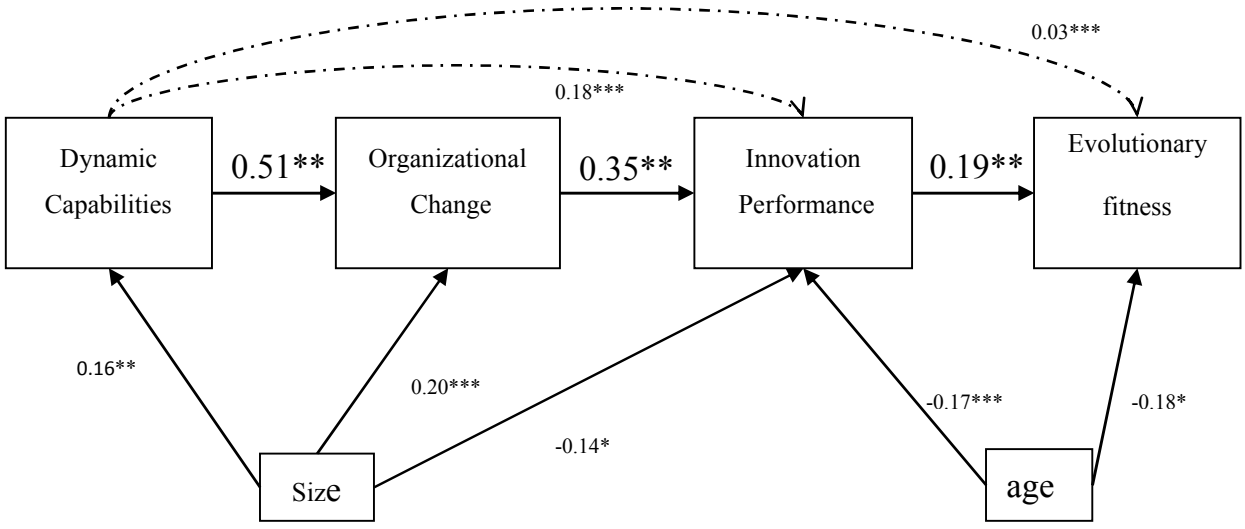

Figure 6.2 The results of the Structural Equation Model ($p<0.001$***, $p<0.01$**, $p<0.05$*): the indirect effect from dynamic capability to evolutionary fitness is positive and significant.

5.1. Detailed Analysis: Group Comparisons and Case Studies

The second stage of the empirical analysis focused in more detail on the relationship between dynamic capabilities and performance in the economic crisis. The creation of composite variables and analyses of variance highlighted any differences in the effect of the different capability types on the evolutionary fitness (relative growth) of the firms (Table 2). Following the grouping of the firms in two categories - negative growth and positive growth – paired t-tests assessed whether the different capability types had differential relationships with performance (see Appendix 3). The first step was to divide the sample into two groups, one group consisting of firms claiming a significant drop in new business opportunities in their market, and the second comprising firms operating in markets in which the economic crisis had not affected the business opportunities. The grouping derived from a survey item asking the firms to respond on a seven-point Likert scale (1= totally disagree, 7=totally agree) to the statement: "New business opportunities have radically diminished in our industry due to the global recession". The choice of a subjective rather than an objective measure of diminished business opportunities followed the suggestions in the literature that the triggering of dynamic capabilities lies in managerial perceptions of the environment, which may be at odds with the actual circumstances (Ambrosini et al., 2009).

The tendency in Group 1, which included the firms that did not perceive any loss of business opportunities, regardless of the capability type, was toward a positive relationship with performance. There were only a few non-significant relationships. The means for both renewing capabilities and regenerative capabilities were significantly higher in the well-performing firms. The difference was larger for regenerative capabilities, whereas for sensing and seizing opportunities and knowledge creation it was larger but statistically non-significant. The analysis revealed, in markets in which business opportunities had diminished (Group 2), a significant and positive performance difference between the firms in terms of dynamic capabilities related to sensing and seizing, and knowledge creation and renewing capabilities as a whole. Product innovativeness was significantly higher in the group of firms that were performing better. On the other hand, organizational change did not appear significantly different between the groups. Interestingly, for the set of regenerative capabilities the relationship was the opposite; the means were larger among the firms in the poorly performing group. In the case of learning the difference was even statistically significant. On the other hand, there were significant performance differences in the other group in terms of resource-reconfiguration capability. These results are as expected – in situations in which new business opportunities disappear, capabilities related to sensing the market and shifting the firm towards new opportunities are more valuable. In addition, knowledge-creation and renewing capabilities in general were stronger in firms that increased their

evolutionary fitness. At first sight this surprising result seems at odds with the expectations of Ambrosini et al. (2009). However, if dynamic capabilities are to have a positive effect on evolutionary fitness, not only must the environmental need for the function be high, but there must also be a competitive need in the form of other relatively better performing firms (Helfat et al., 2007). In this case it seems plausible that the environmental need for the particular dynamic capabilities explains the emergence of the result. Capabilities related to sensing new opportunities are more effective in environments in which there are no new business opportunities and the only way to succeed is to develop new organizational capabilities in order to serve current customers with new and better products. On the other hand, regenerative capabilities, due to their nature as higher-order dynamic capabilities focused on changing the way the organization develops its operational capabilities, incur significant costs, which may not promote short-run evolutionary fitness in such environments (see Winter, 2003). The relative growth variable only extends to the year 2010, which is a relatively short time span.

Table 6.2 Group comparison

Group comparison by perceived business opportunities

Group1	**Negative relative growth**			**Positive relative growth**					
Variable	Obs	Mean	Std. Dev.	Obs	Mean	Std. Dev.	Δ	t	Pr(T < t)
Sensing & Seizing	72	4,10	1,21	76	4,25	1,28	-0,15	-0,71	0,24
Knowledge creation	72	4,47	1,38	76	4,73	1,37	-0,27	-1,19	0,12
Knowledge Integration	**72**	**4,91**	**1,14**	**76**	**5,19**	**1,17**	**-0,28**	**-1,46**	**0,07**
Renewing Capabilities	***72***	***4,49***	***1,00***	***76***	***4,72***	***1,02***	***-0,23***	***-1,38***	***0,08***
Reconfiguration	**72**	**4,11**	**1,19**	**76**	**4,46**	**1,32**	**-0,35**	**-1,71**	**0,04**
Leveraging	**72**	**5,10**	**1,18**	**76**	**5,54**	**0,92**	**-0,44**	**-2,51**	**0,01**
Learning	**72**	**5,46**	**0,96**	**76**	**5,81**	**0,87**	**-0,35**	**-2,32**	**0,01**
Regenerative Capabilities	***72***	***4,86***	***0,89***	***76***	***5,24***	***0,82***	***-0,37***	***-2,65***	***0,00***
Organizational Change	72	4,20	1,59	76	4,25	1,61	-0,04	-0,16	0,44
Innovation Performance	72	0,20	0,21	70	0,22	0,19	-0,03	-0,75	0,23

Group2	**Negative relative growth**			**Positive relative growth**					
Variable	Obs	Mean	Std. Dev.	Obs	Mean	Std. Dev.	Δ	t	Pr(T < t)
Sensing & Seizing	**95**	**3,93**	**1,09**	**58**	**4,26**	**1,11**	**-0,33**	**-1,81**	**0,04**
Knowledge creation	**95**	**4,14**	**1,48**	**58**	**4,48**	**1,30**	**-0,34**	**-1,44**	**0,08**
Knowledge Integration	95	4,82	1,00	58	4,91	1,02	-0,09	-0,55	0,29
Renewing Capabilities	***95***	***4,30***	***0,97***	***58***	***4,55***	***0,92***	***-0,25***	***-1,61***	***0,05***
Reconfiguration	95	4,14	1,21	58	4,17	1,29	-0,03	-0,14	0,44
Leveraging	95	5,16	1,03	58	4,96	1,06	0,21	1,19	0,12
Learning	**95**	**5,72**	**0,91**	**58**	**5,50**	**1,04**	**0,22**	**1,40**	**0,08**
Regenerative Capabilities	*95*	*4,99*	*0,82*	*58*	*4,86*	*0,94*	*0,12*	*0,80*	*0,20*
Organizational Change	95	4,05	1,31	58	3,94	1,26	0,10	0,48	0,32
Innovation Performance	**95**	**0,15**	**0,14**	**54**	**0,21**	**0,20**	**-0,07**	**-2,30**	**0,01**

6. Case analyses

6.1. FoodCo – Prosperity despite the crisis

FoodCo is a small family business that has been in existence since 1977. The company employs around ten people in addition to members of the owner family. The business idea is to develop, produce and market healthy and health-supporting high-quality vegetarian and organic food for consumers who value wellness and wellbeing. More and more of the company's business derives from a product range that appeared on the market in 1995 and was the first of its type in the world. The

basic ingredient is oats, softened by carefully selected probiotics through a patented production process. All the products in the range are nutraceutical and organic.

Intense research and development in cooperation with universities and research institutes, which focused on developing operational capabilities, preceded the production start-up. The product and the whole process were technologically unique, and the target consumer market and values attached to the product and its production differed from the bulk manufacturing that is typical of the product category. The venture was risky for the small company, and raised the suspicions of partners and competitors.

> *Encouragement we did not receive, most of the partner firms didn't understand this choice… We don't think these people understood our vision of pure, vegetarian food, and therefore could not understand our investments and our business. They think it's too small a market, but it's growing… In general we have become used to discovering our own paths when it comes to this product and its production.*

The strong belief in the product was largely about the personal characteristics of the owners, but also derived from the renewing capabilities of sensing and seizing the markets. The entrepreneurs have always been very active in scanning and exploiting consumer trends and consuming habits related to consumption patterns in this type of product.

> *Actually it's also our hobby, we constantly follow what's going on, what the consumers are doing, what the rising trends are and where this market is going.*

The company has managed to create new product and process innovations through the exploitation of its renewing capabilities related to knowledge creation and sensing and seizing opportunities on the consumer market, as well as of its regenerative capabilities of leveraging and reconfiguring its current knowledge and resource base. As a result of these actions, together with active product demonstrations in outlets, positive word of mouth and positive publicity in various magazines, FoodCo has learned what product features give access to the tables of consumers, identifying which customer segments appreciate the positive healthy effects or the organic and ethical aspects. In order to target these segments and fully meet their needs the company widened the range from products to eat to products to drink, continuously made improvements to the ingredients, flavors and packaging, and on the manufacturing side focused on safer and more effective automated production. During this phase of development in 2009 the company and the product range received two prestigious national awards for the innovative and organic nature of the products.

Through its consistent and long-lasting focus on organic, pure, and health-supporting products that have varied on account of the introduction of new flavors and new items, the company has gained a strong position in the minds of consumers.

I think the growing recognition of organic and ethical aspects in general and the wellbeing the consumer experiences by eating our product have made its consumption a growing habit among the public.

FoodCo has not stopped innovating and developing the processes. The company remains future-oriented in constantly sensing and seizing the market, the consumers and the competition in the widest sense, developing new products and improving company processes, strengthening production resources, and taking better advantage of the social media in its marketing. The financial crisis did not have a negative effect on its operations, sales or margins.

The financial crisis did not have an effect on us, or actually it did in that we have invested in production lines and automation because of low interest rates… and we have to look forward and to make these investments now in order to be prepared, to be stronger to compete, this improved automation helps us in this.

6.2 MaritimeCo – Back to the game after a heavy blow

MaritimeCo is a design and turnkey company operating in shipbuilding, and in building construction on land. The company started operations in 1990, and currently employs around 100 people, including project managers, designers, and supervisors. The business focus is on project management, offering complete turnkey solutions, covering everything from planning and design to installation and post-delivery support.

Until 2010 around 90 percent of MaritimeCo's annual turnover was attributable to its role as a supplier to STX Finland Turku Shipyard. As a result of the financial crisis shipbuilding has dramatically decreased in volume since 2008 in global terms as new orders have dried up. Since the end of October 2010 and the delivery of the latest giant cruising ship, "Allure of the Seas", from Turku Shipyard work there has come to a halt, striking a heavy blow on the whole shipbuilding value network. MaritimeCo, for example, saw a decrease in annual turnover from 50 million euro to 10 million euro in 2010 and had to lay off many of its employees.

The end of MaritimeCo's involvement in the shipbuilding industry came as a virtual surprise. The company did not have sensing and seizing capabilities, but were

running the business largely focusing on its existing products and current operational capabilities.

> *We were quite blind, I think. We thought to the very end that Turku Shipyard would get new contracts. On the other hand, we had been so busy for so long that it was challenging even to handle the current business, not to mention observing or even thinking seriously about any new business ideas or fields. ...however I think that in every company there should be a person who is free from the projects at hand and current business and can observe new opportunities and look into the future.*

In this sense the company was looking for new business opportunities on a very minor level. The heavy blow was not fatal: it was rather the case that by virtue of its regenerative capabilities it was able to take the critical leap from sea to land in order to ensure its long-term survival :

> *The financial side is still under control, but we have to find new business areas on land or in other shipbuilding value systems globally, otherwise this will end soon. ...but we have been working very hard recently, we have to, and we can already see positive signs, perhaps we'll even get a couple of significant projects going this month.*

The previous contracting arrangements with the shipyard forced the company to develop certain competences and resources in order to live with diminishing margins and tightening regulations and demands for quality over which representatives of the customer, the shipyard and the authorities, for example, exercise constant vigilance. This knowhow has facilitated the transfer to new business areas in which, so far, there is less control over these procedures. In this sense the company had strong operational capabilities that constituted the basis of the business. MaritimeCo has also trained its employees in the specifics of building on land, and has made preliminary contracts with network partners. In this sense the company also has business-regenerating capabilities in terms of leveraging, learning and reconfiguring the current resource base, as well as operational capabilities in terms of coping with the new situation. However the lack of references for building on land has slowed down penetration into these markets. MaritimeCo has therefore acquired a company that builds different tailored interior components suitable for land and sea construction. The aim of the investment was to strengthen resources, balance demand, and create the necessary trust to secure entry into value networks focusing on land building. This acquisition also represents the strong business-regenerating capability that makes the leap to

another industry possible in terms of changing the current business logic. In this sense its regenerating capability led to the development of a new set of renewing capabilities.

Despite the quite dramatic negative short-term influences on account of its lack of business-renewing capabilities related to sensing and seizing, the company sees the current decrease in business as positive in the big picture mostly because of the strong business-regenerating capabilities that have prevented a total downturn. In the long term this shift to building on land will give MaritimeCo new opportunities to diversify further and reduce its dependence on a single customer.

6.3 MediaCo – Weathering the strong structural change in the industry

MediaCo is a leading printing house in the Nordic region and a service company specializing in comprehensive marketing solutions. The company concentrates on developing printing services, multichannel services, and customer-specific solutions in terms of traditional paper printing and digital printing. The annual turnover used to be over 200 million euro, but started to decline in 2008 to around 182 million, and further after 2009 to around 100 million euro. The financial crisis partly accelerated and partly launched this decrease in business volume. The effects came from two main directions. Firstly the crisis forced the former main customer with a 15-year business relationship with MediaCo to renegotiate the contract, which would have resulted in very tight margins in an area with no future potential. MediaCo therefore withdrew from the business. Secondly, the general demand for traditional printing decreased heavily as companies cut down on print marketing due to the crisis. In addition, the general price level of print products has come down by between five and 10 percent yearly during the last decade due to over-capacity and strong rivalry in the industry, and an overall reduction in the amount of printing worldwide. However, on account of its renewing capabilities of sensing and seizing the company expected the downturn in business, and has been able to make strong structural changes in its operational capabilities in order to improve cost efficiency:

> *I would say that 80 to 90 percent of our energy has been put into cutting costs, which means implementing a structural change in our organization and production in order to get back to the safe side. In practice this means converting a 1000-employee organization into a 500-employee organization.*

Internal efficiency and operational capabilities are a must in a field in which capital costs are high, competition is fierce, and the market is declining.

For example, last year we printed more than in the previous year, but the turnover was lower. The market is declining, but slowly, and our view is that printing and printed products will be around for a long time and there will be a business there, and we will be among the successful companies in that business. However you need to take the cost efficiency to the limit, you need to have high volumes in order to deal with the capital costs.

Despite being locked into the traditional printing business the company has been active in developing new business ideas, intent on leveraging and reconfiguring its current operational capabilities in order to generate new business. A concrete outcome of this was the setting up of a small team called New Ventures in 2007, which in turn led to the launching of some new products generating around a million euro in annual turnover. In addition to making a financial contribution the new team has helped to promote the image of an active forward-looking company.

...the margins from the traditional printing activities will hopefully enable us to develop something new, and to identify new and emerging areas of business in digital solutions, for example. ...and hopefully the revenue from these new ventures will raise the total revenue level. I mean finding viable business areas with better margins.

Despite the fact that printing activity facilitated the new development, the company has faced challenges in converting to new business functions:

When a traditional printing company takes a leap into totally different markets, as we have done with these various projects about printed intelligence, printed electronics, then the whole game and its rules, processes, materials, competences and so on are different, and without large investments it is not possible. The genetics of the organization are so different that you need a totally new organization. And those sorts of large-scale investments are not possible for us at the moment. The best new products and services have been the ones we have built around our current competences, and then it has been about new product concepts or new customers.

In this respect the current number-one target is to run the traditional printing process as efficiently as possible, concentrating on constant improvement, innovation, and investment. The aim is to reconfigure and leverage the current resource base and operational capabilities with a view to facilitating the sensing and seizing of new business opportunities in digital printing. The focus is thus on short-term improvements and minor changes in existing products emanating from current competences. In the short run the effects of the financial crisis were severe for MediaCo in terms of a reduced business volume. However due to its strong financial position and balance sheet the company has been more successful in dealing with the situation than many other companies in the industry. In the long run the effect might even be positive in that the crisis is likely to cut down the over-capacity in the field and to reconfigure the competitive setting through consolidations and bankruptcies.

7. Conclusions and implications

7.1. Theoretical contribution and implications for future research

The study set out to investigate, from the perspective of dynamic capabilities, how firms are able to cope with the drastic effects of a global financial crisis by adapting their behavior and resource base. Recent research has brought the competitive environment back to the forefront of the literature on dynamic capabilities in pointing out that, although the benefits extend beyond dynamic environments, some capabilities are more beneficial than others, depending on the hierarchical level. The aim was thus to analyze this proposition both quantitatively and qualitatively within the context of the global financial crisis, which created an exogenous shock in the environment of the firms.

The study contributes to the research on dynamic capabilities in three significant ways. First, the introduction of a novel measurement scale operationalizes dynamic capabilities as a multidimensional superordinate construct building on the vast conceptual literature, thereby enhancing understanding of the conceptual distinction between dynamic and operational capabilities (Ambrosini et al., 2009; Easterby-Smith et al., 2009; Winter, 2003). Second, the results support the view that dynamic capabilities and innovation give firms competitive advantage and enhance their evolutionary fitness. Furthermore, this relationship is indirect, fully mediated through the operational capabilities and innovation outputs of the firm. In other words, a better evolutionary fit comes not as a result of dynamic capabilities in themselves, but through a sustainable renewal of the organization that positively affects its innovative performance. This finding also complements the literature on dynamic capabilities, which contains relatively fewer quantitative accounts of their combined effect on

innovation performance on the one hand, and firm performance or competitive advantage on the other.

Another contribution on the quantitative level is the use of an objective dependent variable explicitly to measure evolutionary fitness. Third, and most significantly, the study contributes by giving a detailed analysis of dynamic capabilities and the environment in which firms operate. An interesting finding is that different dynamic capabilities may have different effects depending on the competitive environment (c.f. Ambrosini et al., 2009; Barreto, 2010; Helfat et al., 2007). In particular, firms facing a lack of business opportunities due to financial meltdown benefit from renewing capabilities, whereas the results suggest that the effect is the opposite for regenerative capabilities. One might thus conclude that changing its operational capabilities may not be beneficial to a firm in situations in which business opportunities suddenly disappear. Theoretically the implication is that the relationship between the operating environment and dynamic capabilities depends on the context, and that analyses should also take into account other types of environmental conditions, not only technological dynamism as in most research thus far. In addition, the context of the study, three low-tech and traditional sectors, is novel, and the concept of dynamic capabilities clearly applies to them as well (c.f. Easterby-Smith et al., 2009).

The relative significance of the various capabilities seems to differ according to the level of turbulence. Higher-order dynamic capabilities related to observation and evaluation in particular seem to have a positive effect on firm performance in industries in which business opportunities have diminished as a result of strong environmental turbulence. On the other hand, firms in industries in which new business opportunities continue to arise despite the crisis seem to benefit from both regenerative and renewing dynamic capabilities.

Generally, the application of various types of dynamic capabilities entails quite complex, rich and diverse actions in individual firms facing different contextual events and forming collective interpretations of them. The aim in conducting the three qualitative case analyses of companies representing the industries in focus was to further demonstrate this phenomenon. The results exposed certain longitudinal features of dynamic capabilities in terms of continuously enabling and creating a basis for a healthy business and evolutionary environmental fit during the period of the financial crisis. For example, the first case firm, FoodCo, had been constantly monitoring consumer behavior and trends in its operating environment. The company, in collaboration with university and other network partners, used the knowledge resulting from this sensing and seizing activity in the creation of new products and processes. In combination these activities have maintained and strengthened its fit with the environment, not only with regard to current business activities but also in terms of its long-term orientation and successful operation in the future. The financial crisis did not affect the identified trends or the positive consumer

orientation towards FoodCo's products, and thus had little influence in terms of evolutionary fitness. The company also monitored and constantly developed its internal efficiency before and during the crisis. It has been continuously reconfiguring its resource base and has acquired new resources in the form of production machinery, for example, in order to maintain the capacity to implement organizational changes in line with the knowledge emanating from environmental sensing and seizing.

The second case firm, MaritimeCo, differed fundamentally from FoodCo in that it was almost blind to the environmental changes. It had been developing its internal efficiency with respect to shipbuilding, but did not realize that its entire business in this value network was about to collapse, or perhaps totally disappear due to the economic downturn. After downsizing the company started actively to identify new business opportunities in the operating environment in order to survive and create a fit. Quite soon after the collapse of the shipbuilding business the situation started to become more positive. This turnaround was largely attributable to the existence of efficient resources that were reconfigurable to construction projects on land. The crisis was thus eventually more positive in the long run in terms of raising the company's awareness of the potentially better fit available in the construction projects on land and forcing it to sense and actively search the environment.

The third case firm, MediaCo, was unique in that it had actively monitored the environment and was aware of the diminishing business volumes in the printing industry. It had also actively developed its resources in order to maintain efficiency. However, it was not able to maintain its effectiveness and lost around half of its business. Regardless of the diminishing market, MediaCo remains positive about doing viable business in the area through maximizing cost efficiency and bringing in cutting-edge technology, thereby gaining economies of scale. Despite being locked into the current cost-cutting philosophy, the company is actively seeking opportunities in the area of digital printing, although the current new-business potential is limited. Another hurdle in the race for new business is the challenge it has already faced in reconfiguring its organization and resource base to accommodate a totally different line of business.

Although the focal study shed some light on the central role of various dynamic capabilities in providing firms with the means of survival in the global financial crisis, certain theoretical and methodological issues arise with regard to enhancing understanding of the phenomenon.

First, although there is still no universally applicable scale for measuring the construct of dynamic capability, there have been some successful attempts, in addition to the study at hand (e.g., Protogerou et al., 2011). However, the development of the measurement scale and the testing of the full hierarchy of organizational capabilities are still in the early stages. There is a need for more research and further exploitation of the operationalization efforts so far. On the methodological level, in view of the abstract and complex nature of dynamic

capabilities, there is a need for longitudinal, historical research building on clear theoretical ideas and research questions that would enhance understanding of the importance, development and operating mechanisms of dynamic capabilities in varying contextual circumstances. Time-oriented, multi-level approaches are likely to produce knowledge that would also be of use in developing existing quantitative measures for empirical testing in subsequent quantitative studies. This study, despite the forward-looking dependent variable, still lacks a true longitudinal setting and the facility to observe the effects of dynamic capabilities at t_1 at t_2. Future empirical studies in such a setting would capture the actual effect of dynamic capabilities on the resource base of organizations (Easterby-Smith et al., 2009).

7.2. Practical implications

The study shows that a company can manage its fit with the environment, and that a better fit means better performance. However the continuous process of identifying potential opportunities and threats in the operating environment and creating and reconfiguring the organizational resource base in order to exploit the opportunities and avoid the threats both efficiently and effectively is not easy. The company must first overcome the structural inertia that inhibits the process and promotes stability. Therefore, new ways of implementing initiation mechanisms for explorative activities should be inherent in the organization's management model. Secondly, there should be incentives to start the process of changing the resource base and thus to exploit the opportunities and avoid the threats. Of major significance in this activity are the organizational design and communication patterns: top-down and bottom-up information processes, the division of labor and empowerment practices should facilitate the initiation and continuous evolvement of the exploratory process.

In terms of company practice, at least some individuals in all areas of the organization should, in addition to carrying out their core functions and tasks, dedicate time to questioning current performance and considering ways of doing things differently in order to achieve the same or different goals (target markets, value propositions, core benefits). Alternatively, various incentives could encourage voluntary innovation and development activity. This would lead to a wider sensing and scanning of the environment from perspectives other than that of management. Similarly, front-line people are likely to have innovation potential regarding the deployment of current resources, and they have hands-on knowledge of the potential bottlenecks in the resource flow and in value-creation processes. On the company level, the recognition of initiatives would communicate to employees that management takes their ideas seriously, screens them and takes the best ones for further development.

Balancing the creation of new resources to generate new business, the other side of the fit concerns cutting down on inefficiency in terms of reducing the number of employees or downsizing some of the contract manufacturing, for example. From the managerial perspective one challenge is to find a balance between generating the new, which is pleasant, and getting rid of the old, which is unpleasant, so that the organization will attract competent new employees and foster a positive and forward-looking culture.

Finally, there are some policy-making implications. The results support neo-Schumpeterian growth models stressing that the adoption of new technologies or business models is more likely in recessions on account of the lower opportunity costs: development efforts do not disturb the business as much as in boom periods. On the more psychological level, compulsion is a strong motivator. However, political pundits are likely to pour economic subsidies into restructuring industries. Hence, the main policy implication stemming from economic theory and the empirical results is that the motivation for granting subsidies should be to support economically viable change, not to stop competiveness-improving creative destruction that benefits society in the long run.

Appendices
Appendix 6.1 Items used in Measuring Dynamic Capabilities

ITEM NAME	DESCRIPTION
	Sensing and seizing (OBS)
DCOBS1	We systematically search for new business concepts through observation of processes in the environment
DCOBS2	We systematically bring together creative and knowledgeable persons within the firm to identify new business opportunities
DCOBS3	We systematically bring together creative and knowledgeable persons from outside the firm to help identify new business opportunities
DCOBS4	In our firm resources are systematically transferred to the development of new business activities
	Knowledge creation (RENRD)
DCREN1	We seek to increase R&D investments
DCREN2	Firm has specific plans for R&D activity
DCREN3	Our management is involved in R&D processes
DCREN4	We are developing routines for firm R&D
	Integration (ACQNW)
DCACQ1	Firm networks are used as knowledge resources
DCACQ2	The firm exploits the personal network of the manager
DCACQ3	Employees' networks are important information sources for the firm
DCACQ4	Firm networks are used to influence actors in the environment
	Reconfiguration (RECRUT)
DCREC4	We have developed routines to enable employees' active participation in generating ideas for new products or services
DCREC5	We have developed routines to enable employees' active participation in generating ideas for new production processes or organizational procedures
DCREC6	The firm has routines for systematization of employees' experiences
	Leveraging (RENEMP)
DCREN8	Employees are more willing to adopt into new ways of working than those of our competitors (droped from the final model)
DCREN9	Employees are left room to exploit new opportunities as long as it does not affect current activities
DCREN10	Employees and managers are strongly encouraged to promote new visions, goals and ideas
	Learning (RECEMP)
DCREC1	The firm emphasizes to increase the level of competence among employees
DCREC2	The firm allocates resources to increase employees' competence
DCREC3	Employees are strongly stimulated to learn from their experiences

Appendix 2 Construct and Measurement model reliability and validity and structural path estimations

Table 6.A1. Dynamic capability construct

Dynamic capability construct reliability and validity

Second-order construct	Std. Factor Loadings	First-order constructs	Item	Std. Factor Loadings
Dynamic Capability	0,82	*DCOBS*	DCOBS1	0,75
			DCOBS2	0,83
			DCOBS3	0,70
			DCOBS4	0,75
	0,67	*DCRENRD*	DCREN1	0,77
			DCREN2	0,84
			DCREN3	0,77
			DCREN4	0,87
	0,71	*DCRENEMP*	DCREN9	0,62
			DCREN10	0,83
	0,71	*DCRECRUT*	DCREC4	0,88
			DCREC5	0,81
			DCREC6	0,66
	0,70	*DCACQNW*	DCACQ1	0,74
			DCACQ2	0,71
			DCACQ3	0,71
			DCACQ4	0,77
	0,64	*DCRECEMP*	DCREC1	0,91
			DCREC2	0,82
			DCREC3	0,75

Convergent validity

		CR	AVE
	DC	**0,75**	**0,50**
1.	DCOBS	0,76	0,57
2.	DCRENRD	0,83	0,66
3.	DCRENEMP	0,63	0,59
4.	DCRECRUT	0,75	0,62
5.	DCACQNW	0,83	0,54
6.	DCRECEMP	0,82	0,69

Discriminant validity

	1.	2.	3.	4.	5.	6.
1. DCOBS	*0,76*					
2. DCRENRD	0,59	*0,81*				
3. DCRENEMP	0,60	0,37	*0,77*			
4. DCRECRUT	0,60	0,42	0,61	*0,79*		
5. DCACQNW	0,58	0,53	0,55	0,39	*0,73*	
6. DCRECEMP	0,43	0,49	0,52	0,43	0,48	*0,83*

Off-diagonal: construct correlations (all correlations significant at $p<0.01$)

Along diagonal: Square root of AVE

G-O-F	*χ2*	*d.f.*	*NFI*	*CFI*	*Std. RMR*	*RMSEA*
First-order	345.58	155	0,90	0,95	0,06	0,57
Second-order	381.84	164	0,89	0,93	0,07	0,07

Note. The structural and path models were derived from AMOS 19 and the Maximum likelihood estimator.

Table 6.A2. Measurement model

Measurement model						Convergent validity		Discriminant validity		
Constructs	**Item**	**Std. Factor Loadings**								
Dynamic capability	DCRENEMP	0,68				CR	AVE	1.	2.	
	DCRECEMP	0,62	1.	Dynamic capability		0,75	0,50	*0,70*		
	DCRECRUT	0,71	2.	Organizational change		0,67	0,55	0,56	*0,74*	
	DCRENRD	0,68								
	DCOBS	0,83								
	DCACQNW	0,69	*G-O-F*	*χ2*		*d.f.*	*NFI*	*CFI*	*Std. RMR*	*RMSEA*
Organizational change	innoorg5	0,63	Measurement model	476,92		223	0,87	0,93	0,07	0,06
	innoorg4	0,79								
	innoorg3	0,80								

Table 6.A3. Model comparisons

Model	χ2	DF	χ2/DF	Δχ2	ΔDF	CFI	RMSEA	PNFI
Full mediation	524,504	268	1,957			0,927	0,056	0,712
DC→OC→IP→EF & OC→EF	523,508	267	1,961	1,00	1	0,927	0,057	0,709
DC→OC→IP→EF & DC→EF	524,161	267	1,963	0,34	1	0,927	0,057	0,709
DC→OC→IP→EF & DC→IP	524,122	267	1,963	0,38	1	0,927	0,057	0,709
DC→OC→IP→EF & OC→EF & DC→EF	523,504	266	1,968	1,00	2	0,926	0,057	0,707
DC→OC→IP→EF & DC→IP & OC→EF	523,124	266	1,967	1,38	2	0,927	0,057	0,707
DC→OC→IP→EF & DC→IP & DC→EF	523,787	266	1,969	0,72	2	0,926	0,057	0,706
All paths set free	523,12	265	1,974	1,38	3	0,926	0,057	0,704

DC: dynamic capabilities, OC: organizational change, IP: innovation performance, EF: evolutionary fitness

CHAPTER 7: THE HIEARCHICAL STRUCTURE OF DYNAMIC CAPABILITIES AND EVOLUTIONARY FITNESS OF THE FIRM

1. Introduction

Despite the increased attention paid to dynamic capabilities since Teece et al.'s (1997) work, scholars are still searching for solutions to explain the sources of a firm's performance and competitive advantage. Dynamic capabilities are defined as capabilities that enable firms to change their resource base, including both tangible and intangible assets and capabilities (Easterby-Smith, Lyles, & Peteraf, 2009). Although related research suggests that they enable firms to adapt to environmental changes or to create disruptive changes (e.g. Eisenhardt & Martin, 2000; Teece et al., 1997), recent research presents them as the organizational capacity utilized in creating, extending, and modifying a firm's resources (Helfat, et al., 2007). This approach combines the different perspectives presented in the previous literature by focusing on changes within the firm (Easterby-Smith et al., 2009; Helfat & Peteraf, 2009). Despite the implication that dynamic capabilities are a one-dimensional concept, that is not the case and there are various types of dynamic capabilities that perform different functions dictated by the level and type of changes, the organizational capabilities, and ultimately by the firm's resource base (Ambrosini & Bowman, 2009; Helfat & Peteraf, 2009, Madsen, 2010). Scholars acknowledge that this bundle influences performance yet research struggles to explain precisely how (Leiblen, 2011).

An important development in the conceptualization of dynamic capabilities underscores their role as necessary, but not sufficient, conditions for a firm's competitive advantage (Eisenhardt & Martin, 2000). Instead of solely guaranteeing a firm's success, they enable the firm to adjust to endogenous changes within the day-to-day operations in situations where the management recognizes the need (Ambrosini, Bowman & Collier, 2009; Newey & Zahra, 2009; Winter, 2003). Accordingly, in this study we assume that dynamic capabilities are the 'higher order' routines and capabilities that enable firms to change and reconfigure their ordinary capabilities (Helfat et al., 2007; Winter, 2003). This approach dictates a further assumption be made on the hierarchical nature of organizational capabilities (Dosi, Nelson & Winter, 2000; Winter, 2000). This was originally noted by Collis (1994), but in his seminal paper, Winter (2003) specifies the capability hierarchy on three

levels. Zero-level capabilities are the capabilities that enable the firm to make its living. Zahra et al. (2006) identified these capabilities as substantive, enabling a firm to execute its main activities. Winter (2003) continued his approach by distinguishing two levels of hierarchy within the dynamic capabilities: *first-order capabilities* are associated with change in the resource base of a firm, and *higher order capabilities* are the capacity to change the way resources are transformed (Winter, 2003).

In this study, we follow recent conceptual advances and define dynamic capabilities as a hierarchy of higher order (i.e. regenerative and renewing capabilities) and first-order (i.e. incremental) capabilities. This approach offers a better understanding of the complex relationship between dynamic capabilities and firm performance (Leiblein, 2011). Drawing on the evolutionary theory of the firm, scholars have acknowledged that in addition to direct associations, there is an indirect link between dynamic capabilities and firm performance (Helfat et al., 2007; Zahra, Sapienza & Davidson, 2006). Thus, Barreto (2010) suggests that dynamic capabilities should be conceptualized as a multidimensional construct. This has enabled a robust approach to empirical measurement of the dynamic capabilities by avoiding the potential problems of tautology and lack of clarity (Ambrosini et al., 2009; Collis, 1994; Helfat et al., 2007; Winter, 2003; Zahra et al., 2006). However, thus far only a few studies have empirically tested this structure and its link to a firm's performance (e.g. Drnevich & Kriauciunas, 2011; Protogerou, Caloghirou & Lioukas, 2012).

To investigate the hierarchical construct of organizational capabilities and their direct and indirect links with firm performance more deeply, we introduce an empirical test of the dynamic capability hierarchy suggested by Winter (2003) and further developed by Ambrosini, Bowman & Collier (2009). The hierarchical operationalization of dynamic capabilities we introduce and test has both theoretical and practical importance, as it suggests the presence of different kinds of capabilities and their complex links with the evolutionary fitness of the firm. To date, scholarly progress in the area has been hindered by the empirical challenge and only a few studies have empirically tested the hierarchical nature of dynamic capabilities. Our work contributes to this progress by empirically validating that the dynamic capabilities concept consists of different multidimensional hierarchical constructs. We argue that the benefits from dynamic capabilities are captured mainly through the hierarchical alignment of regenerative, renewing and incremental capabilities, as was conceptually assessed by Ambrosini et al. (2009).

Our study is constructed so as to answer our research questions which are: 1) Are dynamic capabilities hierarchical in nature? 2) Does their hierarchical nature affect their relationships with a firm's evolutionary fitness?

We adopt an approach built on established theory and also offer novel insights. Our findings contribute to the understanding of the complex role of dynamic capabilities in relation to firm performance and competitive advantage. Our results

suggest a more complicated relationship between the various hierarchies of dynamic capabilities than previous empirical studies would suggest.

Our paper proceeds as follows. First we review the theoretical foundations and introduce our hypotheses. Then we present the data and methodology, after which we discuss the results and consider their implications. Finally, we conclude the study and discuss its limitations.

2. Dynamic capabilities hierarchy

Defining dynamic capabilities

In linking dynamic capabilities to evolutionary economics we view them as an incremental source of internal evolution for the firm (Newey & Zahra, 2009; Zahra et al., 2006). Accordingly, we assume that there is a path dependency between capabilities that serve as a firm's building blocks and as entities of evolutionary retention (Nelson & Winter, 1982). Thus, dynamic capabilities are defined in terms of routine entities, which evolve over time through the learning mechanisms within firms and which are necessary for a firm to create new and to reconfigure existing capabilities (Helfat et al., 2007; Zollo & Winter, 2002).

Dynamic capabilities are a subset of what the evolutionary theory of the firm calls organizational capabilities (Dosi, Nelson and Winter, 2000). According to Winter (2000, p. 983) they are '*...high-level routines (or collection of routines) that, together with their implementing input flows, confer upon organization's management a set of decision options for producing significant outputs of a particular type'*. The literature on organizational capabilities distinguishes operational capabilities, which facilitate the day-to-day activities of the firm, from dynamic capabilities, which govern the rate of change of ordinary capabilities (Dosi et al., 2000). The term operational capabilities refers to the means and practices needed to efficiently configure existing resources into existing products and services, whereas dynamic capabilities reflect the explorative side of organizations (Zahra, Sapienza, & Davidsson, 2006). Thus, dynamic capabilities allow the realization of new opportunities and the related conversion of the organizational resource base in terms of both tangible and intangible assets and capabilities (Easterby-Smith, Lyles, & Peteraf, 2009). This organizational capacity allows a firm to purposefully create, extend, and modify its existing resource base, and thereby provides the means for changing and renewing current processes, providing a basis to promote innovation and a better fit with the environment (see Helfat, et al., 2007; Eisenhardt and Martin, 2000; Zollo and Winter, 2002; Winter, 2003; Zahra et al., 2006).

Firms, however, are prone to inertia, which is a prevalent and arguably a necessary characteristic of organizational capabilities (Nelson & Winter, 1982; Newey & Zahra,

2009). For example, the different innovation strategies firms utilize have a long lasting effect on the innovation outcomes of firms (Clausen, Pohjola, Sapprasert & Verspagen, 2012). However, inertia may hinder strategic change, and can lead to the failure of the firm. Valuable organizational capabilities may become rigidities if their function becomes obsolete (Leonard-Barton, 1992). Dynamic capabilities allow firms to change continually and deliberately by governing the rate of change of operational capabilities (Collis, 1994; Winter, 2003; Zahra et al., 2006). So dynamic capabilities differ from *ad hoc* problem solving. They enable firms to evolve in a sustainable manner, to adapt to environmental change and help overcome inertia (Helfat et al., 2007; Newey & Zahra, 2009; Eisenhardt & Martin, 2000). However, like capabilities in general, dynamic capabilities themselves are subject to inertia and do not necessarily lead to increased evolutionary fitness.

The hierarchy of dynamic capabilities

Dynamic capabilities consist of different types of higher order capabilities focused on different elements of the organization and different purposes (Helfat et al., 2007). Previous research has conceptually distinguished the different levels of dynamic capabilities based on their role in governing change in the firm (see e.g., Ambrosini, Bowman, & Collier, 2009; Collis, 1994; Helfat et al., 2007). Winter (2003) describes two levels: first-order capabilities reflecting the change in the operational, zero-level capabilities and resources of a firm, and higher order capabilities which cover the capacity to modify or create new first-order capabilities. Building on Winter's (2003) work, Ambrosini et al. (2009) categorize the higher order capabilities as regenerative and renewing capabilities. They define first-order capabilities as incremental capabilities and distinguish them from higher order capabilities in that they incrementally adapt the operational capabilities in a repeatable manner, but do not transform it to a large extent. The incremental capabilities have a direct effect on the resource base and therefore the performance of the firm (Ambrosini et al., 2009). Our conceptual model is presented in Figure 1.

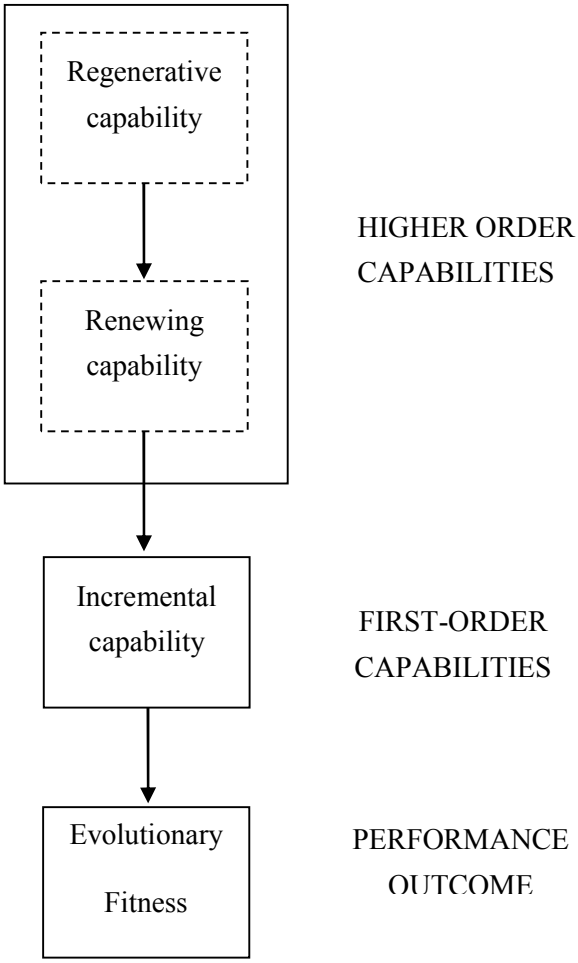

Figure 7.1. Conceptual model

This hierarchical structure emphasizes the distinction between the dynamic capabilities that enable the firm to move away from previous change practices towards new ways of changing the routines of the firm (regenerative capabilities) and the capabilities that modify the firm's ability to deliver new products or reduce production costs (renewing capabilities). Incremental capabilities, on the other hand, are responsible for the gradual adjustments made to adapt the operations of the firm to meet the goals set by management. Dividing dynamic capabilities into three categories makes the complexities of the performance link explicit, something that was not possible for previous research that considered dynamic capabilities as a whole.

Regenerative capabilities form the basis on which the firm renews its lower order capabilities. They represent a long-term investment in the change capability within the organization (Winter, 2003). Renewing capabilities can refresh and renovate the

nature of the resource and capability stock through, for example, the introduction of new product lines (Ambrosini et al., 2009). Renewing capabilities also allow the firm to identify and exploit novel opportunities. Previous research acknowledges several different types or dimensions of dynamic capabilities (e.g. Bowman & Ambrosini, 2003; Madsen, 2010; Teece, 2007). Hence, following recent literature, dynamic capabilities are here conceptualized as a multidimensional construct (Barreto, 2010; Edwards, 2001; Protogerou et al., 2011) comprising several distinct but related dimensions treated as a single unit (Law, Wong & Mobley, 1998). In this paper, we combine the two lines of conceptual development and suggest that dynamic capabilities consist of three hierarchically related constructs, where the higher order capabilities, regenerative and renewing, are themselves multidimensional *latent* constructs (see Wong, Law & Huang, 2008).

Building on the vast body of literature conceptualizing the different dynamic capability dimensions, this study applies a set of six different dimensions (Table 1). The table briefly describes the types of higher order dynamic capabilities and gives the main references.

TABLE 7.1: HIGHER-ORDER CAPABILITY HIERARCHY

Dynamic capability dimensions		Definition	References
Regenerative capabilities	Reconfiguration	The capability to reconfigure the existing capability base by enabling the firm to transform and exploit its existing knowledge in changing organizational context.	Bowman & Ambrosini (2003), Eisenhardt & Martin (2000), Teece & Pisano (1994), Teece et al. (1997), Zahra & George (2002)
	Leveraging	The capability to utilize and deploy an existing resource in new a situation, allowing the firm to replicate an operational capability in a new market.	Bowman & Ambrosini (2003), Eisenhardt & Martin (2000), Pavlou & El Sawy (2006), Teece et al. (1997)
	Learning	The capability that allows the firm to adopt, acquire and create new capabilities through the learning processes of the organization.	Bowman & Ambrosini (2003); Romme, Zollo & Berends (2010); Teece & Pisano (1994); Zollo & Winter (2002), Zott 2003
Renewing capabilities	Sensing and seizing	The capability to position oneself favorably in an environment and to explore new opportunities.	Danneels 2002, Pandza & Thorpe 2009, Teece 2007, Teece et al. (1997)
	Knowledge Creation	The capability to continuously create and absorb new knowledge, to develop new products or processes.	Eisenhardt & Martin (2000), Danneels (2002), Henderson & Cockburn 1994, Mckelvie & Davidsson (2009), Pisano 1994, Verona & Ravasi (2003), Zahra & George (2002)
	Knowledge Integration	The capability to acquire and integrate new knowledge through external sources such as networks, also referring to the utilization of social capital.	Ambrosini et al. (2009), Blyler & Coff (2003), Eisenhardt & Martin (2000), Teece & Pisano 1994, Teece et al. 1997, Verona & Ravasi (2003), Zollo & Winter (2002)

The core higher order dynamic capabilities identified in the literature are reconfiguration, leveraging, and learning and knowledge creation, integration, and sensing and seizing (e.g. Ambrosini et al., 2009; Barreto, 2010; Bowman & Ambrosini, 2003; Teece, 2007; Teece et al., 1997). Reconfiguration refers to the transformation and recombination of assets and resources (Bowman & Ambrosini, 2003). In order to change the way an organization modifies its resource base, it needs

the ability to leverage its existing capabilities and resources and utilize them in building new pathways for the future.

Similarly, learning capability enables the firm to effectively employ and acquire the knowledge necessary to create and modify the capability and resource base (Zahra & George, 2002; Zollo & Winter, 2002). These dimensions together form a multidimensional construct of regenerative capabilities, which forms the foundation for capability modification and development as well as permitting the firm to influence its renewing capabilities.

Renewing capabilities in contrast, enable the firm to create and modify changes in its current operational capability and resource base. These capabilities comprise knowledge creation, sensing and seizing, and integration. The capability to sense and search out opportunities is necessary in order to renew the organizational capabilities efficiently and according to the requirements of the external environment (Danneels, 2002; Teece, 2007). Together with the capability to create new knowledge, sensing and seizing enable the firm to create new products and product categories in accordance with fluctuations in demand and customer taste (Helfat & Peteraf, 2003; Verona & Ravasi, 2003). A knowledge creation capability transforms and realigns knowledge within the organization (Lichtenthaler & Lichtenthaler, 2009). A related renewing capability is that of (knowledge) integration. Not all relevant knowledge is located in the firm, nor can it be developed within the firm. Thus, a firm must be able to integrate knowledge from external sources (Chesbrough, 2003; Lichtenthaler & Lichtenthaler, 2009).

On the next level of the capability hierarchy are the first-order capabilities or incremental capabilities as they are defined by Ambrosini et al. (2009). They are processes of continual improvement and established patterns of the firm (Zollo & Winter, 2002). These capabilities respond to familiar types of change and are likely to be easily repeatable. As they are embedded in the firm, they are less costly than capabilities that must be acquired by the firm (Helfat & Peteraf, 2003; Winter, 2003). These incremental capabilities are unlikely to lead to increased performance by themselves, but may do so through interactions with higher order capabilities (Ambrosini et al., 2009; Newey & Zahra, 2009; Winter, 2003). As discussed above, we assume that the higher order dynamic capabilities are multidimensional and hierarchical constructs comprising different capabilities and the path dependencies between them.

3. Dynamic capabilities and Firm performance

Dynamic capabilities and evolutionary fitness

The reason for the continuing interest in dynamic capabilities research is primarily its potential to shed light on the antecedents of competitive advantage or superior performance (Teece et al., 1997). The majority of recent conceptual and empirical research builds on the distinction between operational and dynamic capabilities. The previous results suggest that the dynamic capabilities influence performance indirectly (Cepeda & Vera, 2007; Danneels, 2002; Helfat et al., 2007; Protogerou et al., 2012; Zahra et al., 2006; Winter, 2003). Dynamic capabilities enable the management to make timely decisions to change the operational routines of the firm when necessary (Ambrosini et al., 2009; Barreto, 2010; Helfat et al., 2007). Thereafter the firm should be able to introduce new innovations, which may lead to improved performance, for example. Thus, the relationship between dynamic capabilities and firm performance is mediated by the dynamic capabilities' effects on the firm's operational capabilities and innovation activities (Danneels, 2002).

However, while dynamic capabilities enable change, they do not necessarily lead to better performance. It is possible for management to misread the need for change and deploy dynamic capabilities unnecessarily or in the wrong form (Ambrosini et al., 2009). The value of a dynamic capability to an organization is context dependent, and determined by the environmental need and constraints (Helfat et al., 2007). If the matching is successful, dynamic capabilities improve the evolutionary fitness of the firm.

Dynamic capabilities need to be aligned with the organizational processes that lead to innovations. The proper deployment of dynamic capabilities increases the probability of making innovative product. Popular product innovation will receive positive feedback from customers, and that will in turn increase the *evolutionary fitness* of the organization (Newey & Zahra, 2009). Recent literature has emphasized the use of evolutionary fitness as the measure of performance (Barreto, 2010; Helfat et al., 2007; Lieblein, 2011). It is suggested that the interaction between the dynamic capabilities and operating capabilities positively affects the evolutionary fitness of a firm by enabling it to overcome inertia and adapt to environmental changes (Helfat et al., 2007). Accordingly, dynamic capabilities indirectly enhance a firm's evolutionary fitness, helping it to survive through heightening its sensitivity to opportunities, and improving the skills required to extend or modify its resource base (Barreto, 2010; Helfat et al., 2007; Zahra et al. 2006).

For the reasons stated above, we focus on evolutionary fitness as our performance measure as suggested in the recent literature. Helfat et al. (2007) explicitly suggest firm growth as a measure of evolutionary fitness. In this paper evolutionary fitness is measured in terms of growth of the firm in relation to its competitors. This measure gives a standardized account of how firms perform. For example, even if a firm experiences negative growth, if its negative growth is less than that of its competitors, its evolutionary fitness is positive.

In addition to the intentions of an entrepreneur or the management (Davidsson, 1991; Gibb & Davies, 1990; Kolvereid, 1992; Stenholm, 2011; Wiklund & Shepherd, 2003), firm growth is affected by various external and internal factors. Covin and Slevin (1997) and Sexton and Bowman-Upton (1991), among others, have emphasized the effects of market constraints, entrepreneurial capabilities, and organizational resources on firm growth. For instance, growth is unlikely without essential resources such as management skills and financial resources (Penrose, 1959; Wiklund & Shepherd, 2003). This suggests that the presence and skilful utilization of a firm's resources are decisive determinants of the firm's growth. In addition, growth is equally unlikely without a suitable opportunity, such as a market niche or a new market. Both of these perspectives imply that given the other prerequisites for firm growth, firms must foster the ability to efficiently adjust their capabilities to the opportunities to be exploited. This highlights the necessity of dynamic capabilities to support and enhance a firm's evolutionary fitness (Teece, 2007). Thus, we assume that dynamic capabilities have a relationship with the firm's evolutionary fitness, and accordingly, we hypothesize that:

Hypothesis 1a: Regenerative capabilities have a positive indirect effect on the evolutionary fitness of the firm.

Hypothesis 1b: Renewing capabilities have a positive indirect effect on the evolutionary fitness of the firm.

The relationship between higher order capabilities

Those studies addressing the development of capabilities have shown that lower order resources and capabilities play an important role in influencing the higher order capabilities (McKelvie & Davidsson, 2009; Rosenbloom, 2000). Furthermore, it has been suggested that dynamic capabilities are developed through a firm's routines, which comprise firm-specific knowledge processes (Zollo & Winter, 2002; Zott, 2003). These processes contribute to the development of the higher order capabilities (Zollo & Winter, 2002). Thus, regenerative capabilities, through learning, leveraging and reconfiguring, precede the renewing capabilities because they determine the type and scope of knowledge and learning processes taking place in a firm (Romme, Zollon & Berends, 2010). As discussed above, its regenerative capabilities create the very foundation for the developing firm's resource and capability base, enabling it to reconfigure resources and learn in a systematic way. This suggests that first-order capabilities enable and enhance the role of renewing capabilities in a firm.

Accordingly, we assume that the regenerative capabilities have a positive effect on renewing capabilities and hypothesize that:

Hypothesis 2: Regenerative capabilities are positively associated with renewing capabilities

Renewing capabilities comprising sensing and seizing, knowledge integration and knowledge creation increase a firm's ability to be more flexible and create innovations. Similarly, they enable firms to overcome the potential inertia created by lower order capabilities. The exploitation of dynamic capabilities intertwines with technological sophistication, market dynamism, and changes in the market. This highlights the importance of fostering a continuous awareness of the market and its dynamics when pursuing growth. Subsequently, this awareness has to be shaped to improve the creation of competitive strategies to exploit the opportunities (Baum, Locke & Smith, 2001). Having a base level of dynamic capabilities is not sufficient to attain firm growth or above average performance, as to do so requires those capabilities to be configured to match the opportunities to be exploited. Dynamic capabilities enable the firm to reconfigure its operating capabilities and thereby to adapt and evolve (Newey & Zahra, 2009). This suggests that the incremental capabilities are enhanced by the higher order capabilities, especially renewing capabilities. For instance, the more skilful and capable employees the firm has or the more adjustable processes it manages, the better chance it has of adjusting its operations to match the opportunities recognized. To successfully pursue and attain growth, firms with high levels of dynamic capabilities should have a well-developed awareness of growth opportunities. Put another way, if the higher order dynamic capabilities are not in place, the chance of achieving the desired performance results is reduced. Accordingly, we suggest that higher order capabilities are associated with the operational capabilities, and hypothesize that:

Hypothesis 3: Renewing capabilities are positively associated with incremental capabilities

Incremental growth capabilities

In this study we assume that incremental capabilities are built on the foundation laid by regenerative and renewing dynamic capabilities. We assume that incremental capabilities are needed in order to refine the zero-level operational capabilities and new resources possessed by a firm. Thus, incremental capabilities are necessary to implement immediate changes to a firm's resource levels when necessary. Accordingly, they amplify the potential embedded in the dynamic capabilities already at hand.

To take advantage of any new opportunity to pursue growth, firms may have to renew and reconfigure their resources or bring new products or services to market, and it is not exceptional for growth-oriented entrepreneurs to emphasize innovative activity and to exploit organizational development more than other entrepreneurs (Gundry & Welsch, 2001). Accordingly, these findings suggest that both a firm's dynamic capabilities and its incremental growth capabilities, deployed to direct the firm towards new growth opportunities, influence relative firm growth.

Since we focus on relative firm growth – a firm's evolutionary fitness – we assume that firm growth is more likely if a firm has the capabilities required to recognize opportunities for growth. Drawing on the discovery approach, we assume that existing opportunities are exogenously generated by different imperfections in the market (Kirzner, 1973; Klein, 2008). Such imperfections might, for instance, be changes in technology or those caused by social and political changes (Shane, 2003). Various new market-product combinations, changes in demand and as yet unrecognized market niches (Cho & Pucik, 2005; Lumpkin & Dess, 1996) provide potential to generate revenue and exploit growth opportunities. It follows that acquiring knowledge of the business environment is an important precondition for recognizing and exploiting new value-adding growth opportunities (Eckhardt & Shane, 2003). Results from new ventures show that opportunity discovery strategies have a positive relationship with firm growth and performance (Puhakka, 2007) and for instance, opportunity discovery and competitive scanning strategies influence the performance of new ventures. Hence, we assume that operational capabilities are associated with firm growth, and hypothesize that:

Hypothesis 4: Incremental capabilities are positively associated with the evolutionary fitness of the firm

The direct effect of regenerative capability on evolutionary fitness

An important issue raised in some critical dynamic capability literature is the fact that dynamic capabilities should not always be viewed as producing competitive advantage or superior performance (e.g. Arend & Bromiley, 2009); for although they may lead to a change within the resource base, that change may not necessarily generate a performance advantage (Ambrosini & Bowman, 2009; Helfat et al., 2007; Winter, 2003).

Like R&D or manufacturing technology investments, dynamic capabilities represent long-term commitments and hence have a negative impact on firm performance, at least in the short term (Camuffo & Volpato, 1996). In a similar vein, Tsai & Wang (2008) show that the positive impact of technology acquisition capabilities is increased through the deployment of internal R&D efforts. In the case of higher order capabilities such an effect is pronounced. Capabilities operate in

integrated bundles, where a consistent integration of the unique capabilities is required to create a valuable end result (Helfat et al., 2007). Thus, an important part of the performance relationship is that regenerative capabilities that are not aligned with renewing and incremental capabilities have a negative effect on the evolutionary fitness of the firm. However, literature on dynamic capabilities seldom addresses the potential negative performance effects of the deployment of dynamic capability.

Since regenerative capabilities are about changing the way firms change, it is necessary that these efforts focus effectively on the lower order capabilities of the organization. Ambrosini et al. (2009) suggest that if dynamic capabilities are not appropriately adapted to the current organizational context, there is a risk that their deployment may destroy sources of advantage and thus cause a decrease in evolutionary fitness. This assumption leans on the idea that regenerative capabilities operate on the higher organizational and strategic level and have an effect on a longer term basis, and, further, that without a proper lower order capability base, the performance effects may be harmful. Thus, we hypothesize that:

Hypothesis 5: Regenerative capabilities have a negative direct effect on the evolutionary fitness of firms

Our hypothesized conceptual model is presented in Figure 2.[19]

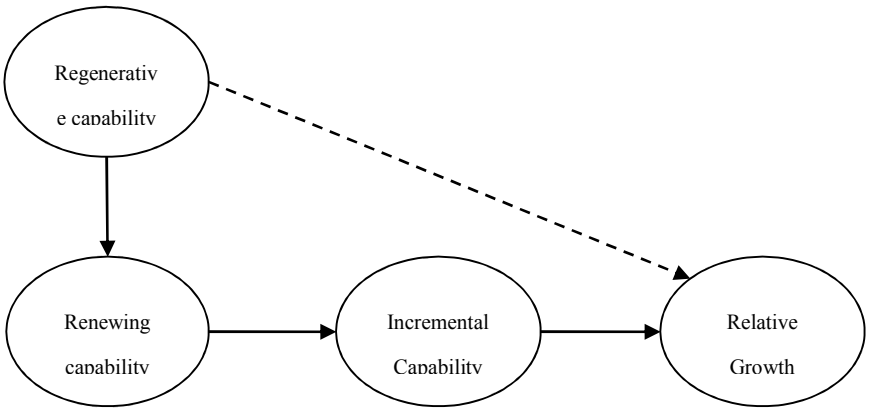

FIGURE 7.2 Hypothesized model

[19] For the sake of simplicity our model does not include operational capabilities, i.e. the capabilities which enable the firm to perform their day-to-day tasks.

4. Methods

Research design and sample

The data used in the quantitative analysis originates from two sources, a quantitative survey targeting three specific sectors in Finland to address the explanatory variables and the Orbis database (www.bvdinfo.com), which contains comprehensive information on the financial statements of companies worldwide, to compute the dependent variable. The three specific sectors the data represents are Finnish firms operating in the food industry (NACE 10–11), the media (NACE 18, 58–61), and the shipbuilding cluster, including ship construction (NACE 301) and any sub-contracting sectors (e.g., furnishing and maintenance). They were chosen for two reasons. First, these are not traditional high-tech, highly R&D-intensive sectors, which have been at the core of research on innovation and dynamic capabilities (Easterby-Smith et al., 2009), and the capability to change and to innovate is more likely to distinguish firms from their competitors. In other words, the posited relationships and the operationalization of the dynamic capabilities dimensions are more explicit in this kind of sample. Second, these sectors represent a broad range of industries facing financial turmoil from different perspectives. Essentially, the choice of population was driven not by a desire to generalize the results to the whole population of Finnish firms, but by the need to distinguish the theoretical relationships in question.

Stratified sampling identified a sample of 2,227 firms from the official Business Register of *Statistics Finland*. The data collection took place through computer-aided telephone interviews in late spring, 2009. The survey targeted a senior manager of the firm in question, preferably the CEO or the owner-manager. The researchers approached the respondents in a random order, and attempted to reach unanswered numbers several times on different weekdays and at various times of the day. A total of 532 responses came from the 2,227 firms, a response rate of 24 per cent. Chi-square tests assessed non-response bias, the analysis taking into account the size of the 532 firms that responded and those that did not participate in the survey. The size distribution of the participating firms turned out to be slightly, but non-linearly, skewed towards larger firms, which is a relatively typical outcome in this type of survey. 170 firms were dropped because the obligation to report their financial statements to the trade register, which is the original source of the dependent variable, only applies to limited-liability companies. The sectorial distribution of the resulting sample of 362 firms is as follows: 23 per cent belong to the food industry, 45 per cent to the media, and 32 per cent to the shipbuilding sector.

Measures

Evolutionary fitness (relative growth). Evolutionary fitness served to measure performance, as the recent literature on dynamic capabilities suggests (Barreto, 2010; Helfat et al. 2007; Leiblein, 2011). Evolutionary fitness was measured by items comprising the growth of sales relative to the mean growth in the sector; the assumption being that relative growth captures the central idea (see e.g. Helfat et al., 2007; Drnevich & Kriauciunas 2011). The growth measurement covered the period between 2008 and 2010.

Higher order capabilities. Due to the deficiencies of the widely-accepted scales used for measuring dynamic capabilities (McKelvie & Davidson, 2009), we adopted and further refined a recently developed measurement model (Alsos et al., 2008). In order to test this model empirically, we created an original measurement scale and validated it in a thorough process meant conducting a set of qualitative semi-structured interviews to test the preliminary items; then piloting the survey, and then examining the prima facie validity by pre-testing the measurement on experts in the field.

The original measurement scale was developed by dropping the non-functioning items or replacing them with better and clearer items. The reliability and validity of the questionnaire was further addressed via an intense pre-testing phase including lengthy discussions with academics as well as around 50 respondents from companies.

The final scale of the higher order capabilities resulted in a set of items on a Likert scale ranging from one to seven (see Table 1A Appendix 1). It is worth pointing out that in measuring dynamic capabilities in general, the definition of the capability level is context dependent (Barreto, 2010; Helfat et al. 2007; Winter, 2003). Thus the context affects the choice of suitable items; for example, product-development R&D is a higher order capability for a firm in the food sector, whose main purpose is to produce and sell products, but a zero-level capability in the case of an independent R&D lab.

The proposed dynamic capability constructs included the following two multidimensional constructs: *Regenerative capabilities,* which comprised the dimensions: *reconfiguration* (RECRUT), *leveraging* (RENEMP), and *learning* (RECEMP); and the following *Renewing capabilities*: *knowledge creation* (RENRD), *sensing and seizing* (OBS), and *knowledge integration* (ACQCO). Given the conceptualization of the constructs as multidimensional and latent, their operationalization proceeded by means of second-order confirmatory factor analysis (CFA) (Edwards 2001). The resulting constructs were derived from hierarchical CFA (e.g. Byrne, 2001; Neuman, Bolin & Thomas, 2000). In other words, in terms of measurement, regenerative and renewing capabilities are second-order factors, and the aforementioned dimensions first-order factors.

The first step was to conduct a confirmatory first-order factor analysis of the six constructs following the guidelines first seen in Fornel & Larcker (1981). Assessment

of the construct reliability and both convergent and discriminant validity was in accordance with the standard means in the literature (e.g. Fornell and Larcker 1981; Hair et al. 2010, Shook, Ketchen, Hult & Kacmar 2004). In terms of model fit, the evaluation was on the basis of standard indexes and their cut-off criteria, again in accordance with the literature. The recommendation is to use more than one index in assessing several indexes and, given the increasing number of measures, one absolute fit measure (RMSEA), one badness-of-fit measure (SRMR), and one incremental-fit index (CFI) (e.g. Hair et al. 2010, Kline 2011, Shook et al. 2004). The cut-off criteria were <0.07, <0.08, and >0.90, respectively (Hair et al., 2010).

The results support the construct reliability and both the convergent and discriminate validity of the constructs, and the resulting fit statistics support the model based on cut-off criteria adjusted for complexity and sample size (Hair et al., 2010; Shook et al., 2004).[20] The second-order CFA of the final construct included the six dimensions of dynamic capability. In other words, the constructs from the first-order CFA served as indicators of the two higher order constructs. The resulting fit statistics supported the second-order CFA model.[2]

Incremental capabilities. The incremental capabilities were assessed in terms of three subjective items measuring the activities related to growth opportunity recognition and exploitation in a firm. We chose to focus solely on these activities in order to assess the activities undertaken to pursue firm growth more precisely. First, the respondents were asked to respond to a statement about their firm's efficiency at recognizing new opportunities: "*Compared to our competitors, we recognize new growth opportunities efficiently.*" Second, in order to assess their capability to act on any new opportunity they were asked about their firm's efficiency in exploiting new opportunities: "*Compared to our competitors, we are able to exploit new growth opportunities efficiently.*" Third, a question on the suitability of the product/service strategies for growth was asked in order to evaluate the perceived growth potential embedded in the current base of products or services. This was measured in accordance with responses to the item: "*Compared to our competitors, our present product-/service strategy provides opportunities for growth.*" These variables were measured on a Likert scale ranging from 1=*totally disagree* to 7=*totally agree*.

Control variables. Firm size and age (log transformed) were used as controls. These were gathered from the survey dataset.

[20] Table A2 in the appendices gives the model and construct assessment results.

5. Results

To test our research hypotheses, we follow a two-step approach of structural equation modeling. The analysis of the hypothesized models, conducted by means of structural equation modeling, covered the full sample.[21] The analysis proceeded in two steps (e.g., Anderson & Gerbing, 1988). First, to test whether the conceptual model of hierarchical dynamic capabilities consisting of regenerative, renewing and incremental capabilities exists, we assessed and validated the measurement model and measures utilized.

The first step was to test the measurement model in order to assess its validity, using a similar process as described above for the hierarchical CFA. The results for the measurement model can be found in Table 2. After testing the core measures via CFA, we assessed the final measurement model on four criteria: convergent validity, discriminant validity, one-dimensionality, and reliability. The results, which are summarized in Table 1, indicate that the measurement model fits the data well. All standardized loadings are highly significant ($p<.001$). The results of the modification indices, residuals and overall fit indices reveal no substantial departures of one-dimensionality. Tests of construct reliability and of convergent and discriminative validity confirm the structural validity of the measurement model. The goodness-of-fit indices offer further support. The construct reliabilities range from 0.71 to 0.77, indicating that the measures are highly reliable.

To assess the discriminant validity, we first computed the square root of average variance explained (AVE) for each construct. Table 2 illustrates how the relevant square root of AVE is larger than the correlation between any pairing of the two constructs in the study, indicating that the constructs have discriminant validity. Based on the analysis, we conclude that the hypothesized measurement model adequately fits the data. We further tested the applicability of the hypothesized model by comparing it to competing models.[22] The hypothesized model fits the data statistically significantly better than a one dimensional or three dimensional higher order capability construct.

[21] The measurement and path models were estimated in AMOS 19 using the Maximum likelihood estimator.
[22] See appendix Table A2

TABLE 7.2 Validity Assessment of the Measurement Model

Measurement model			Convergent validity		Discriminant validity				
Constructs	**Item**	**Std. Factor Loadings**							
Regenerative	RECRUT	0,75		CR	AVE	1.	2.	3.	
	RECEMP	0,77	1. Regenerative	0,71	0,59	*0,77*			
	RENEMP	0,78	2. Renewing	0,77	0,63	0,58	*0,80*		
Renewing	RENRD	0,73	3. Incremental	0,75	0,62	0,71	0,75	0,79	
	OBS	0,85							
	ACQCO	0,81	*G-O-F*	*χ2*	*d.f.*	*χ2/d.f.*	*NFI*	*CFI*	*Std. RMR*	*RMSEA*
Incremental	GRRES7	0,82	Measurement model	484,041	197	2,46	0,93	0,954	0,049	0,052
	GRRES6	0,92								
	GRRES5	0,60								

To test hypotheses 1–5, we estimated the structural equation model depicted in Figure 2. In this step we tested the three-path mediation model. The analysis followed the suggestions regarding tests of mediation in James, Mulaik and Brett (2006), with the complete mediation model as the baseline. We compared the fully mediating model with the seven nested models[23] adding a path in each one to the model starting from the explanatory variables, and finally in the seventh model paths including all the linking variables. The results show that, first, the hypothesized model fits the data; second, that there is no significant relationship between the renewing capabilities and the evolutionary fitness measure and that regenerative capabilities have a negative relationship with the dependent variable; and third, that the comparison models offer no better fit to the data.

In other words, the data support the full mediation hypothesis with the important caveat that regenerative capabilities have a negative direct influence on evolutionary fitness. It therefore appears that as expected, higher order capabilities have a sizable positive and significant effect on incremental capabilities. Likewise, incremental capabilities have a positive and significant effect on the evolutionary fitness of the firm.

The next step was to test statistically for the presence of the hypothesized positive indirect effects by means of bootstrap re-sampling (Mallinckrodt et al., 2006). With bias-corrected confidence intervals on a 95 per cent confidence level and one thousand bootstrap samples, the results indicate a significant and positive indirect

[23] See Appendix Table A3 for the results.

effect. The results support the underlying view that dynamic capabilities give firms competitive advantage and increase their evolutionary fitness.

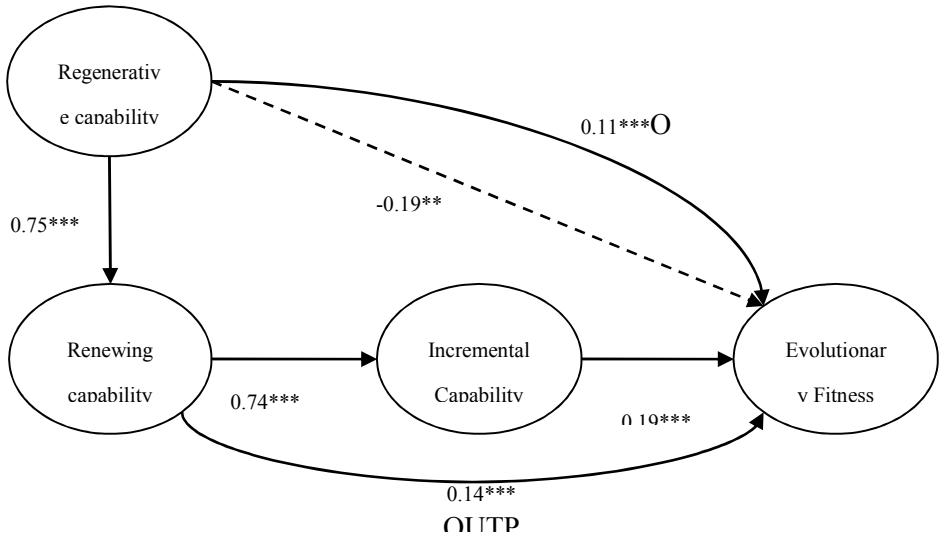

FIGURE 7.3 Estimation results for the hypothesized model

The results of the analysis are summarized in Figure 3. The straight arrows show the direct effects between the variables, while the curved arrows show the indirect effect. The goodness-of-fit statistics suggest that the structural model fits the data well (Table 3). Figure 3 reports the standardized parameter estimates and significance of the direct effects and indirect effects. The control variables are included in the analysis, but excluded from the figure to aid clarity.

TABLE 7.3 Goodness-of-Fit statistics

G-O-F	*χ2*	*d.f.*	*χ2/d.f.*	*NFI*	*CFI*	*Std. RMR*	*RMSEA*
Path model	502,412	218	2,35	0,92	0,95	0,049	0,050
Path model w/ controls	614,744	258	2,38	0,91	0,95	0,049	0,051

Finally, our results show that regenerative capabilities are positively associated with renewing capabilities (p<.001). This supports our Hypothesis 2. The results also support the proposed positive association between renewing and incremental capabilities (p<.001), our Hypothesis 3. These results clearly show that renewing capabilities mediate the relationship between regenerative capabilities and incremental capabilities. Similarly, our results indicate that higher order capabilities operate through the incremental capabilities when exerting their effect on firm performance, supporting Hypothesis 1. Moreover, incremental capabilities have a positive association with the relative growth of a firm (p<.001), which supports our

Hypothesis 4. Lastly, the suggested negative direct effect from regenerative capabilities on evolutionary fitness (Hypothesis 5) is supported.

6. Discussion

This study introduces and validates assumptions on the possible hierarchical nature – the division between higher order and incremental capabilities – of dynamic capabilities. Our results underscore the importance of hierarchically separating dynamic capabilities into three categories of capabilities, when analysing their complex relationship with a firm's evolutionary fitness.

Broadly, this study suggests that the use of a possible non-hierarchical approach is embedded with an incomplete understanding of the path dependency between different types of dynamic capabilities. The hierarchical model introduced in this study provides a robust method for analysing the dynamic capability-performance relationship. In this study we were able to extend the current understanding of the hierarchy of dynamic capabilities by incorporating the hierarchically related constructs of dynamic capabilities into a coherent framework. Theoretically our study suggests that a hierarchical framework is valuable, because it incorporates both different types of higher order capabilities and incremental capabilities, and provides a robust means to address the complexities of firm performance. Thus, extending dynamic capabilities into a hierarchical model enabled us to generate a conceptualization where the whole structure of dynamic capabilities is combined. This method will be valuable for further research and practitioners alike.

Further, our findings advance the understanding of the role of a hierarchical approach to dynamic capabilities, when their association with firm performance is being investigated. The results show that higher order capabilities enable the firm to increase its evolutionary fitness especially when they are aligned with lower order incremental capabilities. As assumed by previous conceptual research (Ambrosini et al., 2009; Collis, 1994; Helfat et al., 2007; Winter, 2003; Zahra et al., 2006) our results generated evidence for the hierarchical path dependency between the dynamic capabilities and firm performance. Instead of resulting directly in increased performance, our study suggests that regenerative capabilities will enhance the use of dynamic capabilities at the other levels. From this perspective the higher order capabilities are used to utilize the incremental capabilities to the fullest in pursuit of better performance.

Importantly, our findings suggest that the relationship between the levels of dynamic capabilities is a mediating one. The mediation effect of the higher order capabilities suggests that they are decisive for a firm willing to exploit its first-order capabilities. These capabilities, such as resource renewal and knowledge creation, refine the opportunities generated by reconfiguration, learning and other similar first-

order capabilities. This shows that higher order capabilities enable firms to change and reconfigure their ordinary capabilities in order to match the needs set by the management (Helfat et al., 2007; Winter, 2003). Thus, our results show that higher order capabilities allow firms to overcome inertia and adapt to environmental changes – which supports the findings presented by Helfat et al. (2007) – and later to enhance their evolutionary fitness. The incremental capabilities mediate the relationship between higher order capabilities and firm growth. This suggests that the incremental capabilities enhance the role of a firm's capacity to change the way in which resources are transformed (Winter, 2003) on performance.

Limitations and further research

Despite the promising results in terms of revealing the complex role of dynamic capabilities in a firm's performance, many of the limitations of this study offer interesting opportunities for future work. The first limitation is that the results are drawn from a cross-sectional dataset. Due to their constantly varying nature, dynamic capabilities should be analysed in a longitudinal research setting (McKelvie & Davidsson, 2009). This approach would also enable the assessment of the actual changes that dynamic capabilities bring about in the firms. Second, the importance of taking into account other elements affecting dynamic capabilities, such as environmental dynamism, which has been recently brought up again in the literature (e.g. Ambrosini et al., 2009; Romme et al, 2010) should not be neglected in further research. In addition, the study was conducted with a sample comprising firms only from one country and specific industries. In terms of further generalization of the hierarchical approach of dynamic capabilities, the model and its operationalization should be tested in other cultural and industrial contexts as well.

In conclusion, by introducing and validating a hierarchical model of dynamic capabilities this study provides a novel perspective and empirical evidence on the relationship between a firm's dynamic capabilities and evolutionary fitness. Given that firms face constant uncertainty, environmental change, and competitive forces, we believe that a hierarchical approach to dynamic capabilities would help firms take full advantage of their potential.

TABLE 7.A3 Model comparisons

Model	NPAR	CMIN	DF	Δχ2	Δ*df*	*p*	Δχ2	Δ*df*	*p*
Model 1 (Full mediation)	80	507,884	219						
Model 2	81	506,772	218	1,112	1				
Model 3	81	505,829	218	2,055	1	*			
Model 4 (Prefered)	81	502,412	218	5,472	**1**	***			
Model 5	82	504,912	217	2,972	2		-2,5	1	*
Model 6	82	501,248	217	6,636	2		1,164	1	
Model 7	82	502,138	217	5,746	2		0,274	1	
Model 8 (all paths free)	83	500,991	216	6,893	3		1,421	2	

CHAPTER 8: DISCUSSION AND CONCLUSIONS

1. Drawing the findings together

The dissertation set out to increase our understanding of the organisation level differences in innovation activity as well as output and effects within organisations, especially focusing on the capabilities and strategies with which organisations pursue new products, processes and organisational structures. This goal was approached by introducing six research papers addressing the determinants and effects of innovation from three perspectives. Table 1 summarises the main contributions, limitations and avenues for further research of each chapter.

The dissertation was structured based on the type of research problems addressed. First, the theme of innovation persistence is addressed. Two articles focused on the ability of firms to innovate continuously over time. *Chapters* 2 and 3 suggest that the important determinants of innovation persistence, the ability to innovate continuously over time, create the long-term differences in the way companies are able to innovate. Persistent innovation requires strategies that emphasise "dynamic learning effects" in other words organisational capabilities emphasising learning, reconfiguration and the renewal of resources. In the second section, the focus was on the specific domain of organisational characteristics, namely the family firm. In the two studies both the antecedents and effects of different forms of innovation in family firms were compared to nonfamily firms. In *chapters* 4 and 5, the main conclusion is that family businesses in general have a different structure, which leads to different innovative capabilities and furthermore, different innovation strategies, compared to non-family firms. Family businesses are not necessarily less innovative, but the determinants of innovation and the way they focus their innovative activity differs. This is an important insight concerning the managerial implications of the studies: it must be clear that firms cannot simply copy, for example, innovation strategies from their peers Instead the underlying structures and characteristics of the focal firm must be understood first. These underlying characteristics of firms were examined in the last two chapters. They develop the work on organisational capabilities and their relationship to innovation and effects on organisational performance. In *chapter* 6, one of the original research questions in the dynamic capabilities literature – how firms are able to cope in a turbulent market environment – was addressed in a novel way. Research on organisational capabilities has previously emphasised an indirect relationship to performance. This study incorporated this view and combined it with

the central idea of the innovation studies literature, which argues that innovation leads to increased performance. However, as discussed, dynamic capabilities are a multidimensional concept and the different dimensions may have a different relationship to the evolutionary fitness of the firm depending on the market environment. Continuing this theorising, c*hapter* 7 approaches the question of organisational capability hierarchy and firm performance. The study shows that dynamic capabilities create increased firm performance – as the literature has suggested. However, higher order capabilities may have negative direct effects on evolutionary fitness. This study is one of the first to show this result, which has been debated in the recent conceptual literature on dynamic capabilities.

The study suggests that the use of a non-hierarchical approach to dynamic capabilities is embedded with an incomplete understanding of the path dependency between different types of dynamic capabilities. The hierarchical model introduced in this study provides a robust method for analysing the relationship dynamic capability to performance. Theoretically, the study suggests that a hierarchical framework is valuable, because it incorporates both different types of higher order capabilities and incremental capabilities, and provides a robust means to address the complexities of firm performance. Extending dynamic capabilities into a hierarchical model provides a conceptualisation, which includes the whole structure of dynamic capabilities, and enables a more holistic picture of the way capabilities are deployed and developed within organisations.

Table 8.1. Study results summary

Topic	Chapter	Contribution	Limitations	Further research
Innovation persistence	2	Distinguishing between incremental and breakthrough innovations	Short panel study. Data collected from a specific set of industries and only from a single country. The datasets include only a small number of covariates due to the nature of CIS.	More in-depth analysis of the reasons for differences between different types of innovation.
	3	The study contributes to the theoretical issues behind innovation persistence.	Short panel study. Data collected from a specific set of industries and only from a single country.	Future research could also try to better understand why and how firms innovate in one time period but not in subsequent time periods, and why and how firms are able to innovate at one point in time, if they have not innovated in the past.
Innovation in Family business	4	The study helps understand the process of innovation in family businesses, showing how proactivity and risk-taking influence product innovation output differently in family firms relative to nonfamily firms	Cross sectional study. Data collected from a specific set of industries and only from a single country.	This paper was a first attempt to delineate the differences between different types of risk taking and proactivity with regards to product innovation in family firms. Future research should study the relationships more closely.
	5	Insights on organisational and managerial innovation in the family business context	Cross sectional study. Data collected from a specific set of industries and only from a single country. The measure of corporate success	Work on family firm innovation is still scarce. Future studies should aim to elaborate on the reasons for the differences between the leveraging of managerial and organisational innovations in family firms. Future work should focus on dimensions underlying the strategic orientation of family firms.
Organisational capabilities	6	The study significantly broadens our understanding of dynamic capabilities in extreme environmental dynamics	Despite the forward-looking research setting, the study still lacks a true longitudinal setting. Data collected from a specific set of industries and only from a single country.	More detailed study of the different capabilities and their interrelationships. A true longitudinal setting for statistical assessment of these relationships and the performance effects of dynamic capabilities.
	7	Clarifies the hierarchical nature of organisational capabilities by introducing a new measurement model to capture the hierarchical structure of dynamic capabilities	Despite the forward-looking research setting, the study still lacks a true longitudinal setting. Data was collected from a specific set of industries and only from a single country.	Future research should test the suggested measurement model in a longitudinal setting.

2. Contributions

The six studies advance the frontier of innovation studies research. In the first theme, the main contribution on innovation persistence is related to the underlying reasons behind the ability of organisations to continuously innovate. Chapter 2 shows that the ability of a firm to develop an innovative breakthrough product has long-term implications for its future innovation performance. The generation of breakthrough innovations over time seems to be driven by a reinforcing circle of learning and knowledge accumulation dynamics. Firms that innovate at one point in time gain valuable learning experiences and the capability to create new spells of breakthrough product innovation. In other words, the development of an innovative breakthrough product creates a strategic commitment to the pursuit of additional breakthrough innovations. Chapter 3 extends prior research on innovation persistence by showing that firms have different innovation strategies, and that such strategies constitute an important source of persistent innovative behaviour. Overall, the studies contribute to this atheoretic strand of literature by moving the theoretical drivers of innovation persistence closer to the forefront and the core of innovation studies in general.

The studies focusing on family businesses aim to contribute to two subject areas. The first aim is to further our understanding of innovation activities in family firms. There is a lack of empirical studies on innovation activity in family businesses, partly because the majority of researchers see family firms as conservative and stable, which is a result of their tradition and aversion towards risk. However, these two studies show that family firms do not lack innovation, but that they differ in the way innovation is conducted. Second, *chapIters* 4 and 5, aim to shed light on how organisations with different structural forms vary in their innovation activities and capabilities.

By focusing on the core entrepreneurial dimensions, Chapter 4 shows that the relationship between risk taking and proactivity and innovation output is complex and depends on the organisational structures of the company. Family firms do innovate but the risk taking dimension is not as important as proactivity. Overall, the findings of the chapter show that because family firms are more than economic entities, this has a residual effect on their approach to innovation. Knowing this, and the effects in behavioural pattern and preferences terms, can lead to increased learning both for leaders of family firms and for those working with them.

Chapter 5 contributes to the literature by showing that innovation strategies in family firms have different consequences for corporate success. By focusing on management innovation – an area of innovation activity that has experienced only a small amount of research – the study is able to focus on the core differences between family and non-family firms.

The third theme, organisational studies, aimed to extend the literature on organisational capabilities. These studies contributed to the research in significant ways. The findings complement the literature especially on the relationship between dynamic capabilities and firm performance. Until recently, relatively few quantitative accounts existed that analyse the full effect on innovation performance, on the one hand, and firm performance or competitive advantage, on the other. First, the introduction of a novel measurement scale operationalises dynamic capabilities as a multidimensional construct. Second, the results support the view that dynamic capabilities and innovation give firms a competitive advantage and enhance their evolutionary fitness. Furthermore, this relationship is shown to be indirect, with even possible negative direct effects in the short run.

Chapter 6 contributes to the formation of a detailed analysis of dynamic capabilities and the environment in which firms operate. A significant finding is that different dynamic capabilities have different effects depending on the competitive environment. The findings enhance our understanding of the conceptual distinction between dynamic and operational capabilities. Theoretically the implication is that the relationship between the operating environment and dynamic capabilities depends on the context, and that analyses should also take other types of environmental conditions into account, not only technological dynamism – as most research has thus far done. On the theoretical level the implication is that, the relationship between the operating environment and dynamic capabilities depends on the context. *Chapter* 7, on the other hand, shows that the different elements of dynamic capabilities have varying relationships to performance. Importantly, both of the studies confirm that the concept of dynamic capabilities clearly applies to firms in sectors not traditionally associated with high technology.

3. Limitations and suggestions for further research

A general limitation within this dissertation is related to the data used. First, both of the datasets applied originate from one country only. Second, the INNOCAS survey is cross-sectional making it impossible to identify causal relationships. The INNOCAS survey also focuses on three specific industries. Both of these make the generalisability of the results hard. Inferences to other countries and industries should be made with caution. In addition, the CIS have limitations regarding their use in quantitative research. First, items related to innovation activities are only observed if the respondents indicate that they have had some form of innovation output in the three-year period that the survey focuses on. Second, there are problems merging the different waves of CIS data into a panel form as the questionnaires have changed over time, which reduces the number of common variables over the different waves. With respect to chapter 2, this means that information about all the possible covariates that

may have an effect on the persistence of innovation is not available. The strategies, among other things, that firms pursue within the context of the innovation process and whether or not these are more or less correlated to persistent product innovation cannot be fully controlled for. A further analysis of whether or not the different strategies firms pursue leads to more or less persistent breakthrough product innovation represents an interesting avenue for further research. The studies in chapters 2 and 3, suffer from the same shortcoming regarding the lengths of the panel. Adding more data from more recent surveys as they become available, thus creating a longer panel, is another interesting research opportunity.

Future studies should analyse how the effects of innovation strategies on innovation persistence differ across countries and industries. Future research could also try to better understand why and how firms innovate in one period but not in the following periods and why and how firms are able to innovate at one point in time if they have not innovated in the past. A firm's initial innovation strategies have a long lasting effect on the way it conducts future innovation, but exploring that and similar issues holds the promise of better understanding the heterogeneity and sources of persistent innovation in firms.

The studies in theme two have limitations regarding the dichotomous distinction between family and non-family firms, which reflects the assumption that family firms are homogenous. In addition, chapter 4 has the limitation of using product innovation as the dependent variable, without differentiating between different types of innovation, for example, breakthrough or incremental innovation. It would be especially interesting to understand in detail how the organisational culture plays a role in the innovation processes of family firms as there is still a lack of research on the relationship between organisational culture and the different types of innovation in the family firm context.

Furthermore, the analysis of dynamic organisational capabilities, the development of the measurement scale and the testing of the full hierarchy of organisational capabilities are still in their early stages. Chapter 7 represents the first quantitative approach to the hierarchy of dynamic capabilities, but there is a need for more research and further exploitation of the operationalisation efforts so far. Both of the studies, despite the forward-looking dependent variable, lack a true longitudinal setting and the ability to observe the effects of dynamic capabilities over time. Future empirical studies in such a setting would capture the actual effect of dynamic capabilities on the resource base of organisations. In a longitudinal design, it would be possible to control for the unobserved heterogeneity and address the related dynamics in order to better pin down the causal relationships (Baltagi 2008). Again, on a more fundamental methodological level, given the abstract and complex nature of dynamic capabilities, there is still a need for longitudinal, historical research built on clearly formulated theoretical ideas and research questions that would enhance the

understanding of the importance, development and operating mechanisms of dynamic capabilities in varying contextual circumstances.

Another limitation related to the studies in this dissertation is survival bias, which refers to the possibility of not being able to analyse and draw conclusions from firms that have exited a market due to failure or other reasons. Put simply, the potential for bias exists because we do not have data from these failed firms. This is especially evident in chapter 6, where the focus is on the effects of a financial crisis. In the INNOCAS survey dataset, the time period of analysis is still rather short and the exit rate small. Hence, it may be argued that the potential survival bias is small. However, survival and its analysis is an interesting and important question in innovation studies, because innovation is, by definition, related to larger risk and thus the larger potential exit rate, as well. The effects on survival should be studied separately and preferably in a longer period than was possible for this dissertation.

4. Overall findings and implications

As mentioned in the beginning of this concluding chapter, the dissertation set out to increase our understanding of organisation level differences in innovation activity, output as well as its effects within organisations, especially on the organisational capabilities, and the strategies with which organisations pursue new products, processes and organisational structures.

The main overall finding strengthens the view of organisations as heterogeneous entities with strong path dependencies in innovation and their underlying organisational capabilities. This thesis aimed to advance the research tradition of Innovation Studies, especially within the two core themes of organisational capabilities and innovation strategies. The studies in this dissertation emphasise the role of organisational capabilities in shaping how firms are able to innovate and therefore survive in the "perennial gale of creative destruction". Drawing together the three sections, a picture emerges of heterogeneous firms with different resources and strategies that compete dynamically through innovations of different types.

The most important overall implications of the dissertation are related to the further development of innovation studies as a research field. The results of this study point towards placing more emphasis on two aspects of innovation research. First, innovation research should move entirely towards longitudinal research designs. The present day methodologies, analytical tools, and datasets available provide the research community with excellent opportunities to study the phenomena of innovation in a detailed and dynamic manner. Second, innovation research should continue shifting its focus towards the hard-to-measure and within organisation elements that create innovations for firms.

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SAMENVATTING

Al een halve eeuw is er stijgende belangstelling voor innovatie in bedrijven en de determinanten daarvan. Vooral de laatste twintig jaar proberen wetenschappers inzicht te krijgen in de organisatie-antecedenten van innovatie en de processen en competenties binnen bedrijven die leiden tot succesvolle innovaties. Wetenschappelijk onderzoek van het concept innovatie gaat terug tot het begin van de twintigste eeuw en de oorspronkelijke werken van Joseph A. Schumpeter (1934, 1939, 1942). Dit werk is de belangrijkste leidraad geweest bij het opzetten van sociaalwetenschappelijk onderzoek betreffende innovatie. Mede dankzij wetenschappers zoals Richard Nelson en Sidney Winter (1982), Giovanni Dosi (1982), Nathan Rosenberg (1982), en Keith Pavitt (1984), begon onderzoek naar innovatie op te komen als nieuwe tak van wetenschap die zich bezighield met de thema's die Schumpeter in zijn werk had aangedragen. De laatste twee decennia heeft onderzoek naar innovatie op organisatieniveau geleid tot het ontstaan van een onafhankelijk vakgebied, Innovatiestudies, dat zich richt op het openen van de “zwarte doos” om te komen tot begrip van de processen en determinanten van innovatie.

De dissertatie gaat verder op dit onderzoeksgebied door zes onderzoeksrapporten te introduceren waarin de determinanten en effecten van innovatie vanuit verschillende aspecten worden besproken. Het gezamenlijke doel van deze rapporten is om ons begrip te verdiepen van de verschillen op organisatieniveau betreffende innovatieactiviteiten en de resultaten en effecten daarvan binnen organisaties. De nadruk ligt daarbij op competenties en strategieën waarmee organisaties streven naar nieuwe producten, processen en organisatiestructuren. Deze dissertatie draagt bij aan de onderzoekstraditie op het gebied van Innovatiestudies, in het bijzonder betreffende de determinanten van innovatie en innovatiecompetenties van het bedrijf.

De dissertatie wil ons begrip vergroten van de verschillen op organisatieniveau betreffende innovatieactiviteiten en de resultaten en effecten daarvan binnen organisaties. Dit doel wordt nagestreefd door zes onderzoeksrapporten te introduceren die de determinanten en effecten van innovatie vanuit drie perspectieven behandelen. Het onderzoek is thematisch ingericht rond twee kernthema's: organisatiecompetenties en innovatiestrategieën van bedrijven. Organisatiecompetenties worden nader onderzocht in Hoofdstuk 2, 4, 6 en 7. De nadruk van Hoofdstuk 3 en 5 ligt op innovatiestrategieën. Deze twee specifieke thema's van innovatie op organisatieniveau die in de zes hoofdstukken worden

besproken, kunnen in drie onderwerpen worden verdeeld. Dat zijn blijvendheid van innovatie, innovatie in familiebedrijven, en (dynamische) organisatiecompetenties.

Het eerste onderwerp betreft de dynamiek van innovatieresultaten, namelijk de blijvendheid van innovatie. Innovatie wordt in het algemeen blijvend genoemd als een innovatie uit het verleden een huidige innovatie positief en significant voorspelt (Peters, 2009). Blijvende innovatie betekent dat de ontwikkeling van een innovatie op een zeker tijdstip een belangrijke bron van kennis vormt die toekomstige innovaties in het bedrijf mogelijk maakt. De belangrijkste bijdrage van de twee hoofdstukken over blijvendheid van innovatie heeft te maken met de onderliggende redenen van de mogelijkheden van organisaties om te blijven innoveren. Hoofdstuk 2 laat zien dat het vermogen van een bedrijf om een baanbrekende productinnovatie te ontwikkelen, op de lange termijn gevolgen heeft voor toekomstige innovaties. Het produceren van baanbrekende innovaties in de loop der tijd lijkt mogelijk te worden door een zichzelf versterkende dynamische kringloop van leren en vergaren van kennis waarbij bedrijven die op een zeker moment innoveren, belangrijke ervaring en competenties opbouwen waarmee ze kunnen komen tot nieuwe baanbrekende productinnovaties. Met andere woorden, het ontwikkelen van een baanbrekende productinnovatie leidt tot een strategisch beleid van bedrijven dat is gericht op verdere baanbrekende innovaties. Hoofdstuk 3 gaat door op eerder onderzoek naar blijvendheid van innovaties door aan te tonen dat bedrijven verschillende innovatiestrategieën hebben en dat die strategieën een belangrijke bron van blijvend innovatief gedrag vormen. In het algemeen dragen de studies bij aan deze tak van literatuur door de theoretische krachten achter blijvende innovaties op de voorgrond en dichter bij de kern van innovatiestudies in het algemeen te plaatsen.

Het tweede onderwerp (Hoofdstuk 4 en 5) richt zich vooral op innovatie in een specifiek soort organisatie, namelijk het familiebedrijf. Door familiebedrijven en overige bedrijven apart te analyseren, kan onderscheid gemaakt worden tussen organisaties met verschillende structuren. Zo kunnen we bestuderen hoe hun patronen van leren en kennis vergaren variëren en leiden tot verschillende soorten innovatiecompetenties. De studies die zich richten op familiebedrijven hebben twee doelen. Het eerste doel is meer inzicht te krijgen in innovatieactiviteiten in familiebedrijven. Nog altijd zien de meeste onderzoekers familiebedrijven als conservatief en stabiel, wat een resultaat is van hun traditie en afkeer van risico. Het is al lang duidelijk dat innovatie een van de belangrijkste krachten is achter het succes van een bedrijf, maar er is in academisch onderzoek tot nog toe vrijwel geen aandacht aan geschonken aan de rol ervan in familiebedrijven. Eerder onderzoek betreffende familiebedrijven was vooral gericht op de vraag hoe ze verschillen van publieke vennootschappen, waarbij familiebedrijven worden beschreven als minder ondernemend dan hun publieke tegenhangers. In bestaande literatuur is ook kritiek op het gebrek aan innovatie in familiebedrijven. Daarentegen blijkt uit deze twee

studies dat het familiebedrijven niet ontbreekt aan innovatie, maar dat ze alleen verschillen in de manier waarop innovatie wordt nagestreefd.

Het derde onderwerp, in Hoofdstuk 6 en 7, betreft vooral de intraorganisationele elementen van innovatie en innovativiteit. Deze studies dragen bij aan het onderzoek doordat ze de literatuur vooral aanvullen op het gebied van de relatie tussen dynamische competenties en bedrijfsprestaties. Tot nu toe bestaan er relatief weinig kwantitatieve verslagen met analyses van hun volledig effect op de innovatieprestaties enerzijds en de bedrijfsprestaties of concurrentiekracht anderzijds. De eerste studie richt zich op het adaptieve gedrag van organisaties bij het doorstaan van de economische onrust na de financiële crisis sinds 2008. In dit kader is er aandacht in de literatuur voor de kernkwesties van dynamische competenties, namelijk het vermogen van bedrijven om zich aan te passen aan veranderingen in de omgeving waarin ze actief zijn. De studie levert een bijdrage door een gedetailleerde analyse van dynamische competenties en de omgeving waarin bedrijven actief zijn. Een belangrijke vaststelling is dat de verschillende dynamische competenties verschillende effecten hebben, afhankelijk van de concurrentieomgeving. De bevindingen verbeteren het begrip van het conceptuele onderscheid tussen dynamische en operationele competenties. De volgende studie richt zich meer in het bijzonder op de kenmerken van de verschillende competenties op hoog niveau en hun relatie met prestaties. Het betreft een bespreking van de conceptuele en theoretische kwesties die in eerder onderzoek aan de orde zijn geweest. Zelfs na twintig jaar werk zijn empirische benaderingswijzen en theoretische conceptualisering nog altijd controversiële onderwerpen in de literatuur. De competentiehiërarchie heeft voornamelijk geleid tot conceptueel getheoretiseer terwijl empirisch bewijs aangaande de complexe relatie tussen verschillende niveaus en bedrijfsprestaties schaars blijft. Daarom richt de tweede studie in dit deel zich meer rechtstreeks op de hiërarchische aard van dynamische competenties en de relaties tussen de verschillende competentiedimensies en bedrijfsprestaties. De studie laat zien dat er variatie is in de relaties tussen de verschillende elementen van dynamische competenties en de prestaties. Bovendien blijkt deze relatie indirect te zijn, zelfs met mogelijk op de korte termijn negatieve directe gevolgen. Het is belangrijk dat beide studies bevestigen dat het concept van dynamische competenties duidelijk van toepassing is op bedrijven in de sectoren die vanouds niet bekend staan om hun geavanceerde technologie.

De in de dissertatie toegepaste methoden lopen van multivariate methoden tot panelregressie en verschillende combinaties hiervan. Een uitzondering op de strikt kwantitatieve analyse wordt gemaakt in Hoofdstuk 6, waar een aanpak met gemengde methoden wordt gevolgd. In Hoofdstuk 2 en 3 is de belangrijkste gegevensbron de communautaire innovatie-enquête (Community Innovation Survey - CIS). De CIS-gegevens zijn verkregen van Statistics Norway. In Hoofdstuk 4 t/m 7 is gebruik gemaakt van een enquête die is uitgevoerd in 2009 samen met een onderzoeksgroep

van de Turku School of Economics. Dit is een kwantitatieve enquête gericht op drie specifieke sectoren in Finland - de voedselindustrie, de media, en de scheepsbouw met scheepsbouwers en eventuele onderaannemers. Methodologisch kunnen de zes onderzoeken worden gegroepeerd in twee categorieën. Allereerst maken Hoofdstuk 2 en 3 gebruik van gemengde CIS-enquêtes en zijn dus voornamelijk gebaseerd op panelmethoden. Daarna maken Hoofdstuk 4 t/m 7 gebruik van structurele vergelijkingsmodellen voor het toetsen van de gestelde hypothesen.

De dissertatie levert interessante en significante resultaten betreffende de besproken onderzoeksproblemen. De belangrijkste algemene conclusie van deze dissertatie is dat het beeld wordt versterkt van organisaties als heterogene entiteiten met sterke padafhankelijkheden in innovatie en de onderliggende organisatiecompetenties. Deze dissertatie wil een bijdrage leveren aan de onderzoekstraditie van Innovatiestudies, in het bijzonder binnen de twee kernthema's van organisatiecompetenties en innovatiestrategieën. Alles bij elkaar benadrukken de onderzoeken van deze dissertatie de functie van organisatiecompetenties die vorm geven aan de manier waarop bedrijven kunnen innoveren en dus overleven in de "niet-aflatende storm van creatieve destructie". Als we de drie onderdelen samen beschouwen, komt een beeld naar voren van heterogene bedrijven die met verschillende middelen en strategieën dynamisch concurreren, waarbij ze gebruik maken van verschillende soorten innovaties. De belangrijkste algemene conclusies van de dissertatie hebben betrekking op de verdere ontwikkeling van innovatiestudies als tak van onderzoek. In overeenstemming met de huidige vooruitgang wijzen de resultaten van deze studie op meer nadruk voor twee aspecten van innovatieonderzoek in het algemeen. Ten eerste zou innovatieonderzoek zich volledig moeten gaan richten op een longitudinale opzet van studies. De huidige methodologieën, analytische hulpmiddelen en beschikbare gegevensverzamelingen bieden de onderzoeksgemeenschap een unieke mogelijkheid om de innovatieverschijnselen te bestuderen op een gedetailleerde en dynamische manier. Ten tweede zou de nadruk van innovatieonderzoek verder moeten verschuiven naar de moeilijk te meten elementen binnen de collectieve entiteiten die innovaties creëren, namelijk bedrijven.

CURRICULUM VITAE

Mikko Pohjola obtained a Master degree in economics in 2005 from Turku School of Economics, Finland. After pursuing an academic career as a project researcher in University of Turku School of Economics first in the Institute for Competition Policy Studies and the Centre for Collaborative Research, in January 2011 Pohjola became a Phd Candidate in Utrecht University School of Economics. His research interests have primarily laid within innovation behaviour and innovation strategies of firms, especially in studying the role of organisational capabilities in innovation performance. He has also studied the sociology of markets. After leaving his post of at the University of Turku, in April 2013, he co-founded a start up in the forestry industry. Mikko is happily married and has three wonderful daughters.

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