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Innovation in Recessions:

Effects on Firm Performance

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Abstract

This thesis investigates how a firm's innovation activities affect performance outcomes during recessions. The thesis uses a heteroskedasticity-robust multiple regression model to analyse a large sample of Norwegian firms with innovation data from 2006-2010 and performance data from 2008-2012. Innovation activities both prior to and during the recession and its performance effects were investigated, and provided very surprising results. Contrary to the positive innovation-performance link suggested by existing literature, the results show that innovators consistently underperform non-innovators on profitability measures. The more a firm innovates prior to or during the recession, the greater the underperformance compared to non-innovators. Type of innovation was also found to affect firm performance, though largely exhibiting the same negative performance link. This thesis also includes an attempt to explain this negative innovation-performance link using existing innovation and business cycle theory. In conclusion, this thesis provides an important limitation to the seeming societal and academic perception that innovation is always positive, and provides fertile ground for future research in the fields of strategy, business cycles, and innovation.

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1. Introduction

Innovation is almost universally accepted as a boon in our society today. We have all seen some politician or CEO on TV, touting the importance of being an innovative country with firms poised for the new knowledge economy. Being an innovator is frequently perceived as a de facto positive trait in politics, in boardrooms, and in academic strategy papers around the world. Empirical studies of the firm-level innovation-performance link tend to support this notion (Walker, 2005), though these studies investigate this link in periods of relative economic stability. Additionally, these studies often define innovation as successful commercial innovations, rather than innovation activity, which may overstate the positive effects of innovation on performance by ignoring failed innovation attempts.

Globally, the recent decade has been filled with economic uncertainty and instability, with the recent financial crisis of 2008 and the continued struggle to regrow the world economy. This crisis has had a pronounced effect on Norway, though it affected Norwegian firms less than firms in many other countries (Knudsen and Lien, 2012). Understanding innovation during recessions is particularly relevant today, as Norway is currently facing yet another economic downturn on account of the low oil price. As a result, politicians and CEOs alike are calling for a renewal of the Norwegian economy and for more innovation.

There is unfortunately very little empirical research on innovation during periods of crisis. This thesis seeks to close this gap in the existing research, will investigate whether the positive innovation-performance link persists during the recent recession and subsequent economic recovery in Norway. The thesis will look at firm-level innovation activities both prior to and during the recession, and its relation to firm performance during and after the recession. The outcome of this investigation will either provide important empirical validation of the above politician’s claims, or help create a more nuanced appreciation for the innovation-performance link during recessions.

This thesis is affiliated with the Center for Strategy, Organization and Performance (S T O P) at NHH Norwegian School of Economics. The research agenda of S T O P is to uncover the origins and mechanisms that cause performance differences between firms and industries, with a particular emphasis on strategy and business cycles, human capital, entrepreneurship, and the theory of the firm.

1.1 Problem Definition and Research Question

In order to address the knowledge gap that exists within research on the innovation-performance link during recessions, we propose the following research question:

> *How do a firm's innovation activities prior to and during the recession affect its performance during and after the 2008-2009 financial crisis?*

In answering this research question, we first investigate the performance differences between innovators and non-innovators. We subsequently analyse whether the relative degree of innovation activities performed affects performance outcomes. Finally, look at whether the type of innovation activity performed is relevant to performance outcomes. We then relate the results to existing theory on the innovation-performance link in an effort to provide plausible explanations for the results observed.

1.2 Structure of the Thesis

In this chapter, we have introduced the background for our chosen research question and its relevance for Norwegian scholars and managers today. Chapter 2 will present the prevailing theory and empirical research on both recessions and the innovation-performance link, before we develop our hypotheses. In Chapter 3, we outline our chosen methodology and analytical model, as well as the validity and reliability of our study. In Chapter 4, we present the results and compare these to our hypotheses. Chapter 5 discusses the results and attempts to explain these on the basis of our theory and literature review presented in Chapter 2, and suggests directions for future research. Finally, Chapter 6 presents our concluding remarks. Chapter 7 lists the appendices.

2. Theory and Litterature Review

The main focus of our thesis is to investigate the relationship between innovation activities and firm performance during recessions. In reviewing the literature, we well look first at the determinants of corporate performance, then the prevailing theories of competitive advantage. We then turn to the existing innovation literature, as well as business cycle and recession theory. We conclude this section by developing our hypotheses based on this literature review.

2.1 Determinants of Corporate Performance

Much of the strategic management literature is devoted to decomposing the variation in profitability of firms, here taken as the measure of corporate performance. Schmalensee (1985) was among the first to analyse the different components of profitability variance, focusing on industry effects, market share effects, and business unit effects on the return on assets (ROA) of 465 US firms in 1975. This paper concluded that industry effects was the biggest explanatory variable, though only a single year was analysed. As such, year-effects and persistent performance effects, which were empirically proven later, were not considered in the study. Rumelt (1991) expanded the study with the years 1974-1977, and found business unit effects to be the biggest explanatory variable for variation in accounting profitability, defined as ROA for these studies. This finding was supported by Porter and McGahan (1997a), though they criticised the Rumelt (1991) and Schmalensee (1985) papers for considering only industrial firms in a time period of relatively large economic uncertainty (Porter & McGahan, 2002).

Porter and McGahan (2002) summarise the combined findings from Schmalensee (1985), Rumelt (1991), Rocquebert, Phillips and Westfall (1996), and Porter and McGahan (1997a). From this literature review, they found that 0.4% of profitability variance came from year effects, 10.3% from industry effects, 11.6% from corporate-parent effects, and that a full 36% was explained by business-specific effects. Though 41.7% remain unexplained by their model, the paper is generally accepted as providing the most comprehensive decomposition of variance in firm profitability today. However, they do not attempt to identify components of the business-specific effects, or any underlying causal relationships, as Porter and McGahan acknowledge in their 2005 paper. We note here in particular that variation in firm profitability can come from a variety of different factors, and that the error term in the models from prior papers are large, and generally vary between 41.7% and upwards of 70%. Further, it is sometimes unclear in studies that focus on firm-level effects whether they refer business-specific effects only, or include corporate-parent effects. In our study, we consider firm-level to include corporate-parent effects.

It is important to note here that these models rely on accounting data, which may include inherent biases stemming from variations in accounting conventions and choices. We know, for instance, that poorly performing firms will tend to try and inflate their accounting numbers to look better for investors, whereas highly performing firms will tend to deflate their accounting numbers in order to minimize their tax burden. Additionally, the return on assets figure does not take into account the risk borne by investors. Hawawini, Subramanian and Verdin (2003) attempts to remedy this by additionally measuring economic profit figures (accounting for cost of capital, or risk) as well as total market value of the firm divided by its capital employed. These alternative performance measurements account for the main criticisms of accounting figures, and show remarkable consistency with the ROA figures of Porter and McGahan's 2002 paper. This strengthens the position of ROA as an appropriate variable for measuring firm performance in the strategic management literature.

Much of the strategic management literature focuses on the actions of managers and their ability to influence corporate performance. This is the basis of a number of articles on competitive advantage, from Barney (1986) to Peteraf (1993) to Porter (1996) and Ruefli and Wiggins (2003) – what activities can a firm perform in order to generate sustainable competitive advantage over its rivals? This is the next topic for our literature review, as we seek to understand how firm activities may influence corporate performance.

2.2 Competitive Advantage

Understanding competitive advantage, and thus why some firms outperform others, is a key issue in the strategic field (Rumelt, Schendel & Teece, 1994). A firm has a competitive advantage when it "… earns a higher rate of economic profit than the average rate of economic profit of other firms competing in the same market" (Besanko, Dranove, Shanley & Schaefer, 2013). In other words, a firm has a competitive advantage when it outperforms other firms in its industry. In order to remain competitive in an industry, a firm need to offer its customers, and the industry in general, some form of economic value. Economic value consists of consumer and producer surplus, and is the difference between the perceived value of the created product and the economic cost. A firm achieves greater economic value than its competitors by offering a better product, producing products at a lower cost, or by a combination of the two (Barney, 2007). As such, we say that a firm that is able to remain competitive manages to create this economic value in its industry.

There are several accepted approaches to understanding how firms achieve and sustain competitive advantage. The most accepted approaches can be divided into those emphasizing the exploitation of market power, and those emphasising efficiency (Teece, Pisano & Shuen, 1997). While the different approaches can be seen as competing, they can also complement each other and provide different relevant insights to complex problems (Amit & Schoemaker, 1993). In the following sections, we will briefly present traditional approaches related to exploitation of market power, before focusing on resource-based theory and its extension, the dynamic capability approach.

2.2.1 Exploitation of Market Power

In 1980, Porter introduced the *competitive forces approach* to explaining competitive advantage. The approach emphasizes competitive strategy as "… relating a company to its environment …", where "… the key aspect of the firm's environment is the industry or industries in which it competes" (Porter 1980). Thus, competitive strategies are often aimed at altering a firm's position within an industry relative to its competitors and suppliers. Porter developed a framework for assessing competitive forces in an industry, called the five forces model. In this model bargaining power of buyers, bargaining power of suppliers, threat from new entrants, threat from substitutes and industry rivalry determines potential profits in an industry (Porter, 1980). Firms that are able to leverage those competitive forces within their industry better than their competitors may generate economic rents superior to that of their competitors (Teece et al., 1997). Industries vary in terms of competitive forces, and thus provide firms with different opportunities for creating and sustaining competitive advantages beyond the short term. In the competitive forces approach, rents are mostly viewed to be generated at the industry level rather than at the firm level. Thus, this view allows for sustainable competitive advantage even when firms are assumed to possess and control homogenous resources and capabilities.

Figure 1: The five forces that shape industry competition (Porter, 2008)

Other early approaches related to exploitation of market power include work from famed economists such as Cournot and Bertrand, who used game theory to analyse competitive interactions between rival firms. The focus of this *strategic conflict approach* is that firms increase their profits by influencing the behaviour of rival firms, thus manipulating their own environment. Carl Shapiro further espoused the view that firms can and should improve their own profits by attempting to influence the competitive actions of competitors (1989; in Teece et al., 1997). However, Teece et al. (1997) claims that this approach loses relevance when competitors are not closely matched. They argue that firms with a tremendous advantage over their rivals ought not be transfixed by the moves and counter-moves of their rivals, as their competitive fortunes are largely dependent on total demand conditions. Nevertheless, the strategic conflict approach can yield valuable insights into market dynamics and competitive forces, and further insights when coupled with other analytical approaches.

2.2.2 Resource-Based View and Dynamic Capabilities

Rather than focusing on economic profits from product market positioning, the resource-based approach focuses on the rents accruing to the owners of scarce firm-specific resources (Teece et al., 1997). Barney (1991) defines resources as “all assets, capabilities, organizational processes, firm attributes, information, knowledge etc. controlled by a firm that enable the firm to conceive of and implement strategies that improve its efficiency and effectiveness.” An alternative definition is offered by Jacobsen and Lien (2015), as “stocks of inputs that affect a firm’s relative ability to implement product market strategies.” These resources and their effective utilisation of the firms are what leads to sustainable competitive advantage (Penrose, 1959; Wernerfelt, 1984; Barney, 1991; Peteraf, 1993). In resource-based theory, vertical integration and diversification can be viewed as ways of capturing rents on firm specific resources that are hard to imitate (Penrose, 1959; Teece, 1980; Wernerfelt, 1984). According to Barney (1991), a resource must meet four criteria in order to be a potential source of sustainable competitive advantage. It must be valuable in the market, rare among competitors, non-imitable by current or potential competitors, and the firm must be organised to use the resource efficiently. This is what is known as the VRIO analysis, a common strategic tool both in the literature and management practice.

Peteraf (1993) summarized the existing literature and assumptions underlying the models within the literature, and presented four cornerstones of sustainable competitive advantage. These are prerequisites that must be met for resource-based above-normal returns, as implied by the models for competitive advantage presented by her peers in the field.

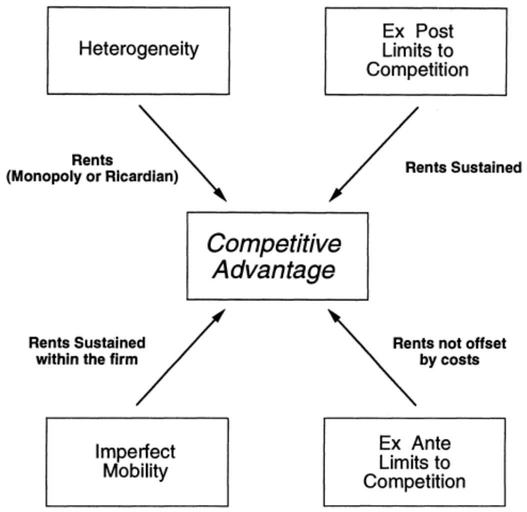

Figure 2: The cornerstones of competitive advantage (Peteraf, 1993)

The first prerequisite for resource heterogeneity within the industry allows for individual resources to generate economic rents. Ex post limits to competition prevent those rents from being perfectly competed away by imitation. Imperfect resource mobility ensures that resources have more value to certain firms than others, due to difficulty of transfer to other firms. Lastly, ex ante limits to competition prevents the benefits of resources from being negated by the cost of acquisition through perfect competition in resource markets.

When resources are acquired in a strategic factor market, the value of these resources are dependent on market efficiency (Barney 1986). In a completely efficient factor market, the price of a resource will equal its value. Thus, resources bought in an efficient factor market will not be able to create a sustained competitive advantage (Dierickx & Cool, 1989). Financial resources are examples of resources considered to have little value, as financial markets are close to fully efficient. However, in most other cases factor markets are flawed to some degree. Buyers rarely have the same expectations of the future value of a resource (Barney, 1986) and as a result, firms are able to buy undervalued resources through luck or superior information. Additionally, the value of a specific resource is not necessarily the same for different firms. As a result of resource heterogeneity, firms are unlikely to possess the same complementary resources. Different degrees of resource complementarity may increase or decrease a firm's valuation of a resource (Denrel, Fang & Winter, 2003). However, intangible resources, such as organizational culture and innovativeness, are not necessarily obtainable in factor markets. These resources are accumulated internally over time (Dierickx & Cool, 1989; Cohen & Levinthal, 1989, 1990). The degree to which the resources can be imitated depends on the characteristics of the accumulation process.

Following the assumption that scarce resources are the drivers of economic profits, skill acquisition, knowledge management, learning and innovation become fundamental strategic issues. However, resource based theory does not specifically address how future resources can be obtained, or how existing resources can be refreshed to address a new environment. This is the topic of the literature concerning dynamic capabilities as an extension of the resource-based view.

The dynamic capabilities approach focuses the ability to achieve new forms of competitive advantage in a changing environment. This seems particularly relevant in a Schumpeterian world of innovation-based competition, price/performance rivalry, increasing returns and the 'creative destruction' of existing competencies (Schumpeter, 1942). In this approach, the term 'dynamic' refers to "… the capacity to renew competencies so as to achieve congruence with the changing business environment", while 'capabilities' "… emphasises the key role of strategic management in appropriately adapting, integrating and reconfiguring internal and external organizational skills, resources, and functional competencies to match the requirements of a changing environment" (Teece et al., 1997). However, the choice of which new competences to acquire is dependent on earlier choices and existing resources. These limits to future resources are called path dependencies, and is a key concept in much of the strategic management literature. Thus, dynamic capabilities reflect a firm's ability to achieve new and innovative forms of competitive advantage, given the firm's market position and path dependencies (Leonard-Barton, 1992).

Teece et al. (1997) explain that dynamic capabilities involve four main processes: Reconfiguration, leveraging, learning and creative integration. Reconfiguration is the transformation and recombination of existing assets and resources. Leveraging refers to replicating a process or system and thereby extending its use into a new domain. Learning increases the efficiency of resources through experimentation. Lastly, creative integration refers to a firm's ability to integrate its resources, resulting in a new resource configuration.

While resources alone can give a temporary advantage, these can frequently be imitated over time in a dynamic environment. However, by continuously utilizing its dynamic capabilities quicker and better than its competitors, a firm can sustain a resource-based competitive advantage. Thus, according to Eisenhardt and Martin (2000), dynamic capabilities are the source of competitive advantage, not the resources themselves. Eisendhardt and Martin also argue that the usefulness of the dynamic capability approach can apply to competitive environments with slow rates of change. They proposed that dynamic capabilities in moderately changing environments are "… detailed, analytic, stable processes with predictable outcomes," while in rapid change "… they are simple, highly experimental and fragile processes with unpredictable outcomes" (Eisenhardt & Martin, 2000).

As the dynamic capabilities approach is a relatively new view of what creates and sustains a firm's competitive advantage, it has received criticism for not being sufficiently backed by empirical data. Pablo, Reay, Dewald and Casebeer (2007) stated that "... while the dynamic capabilities framework is drawing support and increased validity by researchers, empirical studies of dynamic capabilities remain relatively rare". Despite its lack of empirical studies, the dynamic capabilities approach has received wide acceptance within the strategy field.

2.3 Innovation

Innovation is a nebulous concept that is discussed in almost universally positive terms by politicians, the media, and CEOs alike. However, it remains a research challenge to measure and define innovation in a satisfactory way, in order to provide an empirical basis for these almost universally positive claims about the benefits of innovation. In this section, we discuss the current theoretical background and understanding of innovation, and relate it to existing empirical studies on innovation through the resource-based view of competitive advantage.

2.3.1 Theory of Innovation

Innovation has been a key focus area for strategic management and competitive advantage literature for a very long time. Schumpeter (1942) popularised the idea of "creative destruction" as a driving force for growth through innovation. In earlier works, Schumpeter also identified the distinction between different types of innovation (Schumpeter, 1934; in Henderson & Clark, 1990). Since then, the innovation literature has investigated a number of different types of innovation – the most common being radical versus incremental innovation (Henderson & Clark, 1990), but also considering management innovation (Walker, Chen, & Aravind, 2015), technical innovation (Damanpour & Evan, 1984; Kimberly & Evanisko, 1981; in Walker, 2005), and architectural innovation (Henderson & Clark, 1990), to name a few. Since the 1980s, there has been a major focus on product innovation versus process innovation, and whether one produces different performance outcomes to the other (Damanpour, Szabat & Evan, 1989; Subramanian & Nilakanta, 1996; in Walker, 2005). Additionally, several researchers take a particular interest in service innovation. All of these variations of innovation remain of interest to the strategic management research field, to isolate their antecedents and empirical effects on performance.

Besides research on various types and outcomes of innovation, the literature gives insight into the antecedents to innovation, as well as moderating or accentuating effects. Levinthal and Cohen (1989, 1990) takes particular interest in this, and builds on the resource-based view of competitive advantage to argue that R&D serves two important functions in a firm. The most obvious is to create new ideas and develop new products. The second is to build up a stock resource of, essentially, learning capability (Cohen & Levinthal, 1989). In this way, a firm's R&D activities can contribute to a firm's absorptive capacity – that is, the firm's ability to value "… new, external information, assimilate it, and apply it to commercial ends" (Cohen & Levinthal, 1990), which may be the basis for superior innovation capability and competitive advantage. Kostopoulos, Papalexandris, Papachroni and Ionannou (2011) finds that a firm's absorptive capacity is directly and positively related to a firm's innovation performance, measured as percent of sales from new products, and indirectly to a firm's financial performance, measured as ROA and ROS. This research, and more, contributes to the view of innovation capability as a source of competitive advantage through the resource-based view.

Through this lens, innovation can simultaneously be viewed as a concrete resource and as a dynamic capability that can be built and improved upon. Indeed, innovation activities may be viewed as both a stock and a flow variable based on the resource-based view and its extension of dynamic capability.

Though the several studies establish a positive relationship between innovation and performance, firms may fail to obtain significant economic returns of their innovations, as value is frequently captured by competitors and consumers (Teece, 1986). This is referred to as the spill-over effects of innovation (Teece et al., 1997), and is frequently a result of limited intellectual property protection. Teece (1986) suggests that complimentary resources are required to capture the value from an innovation in cases where imitation is easy. Thus firms can increase their return on innovation by focusing their R&D so that the innovation results (technologies, methods, products etc.) are either easy to protect by intellectual property law, or require specialised complimentary resources already existing within the firm. On the other side of this issue, as noted by Cohen and Levinthal (1989; 1990), a firm may increase its returns from such spill-over effects from their competitors by developing their absorptive capacity.

March (1991) implicitly posits his theory of the exploration-exploitation trade-off within the resource-based view. His theory suggests that firms can achieve an optimal balance between focusing on the exploration of new opportunities (i.e. an innovation focus building the innovation resource and capability of a firm), and focusing on exploitation (i.e. improving or building resources and capabilities related to the firm's existing operations). This theory, and the existence of an optimal trade-off between exploration and exploitation, was empirically confirmed by Uotila, Maula, Keil and Zahra (2009), finding a curvilinear relationship between exploration focus and firm performance. This adds nuance to our understanding of innovation (i.e. exploration activities) and its effect on firm performance.

The above paragraphs imply that firms may have a competitive advantage, or a competitive disadvantage, in performing innovation activities. As such, it is important to keep in mind that a positive performance link from empirical studies of innovation does not mean that every firm should innovate. Firms with a competitive disadvantage in performing innovation activities may generate negative performance results by increasing their investments in innovation activities. Finding a positive performance link on innovation in empirical studies also runs into a simultaneity and causality issues – does innovation cause performance, or do high-performing firms innovate more? Viewing this problem through the dynamic capability lens, the answer to this question may depend on path-dependencies many years ahead of the measured data, and thus it is difficult to provide a concrete answer, a limitation of almost all innovation-performance studies.

On an aggregate level, many countries and governments view a country's innovation landscape and capability as crucial to their international competitiveness. Many countries have designated funds and organizations to help foster innovation, such as Innovation Norway, Innovate UK, or National Innovation Agency Malaysia, to name a few. The UK, for instance, hired Michael Porter and Christian H.M. Ketels to conduct a special review on the innovativeness of UK and what next steps to take in order to use innovation in order to narrow the productivity gap between the UK and neighbouring countries (Porter & Ketels, 2003; in Denyer & Neely, 2004). Indeed, research finds that country is a strong moderating effect on the importance and effect of innovation (Filippetti & Archibugi, 2011; Walker et al., 2015). Industry effects are also significant when it comes to innovation performance and importance (Coad & Rao, 2008; Walker et al., 2015). Filippetti & Archibugi's (2011) findings surrounding the accentuated and pronounced effect of national systems of innovation during the recent financial crisis is of particular relevance to our thesis. Where national systems of innovation are relatively less important during expansionary periods of the business cycle, good national systems for innovation reduces the necessity to decrease investments into innovation activities during economic downturns. Additionally, Filippetti & Archibugi (2011) draw from the data a persistence in innovation capability throughout the crisis, similar to literature on the persistence of profits throughout the business cycle. This supports the resource-based view of innovation as a dynamic capability, path-dependent over time, and suggests innovation capability is difficult to copy or imitate easily. Interestingly, Norwegian innovative firms were found to perform worse than the strength of our national system of innovation would indicate, and significantly worse than our neighbouring countries of Sweden and Denmark (Filippetti & Archibugi, 2011).

Innovation is difficult to define in a simple way, which may help explain why the strategic management literature, as well as popular culture, seems intent on dissecting and discussing the various kinds. Perhaps most commonly is a separation between radical and incremental innovation. Whereas an incremental innovation reinforces the existing strengths, resources, and capabilities of a firm, a radical innovation is a new way of doing things, new resources, or revolutionary products that upend or create new industries (Henderson & Clark, 1990), such as the smartphone. Moving on from that, product innovation has been perhaps the most well-known type since the 1950s. Since then process innovation has gathered more attention as new manufacturing methods became important, and LEAN methodologies have risen to the forefront of management attention. As more and more economies transition from manufacturing to service, and as more start-ups take advantage of the opportunities presented by a more connected world, service innovation becomes more important as well – how can you offer an existing service in new and innovative ways that enhance the value for your customers? Add to that new and innovative ways to bring a product or service to the hands of consumers through market innovations, or new ways to organise a firm for its organisational goals, and there is a plethora of ways to innovate. Business model innovation is another kind that has received a great deal of attention in later years.

Whether a firm is able to innovate in any of the ways discussed above, and whether it is successful in its endeavour will be dependent on a number of different factors. Common for them is that it will be dependent on the firm's ability to use its resources, absorptive capacity and learning capabilities to enhance innovation capability, R&D capabilities, and more in order to generate successful innovations.

2.4 Business Cycles and Recessions

An economy is anything but static. There are changes to the composition of firms in the economy, the resources that firms have available to produce products or services, the regulatory environment, opportunities for trade, and a host of other factors. As these change over time, so does the economy as a whole. In addition to these fundamental factors, the economy as a whole is affected by macroeconomic indicators, trade patterns, interest rates, firm and individual leverage rates, and more. Business cycle theory is concerned with the shorter-term fluctuations in the economy as a product of these factors and what this means, whereas recession theory is concerned with sharp declines in the economic climate and strong adverse shocks to an economy that are more severe than those generally considered and predicted by business cycle theory. In this section, we first examine business cycle theory, then recession theory, before we link this to firm performance and theory on competitive advantage and innovation.

2.4.1 Business Cycles

The term “business cycles” refers to fluctuations of economic activity around an economy’s long-term trend (Burns & Mitchell, 1946; Hamilton, 1989). There are two main ways of identifying and measuring these fluctuations. The first is what is called classical cycles (American), and the second is called growth cycles (European). The American standard, developed by the National Bureau of Economic Research (NBER), is based on a set of economic identifiers for the American economy (Benedictov & Johansen, 2005), while the European standard is measured by comparing an economy’s Gross Domestic Product (GDP) to potential GDP. According to Gartner (2009), *boom* years occur when the economy exceeds the potential GDP, while *downturns* occur when the economy falls below potential GDP. Regardless of the measurement of the cycles (classical or growth), these fluctuations around the economy’s long term trends are divided into several distinct phases.

While Gartner (2009) distinguishes between booms and downturns, Benedictow and Johansen (2005) proposed a more detailed approach by introducing four different phases of the business cycle. As shown in the figure below, a period of *expansion* is followed by periods of *slowdown, downturn and retrieval*. The output gap indicates whether the economy is growing at a faster or slower rate than the general trend.

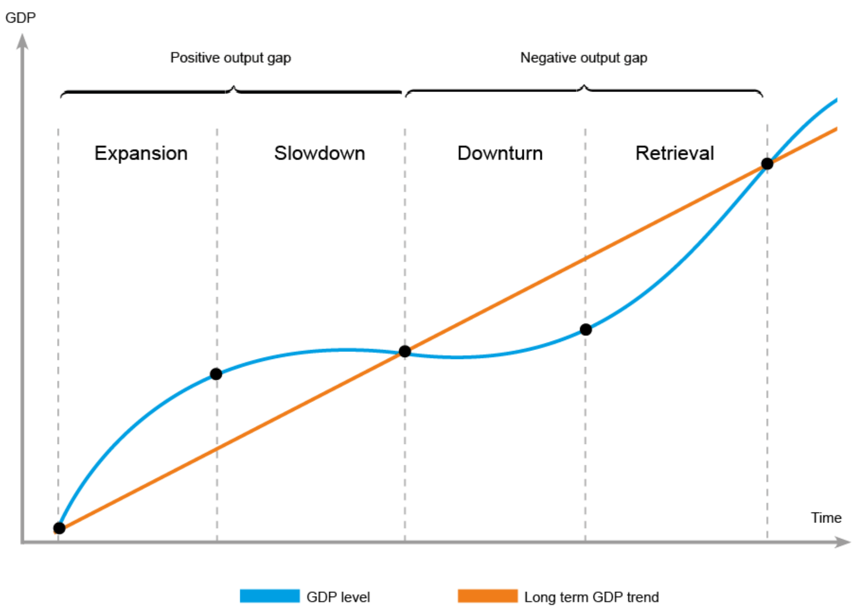

Figure 3: Phases of the business cycle (Benedictow & Johansen, 2005)

As long as the output gap is positive and increasing, the economy is in a phase of expansion, which lasts until the output gap reaches its peak. The slowdown phase consists of the following period where the output gap diminishes and GDP finally equals the predicted long-term trend. After the slowdown, the output gap is negative and the economy enters a downturn phase until the output gap reaches its bottom. The following return to neutral output gap is called the retrieval phase. Periods with positive output gap are typically associated with high growth, low unemployment, increasing investment and strong real estate and stock markets. Periods with negative output gaps are associated with reduced investments, as well as reduced growth and performance in both the stock market and the real economy of a country. With reduced growth, investments and corporate performance, unemployment is naturally higher during these periods as well.

Business cycles in reality are rarely as smooth as depicted in the figure above. The duration and severity of the different phases may differ greatly, and the GDP trend-line may be affected by short-term volatility. Wynne & Balke (1993) claims that the expansion phase has generally been the longest part of the business cycle in the post-war period. There has been some debate as to which types of developments should be considered as parts of the business cycle, and which are to be considered noise.

2.4.2 Recessions

Recessions are not necessarily a part of the business cycle, but occur when there exists "… a significant decline in economic activity spread across the economy, lasting more than a few months, normally visible in real GDP, real income, employment and industrial production" (NBER, 2010). There are in other words requirements to both the severity and the duration of the economic downturn, for it to be considered a recession. A global recession typically occurs every 7-10 years and can last anywhere from 8-18 months, the most recent being the financial crisis of 2008-2009 (Reinhart & Rogoff, 2013).

Though the specific causes of recessions tent to differ, two features are present in most recessions, namely reductions in demand and reductions in access to credit. (Knudsen & Lien, 2014). Thus, firms face reduced investment opportunities, less cash flow from operations available to finance investments and reduced availability of finance (Bernanke, 1983: Ghemawat, 2009; Bhagat & Oberja, 2013; Bond, Harhoff & Reenen, 2005; Ivashina & Scharfstein, 2010; in Knudsen & Lien, 2014). This impact can be viewed as an exogenous environmental shock for a firm, as recessions typically are highly unpredictable (Reinhart & Rogoff, 2013). By using recessions as exogenous treatments to firm performance, Knudsen (2014) presents the following model for assessing the impact of recessions:

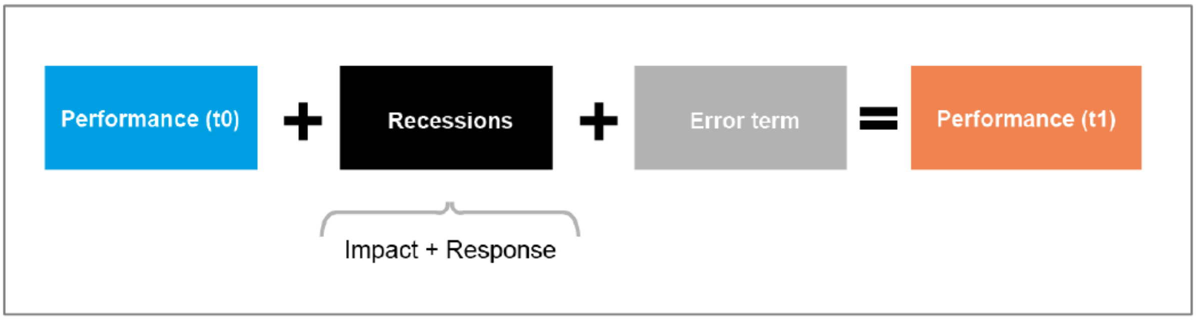

Figure 4: Impact of recessions (Knudsen, 2014)

As shown in Figur 4, recessions affect firm performance through the actual impact of the recession, the firm's response to the downturn and an error term. The error term relates to factors that influence firm performance in the period, not related to the downturn. In empirical studies, the error term can be captured to some degree through the use of control variables. However, separating impact and response may prove difficult. For example, firms may respond to decreased demand by expansive marketing campaigns, resulting in a net positive effect on sales growth, though increased marketing costs. The performance of the firm at t = 1 will depend on the relative effects of the cost and benefit, as well as the error term discussed above.

2.5 Hypothesis Development: Innovation During Recessions

Now that we have established a theoretical overview of innovation in the existing literature, as well as the theory and background of recessions and business cycles, we turn our focus to the empirical evidence provided on innovation thus far. From this review, we will develop our hypotheses about how innovation activities affects firm performance during recessions.

Walker (2005) provides a review of 30 peer-reviewed papers on the subject, and this is an excellent starting point for this topic. Walker (2005) found that in the majority of the studies, innovation was found to contribute to higher levels of organizational performance (the weighted support score was 56,19%). However, he also found that the effect differs depending on the type of innovation. Product innovation was found to influence organizational performance more than process innovation, for instance. Earlier studies found that radical innovation has a stronger influence on financial performance than incremental innovation (Chaney, Devinney & Winer, 1991; Kleinschmidt & Cooper, 1991; in Aas & Pedersen 2011). Service innovation is found to have a significant positive effect on performance (Aas & Pedersen, 2011), while studies concerning operational innovation has shown mixed results (Klingenberg, Timberlake, Geurts & Brown, 2013).

Building on this review of empirical studies, there are several results we have examined in our review of the literature. Geroski and Machin (1992) examined 539 large UK manufacturing firms, and results suggest that innovators tended to outperform non-innovators. Though definitions and methodology differs between studies, similar results were obtained by Filippetti and Archibugi (2011), Kostopoulos et al. (2011), Aas and Pedersen (2011), Hausman and Johnston (2014), Walker et al. (2015), and more. Of note, Freel (2000) found no profit margin or profit growth effects of innovation in his study of small innovating firms, though this may be due to the size of the firms he analysed.

So the general empirical consensus from these studies is that innovation does have a positive effect on firm performance. Within these studies however, there were several factors that were found to affect or moderate the effect of innovation on firm performance. Walker et al. (2015) found country and industry to be strong moderating effects, supported by the findings of Aas and Pedersen (2011) for industry and Filippetti and Archibugi (2011) for country. Furthermore, large firms seem to be able to obtain greater returns on innovation than smaller firms (Freel, 2000). Geroski, Machin and Van Reenen (1993) found that the positive effect of innovation on performance is greater than the direct gains from the specific innovations. They conclude that the remaining indirect effects reflect differences in competitive ability, closely tied to innovation, between innovators and non-innovators, further supporting Filippetti and Archibugi’s (2011) persistence of innovation thesis.

Less attention has been devoted to innovation activities during recessions, both theoretically and empirically. Knudsen and Lien (2014) synthesise the existing literature on the recession effects of reduced demand and reduced credit access for firms, and hypothesise about the effects on different types of investments. Of particular interest to our thesis is the conclusion they reach that more credit-constrained firms will have to reduce their R&D and innovation investments more than less credit-constrained firms during recessions. This is because the demand reduction forces firms to either cut investments into R&D and innovation (which is more difficult for long-term R&D investments than for other types), or increase borrowing to maintain this R&D spending, (which is generally preferred to reap the future benefits of such activities). Thus, credit constraints force firms to cut R&D investments, as opposed to maintaining these investments through increased borrowing (Knudsen & Lien, 2014). In 2015, Knudsen and Lien found empirical evidence that firms focusing on exploration over exploitation tended to take better advantage of the efficiency breakdown in human capital factor markets during recessions in order to generate competitive outcomes through training and hiring. If we consider there to be a link between a firm's innovation activities and an exploration focus, this suggests that innovative companies may be better able to take advantage of such factor market inefficiencies than others. However, Knudsen and Lien (2015) also found that exploration-focused firms were quicker to fire non-core personnel in recessions, perhaps in an effort to avoid cutting more essential resources, such as R&D and innovation investments.

This suggests that innovative firms are likely to react differently to recessions than non-innovative firms, and that the characteristics of those innovative firms will affect their response to the recession and subsequent competitive outcomes. Building on the theory of innovation in recessionary times, Geroski, Machin and Van Reenen's 1993 paper suggests that innovative companies may actually be less sensitive to adverse economic shocks, due to their ability to absorb spill-over effects. Hausman and Johnston (2014) further finds that the factor conditions that exist in recessions favour innovation as a means to recover, supporting Knudsen and Lien's (2014; 2015) thesis that the efficiency of factor markets during recessions is impaired, and therefore highly relevant for both managers and researchers alike. Combined with the idea of persistent performance gaps between innovators and non-innovators, even in recessionary times (Geroski, Machin, & Van Reenen, 1993), the theory seems to suggest that firms that are able to remain innovative during recessions will outperform their non-innovative peers.

In summary, the majority of studies find net positive effects of innovation on firm performance, though with several moderating effects on innovation's ability to influence firm performance. During recessions, innovation activity is likely to be more important to maintain than in normal economic conditions, but recessionary pressures may, depending on the characteristics of the firm, make it more difficult to maintain investments into R&D and innovation activities. These findings are in line with existing theory on competitive advantage, innovation literature, and known determinants of corporate performance outside of innovation.

While there exists some literature regarding the effect of innovation on firm performance during recessions, the area has received little explicit empirical attention. This is the area where we hope our thesis will contribute to the field of strategic management literature. From the theory regarding factors affecting firm performance and innovations, we develop the following hypotheses:

2.5.1 Innovators versus Non-Innovators and Firm Performance

Our main hypotheses surround the focus variable of innovation and innovation activities. However, we will, based on the literature review, also develop hypotheses for how we expect the other variables influencing performance to behave as well, and thus we will be able to view them in light of, and potentially contribute to, this existing literature in the field.

H1: Innovators will outperform non-innovators during and after a recession.

We further divide this hypothesis based on the timing of the innovation activity and the lag for financial performance.

H1a: A firm that innovates prior to the financial crisis will outperform non-innovators during the downturn phase of the recession.

We believe, as the literature suggests, that firms who innovate will have newer and more relevant products, processes, organisational structures, and market orientations. This would then suggest that innovative firms are better able to remain relevant to the consumers during a financial downturn where consumer spending decreases, or manage internal resources more efficiently and productively than their non-innovative peers. As such, innovators seem likely to outperform non-innovators during the downturn years of the recession.

H1b: A firm that innovates prior to the financial crisis will outperform non-innovators in the retrieval phase of the recession.

Similar to the above arguments, an innovative firm may be better organised and better able to provide relevant products and services to consumers and customers when their spending increases again. As such, innovative firms may capture a larger share of new or returning customers during the retrieval phase. The time lag here is longer, however, so we would expect a weaker connection to firm performance in the retrieval phase than during the financial downturn.

H1c: A firm that innovates during the financial crisis will outperform non-innovators in the retrieval phase of the recession.

The argument here is the same, though the time lag between the downturn and the retrieval phase is shorter, and as such we expect to see a higher effect from innovations during the crisis years than prior to the crisis, on performance during the retrieval phase.

2.5.2 Degree of Innovation and Firm Performance

H2: The more innovative a firm is, the better it will perform relative to its peers, during and after recessions.

In this hypothesis, we look at whether there is a relationship between degree of innovativeness and firm performance, looking at similar timings as in H1.

H2a: Firms that were relatively more innovative before the recession will outperform less innovative firms during the downturn phase of the recession.

H2b: Firms that were relatively more innovative before the recession will outperform less innovative firms during the retrieval phase of the recession.

H2c: Firms that were relatively more innovative during the downturn phase of the recession will outperform less innovative firms during the retrieval phase of the recession.

Based on these hypotheses, we should be able to say something about the degree of innovativeness of a firm, and provide valuable insights for managers about innovation activities during recessionary periods.

2.5.3 Type of Innovation Activity and Firm Performance During Recessions

There is little literature from which to develop a concrete hypothesis surrounding the type of innovation activity. Though there exists some literature suggesting different effects based on the type of innovation, there is no existing literature that compares the four types of innovation outlined in our CIS datasets – product innovation, process innovation, market innovation, and organisational innovation. As such, we will not be testing the performance effects of the different types of innovation against specific hypotheses formed by theory and empirical findings, but will be conducting an exploratory analysis into these potential differences. For this analysis, we follow a similar approach to the above hypothesis testing, though we look specifically at innovative firms and the relative performance between them.

In this analysis, we will look at the type of innovation activity, and whether this affects relative firm performance between innovators. We will further break this down by the same time lags as in H1 and H2, to see if the relative effect of innovation type changes during recessions.

3. Methodology

Now that we have outlined the relevant theory and developed our hypotheses, we consider the best methodology by which to test these hypotheses. In this section, we explain our research design, explore the empirical setting for our study, and outline our proposed methodology for investigating our hypotheses.

3.1 Research Design

Saunders, Lewis and Thornhill (2009) suggests that at research purpose can take one of three forms: exploratory, descriptive or explanatory. Our research question concerns the relationship between innovation and firm performance during recessions, and arguably includes aspects from all three. As the relationship between innovation and firm performance previously has not been thoroughly investigated from a depression-perspective in Norway, our thesis can be said to be exploratory. Similarly, as we seek to establish causal relationships between these variables, our study is also explanatory. However, it is also our aim to describe our empirical findings as accurately and robustly as possible, which indicates a descriptive purpose (Saunders et al., 2009). The explanatory element emerges as a purpose of the study is to find a causal relationship between innovation and firm performance. As a result, our thesis has a descripto-explanatory research purpose.

Saunders et al. (2009) states that the research approach of business and economic studies typically is either deductive or inductive. In a deductive study, existing literature is applied to form hypotheses and expectations that are analysed quantitatively. In this study, we are utilizing existing literature to form expectations and hypotheses about how firm performance is affected by innovation in recessions. Thus, our research approach is deductive, which fits our descripto-explanatory research purpose.

This study will be using both binary Yes/No innovation survey responses as well as financial data in order to establish the relationship between innovation activities and financial performance. These data are quantitative, and are well suited to our descripto-explanatory study, as they enable objective and accurate portrayals of reality.

Based on the above discussion, Figure 5 summarizes our research design:

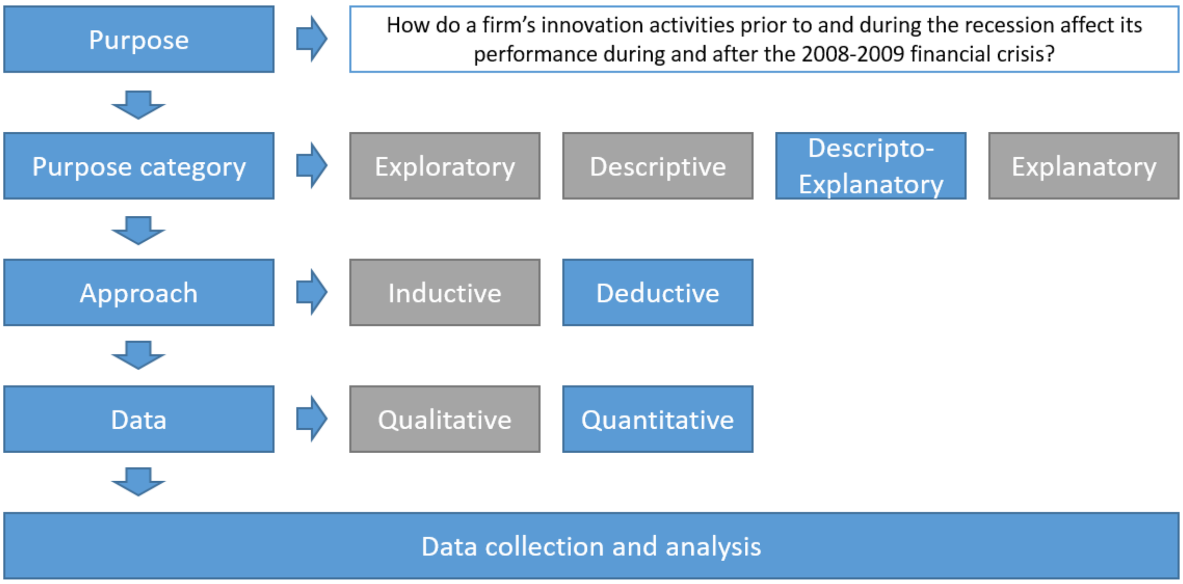

Figure 5: Research design

3.2 Empirical Context

Given our research design, we will now explore the national empirical context for the financial crisis, as well as the data we have available with which to conduct our study.

3.2.1 Norway before, during and after the financial crisis of 2008-2009

In September 2008, the American investment bank Lehman Brothers declared bankruptcy, indicating the start of the financial meltdown now simply called "the financial crisis" or "the Great Recession" (Filippetti & Archibugi, 2011). In this thesis, we will not go into the causes for the financial crisis, as this is not our focus, but the meltdown of the American financial sector in September 2008 resulted in the most severe global recession since the Great Depression of 1929. As a result, much of the world saw significant negative demand shocks, rising unemployment rates, falling GPD, and government funding crises.

In the years preceding this financial crisis, the Norwegian economy saw stable growth in GDP, excepting a slight downturn during the dotcom bubble bursting in the late 1990s. The Norwegian volume of credit close to quadrupled from 1992 until the fall of 2008, and the Oslo Stock Exchange Benchmark Index (OSEBX) showed annual growth rates averaging 45% from 2003 until 2007 (Oslo Børs, 2016). As shown in Figure 6, the Norwegian economy showed clear signs of being in an expansion phase in the years leading up to 2008.

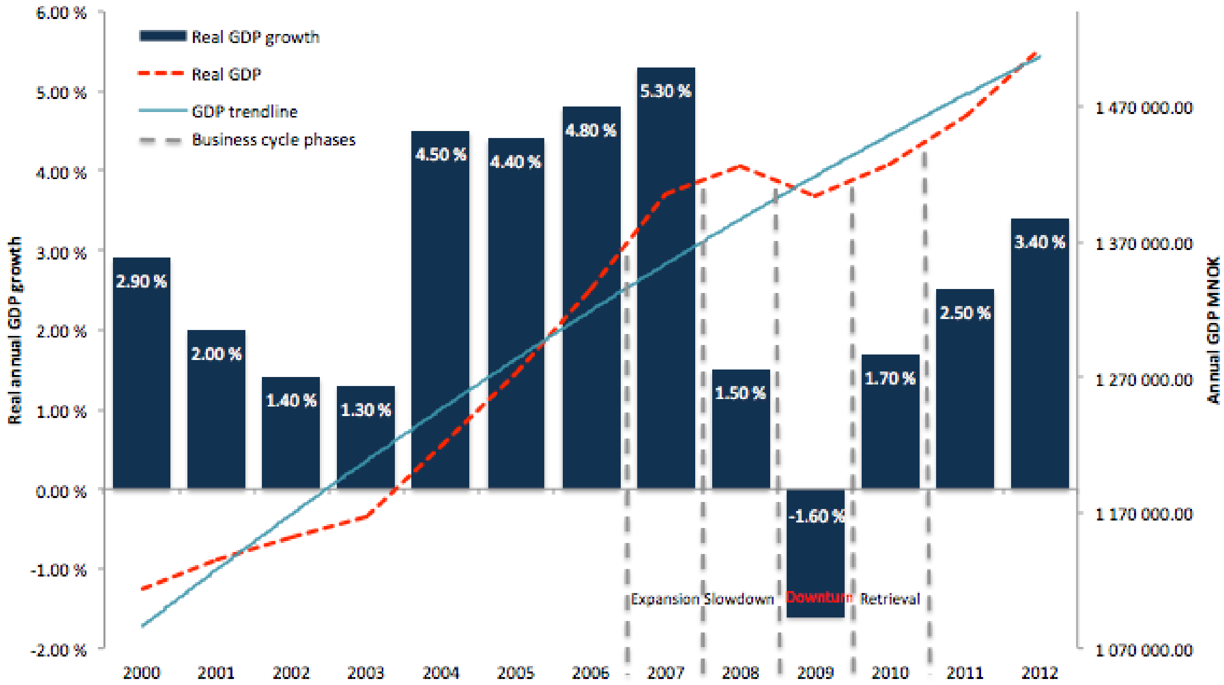

Figure 6: Norwegian GDP 2000 to 2012 (Brynhildsrud, 2013)

The Great Recession had a somewheat reduced effect on the Norwegian economy compared to most other Western economies. That being said, Lien and Knudsen (2012) found that Norwegian firms experienced severely reduced profitability and growth, and the financial crisis certainly qualified as a recession in Norway as well. The figure above strongly indicates phases of slowdown and downturn in the Norwegian economy from 2008 - 2010. The following years of retrieval ended in a neutral output gap in 2012, as we can see from Figure 6.

3.2.2 Datasets, Selection Criteria and Data Treatment

The main purpose of this paper is to assess the causal effects of innovation activities on firm performance during recessions. In order to analyse this relationship, we access publically available accounting data combined with the Community Innovation Survey (CIS) for Norwegian firms, conducted by Statistisk Sentralbyrå (SSB, Statistics Norway). The CIS data consists of three data sets on the innovation activities undertaken by Norwegian firms between 2006-2008 and 2008-2010. The accounting panel data was obtained from NHH through SNF (NHH Institute for Research in Economics and Business Administration), and runs from 2008 to 2012. The CIS data was originally obtained from SSB. SSB then matched the CIS and accounting data and handed over the anonymised combined dataset to us, thus preserving the integrity of the dataset and the protection of firm privacy. We will use the statistical software IBM Statistical Package for the Social Sciences (SPSS) Version 23 to analyse these datasets, and present our findings using Microsoft Office Excel 2016.

We were unfortunately unable to affect the contents of the datasets handed over to us. These datasets have been previously treated through selection processes and other treatments, which has led to some unfortunate exclusion of certain relevant variables, such as firm age. With anonymisation of the firms in the datasets, we are unable to obtain and match such data from additional sources. Additionally, our thesis would have benefited from accounting data over a larger time span, perhaps most notably the inclusion of 2006 and 2007 as the initial years for our analysis, and 2013 and 2014 to have an equal time lag for each CIS dataset. However, as is often the case with secondary data, we have to do our best with the data provided to us.

CIS Dataset

The CIS was sent out to all Norwegian firms with 50 or more employees, and a random representative selection of firms with 5-49 employees. Firms with four or fewer employees are excluded. Second, the survey also excludes twelve industries to avoid firms that are not profit-maximizing, as well as non-competitive firms. The response rate for both surveys were in excess of 95%, thus greatly limiting the respondent bias inherent in the datasets. In the 2006-2008 CIS had 5,994 respondents, and the 2008-2010 CIS had 6,541 respondents.

The survey is based on the Oslo Manual, an internationally recognised methodology for measuring innovation. It represents the global best practice for measuring innovation, and consists of some 230 questions. Most of these are yes/no questions. The strength of the survey is that it breaks down four types of innovation activities – market innovation, product innovation, process innovation, and organisational innovation. This allows for measuring, through dummies, the effect of particular types of innovation from within the subset of innovative firms.

An important thing to note here, is that an innovation does not have to be successful to be considered and measured under the Oslo Manual and CIS datasets – a number of studies use the idea of commercial success (Geroski & Machin, 1992) as the basis for their studies, which will overstate the effect of innovation in their results by ignoring the impact of failed innovation activities. As we established that some firms may have competitive disadvantages in performing such innovation activities, this is an important limitation of those studies to note, and one that the CIS datasets thus avoids.

SNF Accounting Dataset

The SNF accounting dataset was provided to us by NHH. The SNF accounting dataset represents the most complete set of publically available accounting data for all firms required to file accounting data in Norway, and includes all variables in a Norwegian business tax return. The dataset includes accounting data for 234,213 – 247,457 Norwegian firms between 2008 and 2012. In these datasets, we will adjust for inflation, using 2008 as the basis year.

Further Selection Criteria:

In addition to the above, we now outline the selection criteria for our data that we apply in our thesis.

Time Period: 2006 – 2012

The CIS survey is sent out biannually and contains innovation data for a three-year period. We will be using the CIS datasets for 2006-2008 and 2008-2010, and accounting datasets from 2008-2012, in order to analyse innovation effects during the time periods before, during and after the recession.

CIS 2006-2008 is defined as before the recession. As such, innovation activities undertaken during this time period are considered to be made prior to the recession, during the expansion/slowdown phases of the business cycle. CIS 2008-2010 captures all the years where Norwegian businesses were most impacted by the crisis (Lien & Knudsen, 2012). As such, we defined innovation activities during this time period as occurring during the financial crisis, or during the downturn phase of the crisis.

Financial data from 2008 is considered pre-crisis, and will be used as our measure for initial profitability. This is a crude estimation of pre-crisis variables, as 34.9% of Norwegian businesses reported being affected by the financial crisis during 2008 (Lien & Knudsen, 2012), but due to lacking 2007 data this is a necessary assumption to make. Financial data from 2009 and 2010 is considered to be during the financial crisis, and this is the time period where the majority of Norwegian businesses were hit by the recession. Finally, the financial data from 2011-2012 is considered to be post-crisis, during the retrieval period of the business cycle.

Profit-Maximizing Industries:

Including the twelve industries excluded in the CIS data, we exclude 20 two-digit NACE codes. These industries tend to have high tariff barriers, abnormal market conditions or are heavily subsidised. Affiliated firms are likely to exhibit non-competitive or non-profit-maximising behaviour. We therefore exclude the following industries:

NACE code	Industry name
1	Crop and animal production, hunting and related service activities
2	Forestry and logging
45	Wholesale and retail trade and repair of motor vehicles and motorcycles
47	Retail trade, except of motor vehicles and motorcycles
65	Insurance, reinsurance and pension funding, except compulsory social security
66	Activities auxiliary to financial services and insurance activities
68	Retail estate activities
69	Legal and accounting activities
73	Advertising and market research
75	Veterinary activities
77	Rental and leasing activities
78	Employment activities
79	Travel agency, tour operator and other reservation service and related activities
80	Security and investigation activities
81	Services to buildings and landscape activities
85	Education
90	Creative, arts and entertainments activities
91	Libraries, archives, museums, and other cultural activities
92	Gambling and betting activities
99	Activities of extraterritorial organisations and bodies

Table 1: Excluded NACE codes

Complete and Reasonable Data:

Firms with missing or unreasonable variables needed in our analysis will be excluded. Here, we define unreasonable values as those that are likely a result of faulty data. The following cases will be deleted:

ROA	Less than -1
EBITDA Margin	Less than -1
EBITDA Margin	More than 1
Sales Growth	Less than -1
Asset Growth	Less than -1
Leverage	More than 1.5
Proportion of fixed assets	More than 1

Table 2: Deleted cases

Overall Sample Size:

After adjusting the data sets with the above mentioned selection criteria and outliers, we are left with the following sample size:

CIS 2008-2010					CIS 2010-2011		
2008	**2009**	**1010**	**2011**	**2012**	**2010**	**2011**	**2012**
5326	5093	4874	4722	4556	2760	2695	2615

Table 3: Sample size

3.3 Defining the Relevant Variables

3.3.1 Dependent Variables

Our focus is on financial performance and its relation to innovation activities. As such, our dependent variables are all financial performance metrics. In particular, we are interested in the effect of innovation on a firm's ability to drive profits in a competitive market. As such, we are interested in three main performance indicators.

$$Y_1 = \ Return\ on\ Assets\ (ROA) = \frac{Net\ Income + Interest\ Expense}{Total\ Assets}$$

The ROA figure measures how well a firm is able to utilise its assets to earn money for its investors. ROA is defined as net income divided by total assets, and is a common performance variable within finance and management research and literature. ROA is sometimes defined as net income over total assets without the interest expense. We include the interest expense in our calculation of the ROA figure, as we are interested in the result generation for the total firm, not just the equity holders. This also minimises the influence of capital structure on this performance variable.

As net income includes tax and capital structure effects, we take EBITDA margin as a second performance variable. This is a better approximation of cash generation to the firm per unit of sales.

$$Y_2 = \ EBITDA\ Margin = \frac{EBITDA}{Total\ Sales}$$

Defined as EBITDA divided by total sales, this measure fives a good indication of how effectively a firm is able to turn a dollar of sales into a dollar of cash flow. As we are interested in eliminating tax, capital structure, and asset-level effects, the EBITDA margin is a better measure than the EBIT margin or the net income margin.

$$Y_3 = \ Sales\ Growth = \frac{Sales_{T_1} - Sales_{T_0}}{Sales_{T_0}}$$

Finally, based on our literature review, we hypothesise that innovations will enable a firm to grow its sales. As such, we are interested in seeing if innovation activities can affect the sales growth of a firm in the years following such activities. As this dataset considers a recession, we expect to see a negative sales growth figure for most companies, but postulate that innovative companies will see less of a decline during the recession, and potentially a higher growth rate during the recovery.

3.3.2 Independent Variables

Focus Variable: Innovativeness

Innovation and innovativeness has traditionally been quite difficult to measure, and this continues to be the case with the CIS data. In our analysis, we will define the innovative firms as those who have answered yes to completing various market, product, process, or organisational innovation activities during the survey period. As such, we intend to measure innovation in three ways.

The first is to categorise the firms quite simply as either innovators (those firms that have completed one or more innovation activities during the CIS time period in question), or non-innovators (those that have not completed such activities). This is the simplest way to create a binary innovation variable that will give us a sense of whether innovative firms do better than non-innovative firms. This is, of course, a common method used for much of the existing innovation research literature (Geroski & Machin, 1992; Freel, 2000), though attempts have been made to categorise innovation more granularly (Kilic, Ulusoy, Gunday & Alpkan, 2015). We categorise a firm as an innovator if it completes one or more of the four types of innovation activity outlined in the CIS dataset during the CIS period in question.

$$Innovator\ Dummy = \ [1_{\ Innovation\ =\ Yes}\ or\ 0_{\ Innovation\ =\ No}]$$

Our second method is to construct another variable from the data we have available, in order to try and ascertain each firm's degree of innovativeness. The CIS data makes no attempt to measure the degree of innovativeness, and uses simple dummies for the different kinds of innovation, in addition to a dummy for whether the firm has completed innovation in any one of the innovation types captured by the CIS data. Combining the questions within the four types of innovation allows us to construct a category variable of overall innovativeness.

The second category variable considers the answers to the individual questions about each type of innovation. The weight-adjusted variable ranges from 0-16, and is based on combining answers to questions about innovation activities within product- (two items), process- (three items), market- (four items) or organisational innovation (three items). We weight-adjust the questions to give each innovation type the same overall importance for determining the degree of innovation a firm engages in. With this INNOV16 variable, we designate each innovative firm a dummy based on its quartile, giving us further granularity into the importance of degree of innovativeness.

$$INNOV16 = \sum Weight - Adjusted\ Innovation\ Question\ Dummies$$

We can now determine each firm's innovation quartile:

$$Non - Innovator\ Dummy = \ [1_{\ INNOV16 = 0}\ or\ 0_{INNOV16 \neq 0}]$$

$$4th\ Quartile\ Dummy$$
$$= \ [1_{\ INNOV16 = Within\ 4th\ Quartile\ Bounds}\ or\ 0_{INNOV16 = Outside\ 4th\ Quartile\ Bounds}]$$

$$3rd\ Quartile\ Dummy$$
$$= \ [1_{\ INNOV16 = Within\ 3rd\ Quartile\ Bounds}\ or\ 0_{NNOV16 = Outside\ 3rd\ Quartile\ Bounds}]$$

$$2nd\ Quartile\ Dummy$$
$$= \ [1_{\ INNOV16 = Within\ 2nd\ Quartile\ Bounds}\ or\ 0_{NNOV16 = Outside\ 2nd\ Quartile\ Bounds}]$$

$$1st\ Quartile\ Dummy$$
$$= \ [1_{\ INNOV16 = Within\ 1st\ Quartile\ Bounds}\ or\ 0_{NNOV16 = Outside\ 1st\ Quartile\ Bounds}]$$

With this, we can measure the impact of the degree of firm innovativeness to a greater and more appropriate extent using quartiles.

The final way is measuring the effect of specific innovation activities within the four categories of innovation using a dummy for each type. This allows us to analyse whether there are any direct and measureable effects of singular types of innovation activities on firm performance during recessions. Here, we use the innovation type dummies:

$$Product\ Innovation\ Dummy = \ [1_{\ Product\ Innovation = Yes}\ or\ 0_{Procuct\ Innovation = No}]$$

$$Process\ Innovation\ Dummy = \ [1_{\ Process\ Innovation = Yes}\ or\ 0_{Process\ Innovation = No}]$$

$$Market\ Innovation\ Dummy = \ [1_{\ Market\ Innovation = Yes}\ or\ 0_{Market\ Innovation = No}]$$

$$Organisational\ Innovation\ Dummy = \ [1_{\ Org.Innovation = Yes}\ or\ 0_{Org.Innovation = No}]$$

With these variables, we can effectively measure the performance of innovators versus non-innovators, high innovators versus low innovators, whether a firm's innovation innovativeness quartile is a good predictor of performance, and whether certain types of innovation are more likely to lead to improved performance than others. In order to cleanly measure the effect of innovation on performance with the least amount of noise and bias, we now need to establish the what other variables that are likely to affect firm performance, and control for these in our model.

Control Variables:

Now, a firm's characteristics will tend to influence performance in both normal business cycles and recession. These characteristics may act as moderating effects on both the recession impact, the choice of response, as well as the impact of innovation throughout business cycles and recessions. It is these potentially moderating effects we now turn our attention to. As these effects are only of ancillary interest to our thesis, we will not outline the theoretical and empirical findings of the effects of those characteristics. We will insteade attempt to control for these effects in our study, in order to most cleanly assess the impact of innovation on firm performance during recessions.

We note from previous studies that industry and country effects are significant explanatory variables with regards to firm performance, but do not intend to delve more deeply into the theoretical background behind this, as it is of little practical significance for managers and scholars, beyond the awareness that its effects are substantial. We do, however, control for industry in our analysis of the data.

Prior Profitability:

Profitability in prior years is generally considered to affect future firm performance, both in recessionary times and in normal times. Indeed, the literature surrounding this topic has its own name – the "Persistence of Profits" literature (Bottazzi, Secchi & Tamagni, 2008). This builds on the natural selection in economics literature (Alchian, 1950; Friedman, 1953), in that firms exit or enter competitive markets when doing so would increase the expected cash flow to the firm (Jovanovic, 1982; Hopenhayn, 1992; Ericson & Pakes, 1995; in Nishimura, Nakajima, & Kiyota, 2005).

This idea of persistent profitability is generally supported by empirical findings (McDonald, 1999; Porter & McGahan, 2002; Porter & McGahan, 2003; Bellone, Musso, Nesta & Ouéré, 2008). Lien and Knudsen (2012), building on the work of Knudsen (2011), find in their analysis of 1248 Norwegian firms throughout the recession that prior firm profitability is negatively correlated to the likelihood of being severely affected by a recession. However, it is important to note that other studies have found little or no significant effect of prior profitability on performance during recessions (Geroski & Gregg, 1996; Nishimura, Nakajima

& Kiyota, 2005), though this may be due to differences in performance measurement methodology and shorter time periods of study.

As such, we need to include control variables for prior firm profitability. The variables used here will be the same as the dependent profitability variables, namely ROA and EBITDA margin, one time-period before the relevant regression:

$$Prior\ Profitability_{ROA} = \mathrm{ROA}_{\mathrm{t=0}}$$

$$Prior\ Profitability_{EBITDA} = \mathrm{EBITDA}_{\mathrm{t=0}}$$

We note here that since our accounting data begin in 2008, we are unable to control for prior profitability in our analysis prior to 2009.

Sales Growth:

Just before the onset of a financial crisis, the economy is considered to be in a boom, with high growth rates and general economic optimism. This is a period where most firms in the economy are experiencing strong growth in both sales, business opportunities, and profits. There are, however, several studies that suggest that high pre-crisis sales growth may lead to a more severe recessionary impact, as these customers may be less loyal or attached to the product of a particular firm (Geroski & Gregg, 1997; Campello, 2003; Lien, 2010). As such, we can say that there is evidence for a weak positive relationship between high pre-crisis sales growth and severity of recessionary effects on a given firm. As such, we find it necessary to include prior sales growth as a control variable for our analysis:

$$Prior\ Sales\ Growth = \frac{Sales_{T_0} - Sales_{T_{-1}}}{Sales_{T_0}}$$

Similar to prior profitability, our accounting data begin in 2008, we are unable to control for prior sales growth in our analysis prior to 2010.

Capital Structure:

Though initially perceived to not affect firm values under perfect market conditions (Modigliani & Miller, 1958), and therefore implicitly leaving performance unaffected by capital structure choice, more recent literature assets its influence on firm performance. Jensen and Meckling (1976) found evidence of agency costs related to capital structure. Myers and

Majluf (1984) found that capital structure choice in investments to act as an information signal to the market, leading to the pecking order theory and the recognition that capital structure may limit a firm's ability to take on profitable projects due to the debt overhang problem, and similarly underinvest if external financing is needed. Jensen (1986) finds that debt may have a disciplining effect on managers by reducing the agency problems between owners and managers. This assertion that capital structure matters for competitive outcomes is supported by a number of other studies (Lang, Ofek & Stultz, 1996; Campello, 2003; Margeritis & Psillaki, 2010).

This assertion is also borne out in recessionary times. Increased leverage is an important factor for a firm's liquidity and thus likelihood of financial distress. Opler and Titman (1994) even go so far as to view financial leverage as a direct measurement of vulnerability to economic downturns. Bernanke, Gertler and Gilchrist (1996) find empirically firms with strong balance sheets are preferred by investors during recessions, representing a "flight to quality." Their paper finds that the borrowers with the highest agency costs of debt are more adversely affected by a recession than those with smaller agency costs. From Jensen and Meckling (1976), we also know that the higher the leverage ratio, the higher the agency costs of debt. From these papers, as well as supporting evidence from Knudsen (2011) and others, there seems to be significant support for arguing that high leverage increases a firm's vulnerability to recessions.

Naturally, we control for this firm characteristic as well, through the firm's debt ratio:

$$Debt\ Ratio = \frac{Total\ Debt}{Total\ Assets}$$

Size Effects:

It is quite commonly accepted that size has an effect on corporate financial performance. The concept of economies of scale is present in every self-respecting textbook on strategy, as is the concept of the minimum efficient scale, all relating to firm size. The Baumol hypothesis that large firms have every opportunity a small firm has, plus scale benefits, has been initially supported (Hall & Weiss, 1967). A number of size effects, such as economies of scale and reduced capital costs, are included in modern literature under the "barriers to entry" bucket outlined by Porter (1980). Empirically, there are mixed results. A number of studies find that firm size is positively related to firm performance (Boyd & Runkle, 1993; Orser, Hogarth-

Scott & Riding, 2000; Fackler, Schnabel & Wagner, 2013). Others again find that there may be diseconomies of scale and other negative effects from managing large and diverse firms (Jensen, 1986; Hansen & Wernerfelt, 1989). Drawing on transaction cost economics, Canbäck, Samouel and Price (2006) find find evidence for both positive and negative effects of firm size.

During recessions, the size effect is also important. Bernanke, Gertler and Gilchrist (1996) find that smaller firms are more severely hit by recessions, echoing prior research (Oliner & Rudebusch, 1993; Gertler and Gilchrist, 1993; in Bernanke et al., 1996), though they note that smaller firms grew more during the retrieval period of the recession. Geroski and Gregg (1997) arrived at similar results, as did Fackler et al. (2013), Sahin, Kitao, Cororaton and Laiu (2011), and Gertler and Gilchrist (1993). Other studies find little or no size effects of recessions (Opler and Titman, 1994), whereas others again found larger firms to be more severely hit by recession (Bumgardner, Buehlmann, Schuler, & Crissy, 2011; Varum & Rocha, 2013; in Knudsen, 2015). Thus, it is clear that size matters to firm performance, though there is no empirical consensus about a unilateral direction of the effect. Naturally, we control for this effect as well.

After testing both Total Assets and Sales as measures of firm size in our regressions, we found that Sales had the highest impact on explanatory power and often were more significant than Total Assets. Thus, we chose Sales as our measure of firm size.

$$Size(Sales) = \ln(Sales)$$

Firm Age:

Firm age affects a firm’s presence, branding, and often strength in a given market. As such, it is is likely to affect product market outcomes. Geroski (1995) estimates that roughly 50-60% of new market entrants will be forced to exit their market within five years of establishment. Fackler et al. (2013) refer to both firm size and age as mere “stylized facts,” and discusses their findings of the “liability of newness,” which, though statistically significant, was not found to be unilateral. Bellone et al. (2008) find that firm age has a curvilinear concave effect on likelihood of market exit, suggesting that the importance of firm age varies by age. They also find that older firms are less sensitive to market concentration effects on likelihood of market exit. Age may also signal quality and firm strength, leading investors to prefer older firms in the “flight to quality” occurring during recessions ((Bernanke, 1983; Gertler & Gilchrist, 1993; Bernanke et al., 1996). Knudsen (2015) argues that this may favour older, as well as larger, firms, and as such represents another example of the “liability of newness” that may increase in its effect during recessions. As with size, it is clear that firm age is important, though empirical findings are far from unilateral.

Naturally, we would prefer to control for this variable as well. Unfortunately, firm age is not an included variable in our dataset. However, as Aas and Pedersen (2011) and other studies sometimes exclude this control variable, we hope this limitation to our data will not impact our results significantly.

Firm Liquidity:

In much the same way as leverage, liquidity constraints affect a firm’s performance in both normal and recessionary times, and, indeed, the need to cut R&D and innovation investments (Knudsen & Lien, 2014). Firm liquidity is a measure of a firm’s ability to meet its short-term obligations, and a lack of adequate liquidity may mean that a firm has to forego positive investment opportunities (Wang, 2002; Lang et al., 1996; Myers & Majluf, 1984). Some papers also define liquidity as the availability of internally generated funds (Hoshi, Kashyap, & Scharfstein, 1991; Bernanke, 1981). In surveying the literature, there is a clear consensus that liquidity does affect financial performance and product market outcomes in a positive direction (Myers & Majluf, 1984; Cleary, 1999; Wang, 2002; Fresard, 2010). Liquidity also relates to the strength of the economy not only on a firm level, but also for consumers, especially during recessions, working through leverage levels (Bernanke, 1981). Increased leverage ties up more firm or consumer spending, thus reducing liquidity. As such, we can apply Bernanke, Gertler and Gilchrist’s (1996) concept of “flight to quality” to liquidity concerns as well – investors are likely to prefer highly liquid firms in times of recession. Recession, by reducing demand and cash flow to firms and household, also exasperates the troubles of firms with liquidity constraints and challenges, and as such it is an important determinant of performance during recession.

We control for this effect also. There are two main ratios that are commonly used to assess a firm’s liquidity: the current ratio and the cash ratio. After testing these in our regressions, cash ratio seemed more appropriate, providing the highest explanatory power of our models and being significant more often than the current ratio.

$$Cash\ Holdings\ Ratio = \frac{Cash}{Total\ Assets}$$

Proportion of Fixed Assets:

A firm's proportion of fixed assets, though expected to vary highly with industry, may be indicative of its financial stability. A fixed asset takes more than one year to organically convert into cash (Ross, Westerfield, Jordan & Roberts, 2010). The proportion of fixed assets is a measure of the percentage of long-lived or capital assets a firm has. Firms with high proportions of fixed assets may have several advantages. First, fixed assets can be collateral for a firm's debt. This can reduce the cost of debt for the firm due to increased security in the debt (or indeed allow the firm to obtain financing in the first place) (Ross et al., 2010), and may increase the debt capacity of the firm (Drobetz & Fix, 2003). This may mean that a higher proportion of fixed assets will make a firm more attractive to investors in recessions, consistent with the Bernanke et al. (1993) idea of "flight to quality." Additionally, a firm's chosen (or optimal) level of leverage may directly increase with its proportion of fixed assets (Harris & Raviv, 1991; in Drobetz & Fix, 2003). We initially control for this variable to evaluate its importance, though we expect significant correlation with leverage and liquidity measures.

$$Proportion\ of\ Fixed\ Assets = \frac{Fixed\ Assets}{Total\ Assets}$$

Industry Dummy:

In addition to the above variables, we include an industry dummy. This is done to ensure that our model captures any industry-level effects, thus providing the best possible estimate of our focus variables' effect on firm performance. With this indicator variable, we account for, insofar as possible, any potential industry-level omitted variable bias that might interfere with the veracity our model and the validity of the results. We measure industry in the dataset by the two-digit NACE codes.

$$Industry\ Dummy_j = \left[1_{\ Industry\ =\ j}\ or\ 0_{\ Industry\ \neq\ j}\right]$$

Prior Innovation

In our CIS 2008 to 2010 datasets, we would prefer to isolate the effects of innovation to activities performed in the relevant time period by controlling for innovation activities from the CIS 2006 to 2008 dataset. However, this variable proved not statistically significant and to have minimal impact on the explanatory power of our models. Thus, after testing for relevance, we chose to omit this variable.

3.3.3 Treatment of Data Outliers

Outliers are extraordinarily influential observations that have the potential to greatly affect regression results. These observations are especially impactful in an ordinary least squares regression as they are allocated disproportionate weight in the OLS method (Wooldridge, 2010). An observation can be defined as an outlier when its omission substantially impacts regression results. While outliers can occur both as a result of erroneous data and unusual observations, we lack the information to determine whether observations in our datasets are erroneous. Thus we will treat outliers as correct, but unusual observations. Omitting such variables is not without its problems as extreme observations can provide valuable information regarding the variation of the independent variables (Wooldridge, 2010). Outliers can, however, cause violations of the normality criteria for regressions (Keller, 2009).

The selection of outliers to be omitted can be done either by determining our own selection criteria or by utilizing established statistical techniques. As we lack the required expertise and experience to develop our own selection criteria, we will be using the known techniques of Cook's distance and Leverage. Further, we will exclude observations with a standard deviation further than 2 from the mean.

Cook's Distance and Leverage

Cook's distance is a measure of the influence of observations, broadly used in least squares regression analysis. It measures the change in the regression coefficients that take place if an observation is emitted (Field, 2009). There are differing opinions as to the threshold for exclusion. Hamilton (1992) defines influential observation as those with a Cook's Distance value exceeding 4/N, where N is the number of observations in the dataset, while Cook and Weisberg (1982) and Tabachnick and Fidell (2005) argues that all values above 1 should be investigated. In our analysis, we choose to follow the original author of the method, Cook, as well as Weisberg, Tabachnik and Fidell in choosing a threshold of 1. This has the added benefit of removing fewer cases from the sample.

Leverage is another measure of the potential influence of observations. However, the Leverage method focuses on observations with an unusual combination of values among the independent variables. Thus, we argue that it complements Cook's distance well, as utilizing both methods enable us to identify both extreme and unusual observations. As with Cook's Distance, there are differing opinions regarding the threshold. Huber (1981) recommends avoiding observations with a Leverage value above 0.5, while Hamilton (1992) states that values above 0,2 should be avoided. We will be using 0.5 as our leverage threshold, in order to remove as few as possible observations.

Standard Deviation Trimming

After trimming the dataset according to the criteria of the above mentioned Cook's Distance and Leverage, we initially intended to exclude observations with a standard deviation further than 3 from the mean, as this is a common method for removing outliers. However, this is a dataset with a relatively large number of observations outside of the threshold of 3 standard deviations, and such a method would result in removing some 300 or 400 observations per dataset. As such, this common method would not be removing outliers, but significant portions of the dataset.

In the end, we therefore decided to exclude outliers solely based on Cook's Distance and Leverage. This ended up removing between 0 and 5 observations per dataset, well within acceptable limits for number of cases trimmed on datasets with over several thousand observations in each.

3.4 Data Concerns, Validity and Reliability

As with any dataset, there are a number of concerns and limitations surrounding it, which may impact the validity and reliability of our study. Here, we first look at the concerns surrounding our two datasets, and then the way the structure and type of data limits what we are able to accomplish in our thesis. We then discuss the validity and reliability of our model and thesis.

3.4.1 Data Concerns

The CIS dataset is a survey distributed by the SSB (Norwegian Bureau of Statistics), using the existing OECD and Eurostat best practices for measuring innovation and using surveys. Combined with the very high response rate, the dataset seems to be of very high quality.

Similarly, the SNF accounting dataset is widely considered the best source of accounting data for Norwegian firms for research purposes. That being said, there are a number of potential biases to be aware of.

The survey is distributed during the final year in the CIS time period, and is inherently retrospective. As such, it is dependent on both the memory of the respondent, as well as that respondent's complete knowledge about the firm's innovation activities. This creates a potential respondent memory bias. However, under the assumption that the respondents are highly knowledgeable of the firm's activities during the time period, and that most innovation activities are significant events that are easy to remember, we do not presume this to be a major problem. Further, any potential memory bias is unlikely to exhibit any particular pattern or occur in any systemic way, and will therefore most likely occur as a random error in our model.

There is also the potential for common method or single-respondent bias. The person answering the survey may want to answer in a way that makes their firm look good based on social pressures. This would create a potential bias in the data. Further, respondents may interpret the definitions used in the questions in the survey differently. However, the CIS explains the definition of various types of innovation in the survey, and we therefore conclude that this type of bias has been efficiently minimized. Any respondent bias as outlined above is unlikely to have any type of discernible pattern, so we assume that any bias here will also be randomly distributed and captured by the error term of our model.

Additionally, there is a concern about survivor bias. As the CIS questionnaires are distributed at the end of the three-year period, they can only be distributed to those firms that have survived those three years. As such, there is a survivor bias, particularly salient for CIS 2010, as recessions tend to increase the number and likelihood of bankruptcies. Another survivor bias emerges as a result of our control variables, as only firms with prior profitability carry over to the dataset for the next year. This reduces the sample size for our CIS 2008 to 2010 datasets significantly, though not enough to impact statistical significance. The direction of these potential biases on our results are uncertain.

A final concern is regarding the SNF accounting dataset. This is the most complete accounting dataset available for all Norwegian firms during the time period. Though we have no reason to doubt the integrity of the data collected, we do note that accounting figures are not necessarily an accurate reflection of a firm's financial position and performance. This is due to a susceptibility to being manipulated by accounting firms for motives such as tax effects, concealing competitive information. This is especially true for publically listed firms. Again, we do not believe any such bias will behave in a systematic way, and presume it to be captured by the error term of our model.

3.4.2 Data Limitations

The CIS dataset is primarily a series of Yes/No answers to questions about innovation activities over a three-year period. This poses several challenges.

One is that it makes it difficult for our study to conclude anything about degree of innovativeness of the firms we investigate, and as such seems to limit us to the innovator / non-innovator dichotomy common in the literature. This is true both for innovativeness in general as measured by the entire survey, but also the amount of a particular innovation activity as measured by a single question. A firm that introduced a single market innovation will show up in the dataset in the same way as a firm that introduced five, or ten. Similarly, drawing on existing literature focusing on separating incremental, radical, and architectural innovations (Henderson & Clark, 1990), the CIS data does not allow us to do that, and in this way contribute to that area of the innovation literature.

Further, there is no way to identify the timing of the innovation activity within the three years the CIS considers. This creates some potential limitations and concerns with regards to a time-lagged regression model, such as the one we propose. We are thus unable to identify what the correct lag period is for innovation to have the maximum effect on performance. In addition, we are unable to analyse performance concurrent with the innovation activities (e.g. innovation activities in 2009 with performance in 2009) on a year-by-year. In a similar vein on timing of impact and activities, we have no way of ascertaining when the various firms were hit by the recession. From Lien and Knudsen (2012), we know that there was a high degree of variation regarding the self-reported timing of recession impact among Norwegian forms, which further compounds this timing problem.

Additionally, there are some overlap in the CIS data. The surveys consider a three-year-period, but is distributed bi-annually. As a result, a firm performing a single innovation activity in 2008 may show up as an innovator in our datasets for both 2006 to 2008 and 2008 to 2010. This complicates the comparison of our results from the two time periods.

As our study is not a sophisticated time series analysis, but rather independent analyses of datasets matching financial and innovation data over different time periods, year-effects are not considered. Including year effects would enhance the strength of our results, as year-effects have been shown to have an influence on firm performance (Porter & McGahan, 2002).

The CIS also strictly considers discrete innovation activities within a number of different categories, frequently with many activities in the same category. This makes it challenging to classify firms according to either their degree of innovativeness, or, indeed, to create a clear-cut distinction between innovators and non-innovators.

SSB has distributed the CIS questionnaire together with the biannual R&D survey of Norwegian businesses between 2001 and 2012. Due to an interaction effects between these two surveys, SSB has decided to distribute these surveys separately from 2013 onwards. As such, there is a break in the datasets of SSB, making direct comparisons across years potentially difficult for future studies. That being said, there are no indications that the CIS questions will change. As such, we do not presume this to be a major problem preventing comparisons, but we highlight this change in data collection methodology for the benefit of future studies and comparisons of results.

Prior studies have found significant country effects of innovation, based in part on their national systems of innovation (Filippetti & Archibugi, 2011; Walker et al., 2015). As this thesis only considers Norwegian firms, such country effects are impossible to adjust for. Comparisons with similar analyses of innovation activities among firms in other countries may therefore be limited.

Further, based on the significant industry effects found by Coad and Rao (2008) and Walker et al. (2015), we use NACE industry classification codes to adjust for this effect. Unfortunately, the NACE industry codes can be quite broad and may not neatly distinguish between firms that differ greatly in their operation, or on the other hand divide up firms with similar operating characteristics and drivers into different industries. Some of these industries will also have very few firms in them, potentially lowering the statistical validity of measured industry effects. As such, we note that the industry classification used in our study is far from perfect, but we are fairly certain that any adverse effects resulting from the use of NACE industry codes will be randomly distributed, and largely inconsequential for the results we arrive at in this study.

Finally, we were unable to obtain accounting data for 2007 that we could match to the CIS dataset. Ideally, 2007 would be our base year for financial data, providing the numbers for industry and firm profitability, as well as other control variables for our model. Though it is unlikely to gravely affect the results we generate, we note that using 2008 as the base year is sub-optimal from a model point of view.

3.4.3 Validity and Reliability

Assessing the quality of a study, and thus if stated results will stand up to scrutiny, is a difficult yet important task. In this section, we aim to minimize the probability of drawing wrongful conclusions by evaluating our thesis, using four commonly used determinants of the credibility of empirical social studies: construct validity, internal validity, external validity and reliability (Yin, 2013).

Construct Validity:

Construct validity refers to establishing correct operational measures for the concepts being studied. This is particularly relevant to our study, as our constructs for innovation has certain limitations.

For measuring firm performance, we use the tried and tested performance variables of ROA and EBITDA margin. This accurately captures the operating efficiency of the firm, especially when applying industry-adjustments and controls. Additionally, we use sales growth as our third dependent variable. The thesis here is that innovation activities may help drive future sales growth. Though these variables are commonly accepted and widely used in the innovation and performance literature, its use is not without criticism. Using aggregates of all firm activities (such as ROA or EBITDA margin) to measure effects of specific activities (such as process innovation) has received some criticism, as the effect of such specific activities may be hard to isolate (Klingenberg et al., 2013). This criticism, however, could be levelled at any empirical study with respect to determinants of firm performance. As the criticism is, in essence, the definition of the omitted variable bias, it is also the reason for our inclusion of a variety of control variables, as well as significant time and space in this thesis devoted to the discussion of determinants of corporate performance other than innovation. We are confident that such aggregate measures of firm activity, once we control for known determinants of performance, will still yield solid and highly valid estimates of the effects of innovation on firm performance.

As with other studies, we first categorise firms into innovators and non-innovators, and this is easy to do with a high degree of validity given our dataset. However, we would also like to measure the degree of innovativeness of the firms in our dataset. Creating such a measure for firm innovativeness is difficult. Our approximation, as discussed in the previous section, is using the number of types of innovation and Yes answers in those sections of the questionnaire. We weight these questions so that each type of innovation carries the same importance. Then we divide the innovating firms into quartiles of innovators – in other words, the top 25% of firms who innovate the most, the second quartile of innovators, third, and fourth quartile of innovators. With these dummy variables, we are able to easily classify firms according to their degree of innovation. There is however, an issue regarding that, as many firms have the same innovation score, quartiles are not exactly 25 % divisions of innovators (see Table 4, descriptives), but we consider our approximation to be close enough. Finally, we consider the effect of different types of innovation. As with innovators and non-innovators, this is an easy and reliable dummy variable to construct given our dataset, though it does not capture several instances of the same type of innovation during the CIS time period.

Internal Validity:

Internal validity concerns the establishments of causal relationships. When running regressions, we need to ascertain whether the relationship between two variables is causal or simply correlated. As our regression is based on time-lagged secondary financial data, and the relatively extensive CIS survey, we can be confident that the causality of the model is not opposite. As was mentioned in our Innovation Theory section, there is a simultaneity issue, in that it is very difficult to determine whether innovating firms perform better, or whether high-performing firms innovate more. However, with our time-lagged model, we can be relatively confident in the direction of the causality, and that our model provides the best estimates possible. In order to further ensure that there exists no multicollinearity between the independent variables that could jeopardise the validity of our findings, we run a correlation analysis to ensure that all variables can be included in the same models. This further strengthens the validity of our model.

Another concern is whether we are including all the relevant independent variables in our model. Omitting a moderating variable could have grave implications for the validity of our causality statements. To address this issue, we have made extensive use of existing literature to identify and account for all well-known relevant variables that could have a moderating effect on firm performance.

That being said, firm response to the crisis is an important variable we would like to control for, but are unable to due to the limitations of our data. Any such response would be more likely to reduce the effect of the crisis. As we have no way of controlling for firm response, this is a missing variable that we expect to have an impact on the firm performance during recession.

Further, firms that perform innovation activities may experience decreased performance during the year(s) during which the innovation activity is undertaken. This is due to the investments necessary in order to complete innovation activities. Such investments may be reduced as a firm response during recessionary times, however, and this may give our estimate of innovation effect an upward bias.

External Validity:

External validity relates to whether the findings of our study can be generalized. Due to the varying nature of recessions discussed in the theory section, the generalizability to other recessions is debatable, as they can originate from different sources, and manifest themselves in different ways. However, we believe the findings to be relatively valid for other recessions as well, and perhaps also for other negative economic shocks to firm performance.

Further, as Lien and Knudsen (2012) notes, Norway was hit relatively less by the recession than many other countries. As such, the effect of innovation during recession may be more pronounced, or more subdued, when compared to innovation effects for more severe recessions.

Additionally, earlier studies identified considerable country effects when measuring the effect of innovation on firm performance. Aas and Pedersen (2011), referring to the work of Hall and Soskice (2001), argued that Norway can be considered a coordinated market economy. As such, it provides better opportunities for incremental than radical innovation relative to liberal market economies. Thus, the innovation activities we observe may be more incremental in nature than similar studies conducted on liberal market economies.

Though there are some concerns regarding the external validity of our study, we do believe our findings can be generalized to most firms and market economies.

Reliability:

Reliability refers to the replicability of our findings. In other words, it relates to whether our data collection techniques and analysis procedures will yield consistent findings (Easterby-Smith, Thorpe, Jackson & Lowe, 2008; in Saunders et al., 2009). Saunders et al. (2009) outlines four threats to the reliability of a study (Robson, 2002; in Saunders et al., 2009): subject error, subject bias, observer error, and observer bias.

For our SNF accounting data, we find that there may be subject error, as the accounting data may have been reported differently or erroneously by the firms. Further, there is some subject bias in accounting data may be misrepresented for a variety of different incentives, including stock price performance and more. The incentive to embellish accounting data may also be greater during recessionary times, as every management decision is under close scrutiny by investors. However, we believe there to be a low degree of observer error (as the forms are standardised, structured and rule-bound), and low observer bias, as the interpretations of accounting data is well-known and a fairly standardised process.

For our CIS data, we again believe there to be the potential for both subject error (due to different interpretations and understanding of the innovation definitions) and subject bias (memory bias or knowledge gaps may exist, and respondents may be incentivised to report what would be considered favourable for the firm). As with the SNF accounting data, the structure and standardisation of the CIS questionnaire makes us confident in a low degree of observer error, and the responses are all Yes/No answers, which we are fairly certain in our ability to interpret without bias. Thus, we consider the reliability of our thesis to be high.

3.5 Empirical Method

In this section, we will put forth the statistical analysis techniques we intend to use in order to assess the effect of innovation on firm performance during recessions. First, we will present theory on ordinary least squares (OLS) regressions and multiple linear regressions. The theory in this section comes from Woolridge (2010), unless otherwise stated. For our analysis, we will be using SPSS statistical software.

3.5.1 Regression Analysis

Simply put, a regression analysis asks the question "What happens to variable Y when I change variable X?" The variable Y is referred to as the dependent or response variable, whereas X is referred to as the independent, predictor or explanatory variable.

Though the answer to that question is rarely straightforward, an OLS regression analysis finds the line of best fit given a dataset for the values of Y for given levels of X, and gives us a good indication of a linear relationship between the two variables. This line of best fit is determined by minimising the sum of squared distances between the regression line (predicted variables) and the actual dataset in its simplest form, a regression analysis takes the form of the following linear algebraic equation:

$$\hat{y} = \beta_0 + \beta_1 x + \varepsilon$$

Here, $\hat{y}$ is the predicted value of Y given by the model, β_0 is a constant, β_1, called the variable beta, is the size effect of X on Y, x is the size or level of the independent variable, and ε is the error term – that is, the part of changes in Y that the regression model is unable to explain on the basis of the chosen independent variable(s). This model can be expanded by any number of variables that could feasibly contribute to predicting the value of Y. In this case, these variables each get a separate beta, and the formal regression equation looks as follows:

$$\hat{y} = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \dots + \beta_{n-1} x_{n-1} + \beta_n x_n + \varepsilon$$

This, then, is a multiple linear regression model. Quite simply, each beta measures the effect of a change to that variable, given that all the other variables remain constant. In our analysis, this is superior to the simple OLS regression, as we wish to examine and control for other the effects of other variables we know from the theory that affects firm performance.

3.5.2 Criteria for an Unbiased OLS Regression

A regression analysis can technically be run on any dataset. However, there are several properties of datasets that may bias the regression output, meaning that the regression results are less likely to be a representation of the relationships between the variables in the actual population, as opposed to the sample contained in the dataset. There are five core assumptions that are necessary in order to get an unbiased regression, whether it is an OLS or a multiple regression analysis. Listed below, these are collectively referred to as the Gauss-Markov assumptions.

Assumption 1: The model is linear in its parameters (variables).

Assumption 2: The dataset is based on a random sampling of the population.

Assumption 3: There is no perfect collinearity between the independent variables, and none of them may be a constant.

Assumption 4: The error term has an expected value of zero.

Assumption 5: The error term has equal variance for all values of the independent variables (homoscedasticity).

So given these assumptions, what areas might pose challenges for our thesis?

One key area is endogeneity issues affecting the assumption regarding a zero-mean error term. Here, there are several potential biases. One is the omitted variable bias. We do not believe this to be a problem for our thesis, as we include most variables known to affect company performance based on our extensive literature review. Another potential bias is the simultaneity bias. This becomes a problem when trying to regress two simultaneously determined variables on each other. In this case, it is impossible to say anything about which variable is the causal variable. However, due to our time-lagged explanatory variables regressed on past innovation activities, with clear time-based direction, this is unlikely to be a problem. Finally, multicollinearity between the independent variables can bias the error term, violating the fourth assumption. Therefore, we intend to perform correlation analyses between our independent variables, and make any adjustments necessary to our model to minimise any problems multicollinearity may cause.

The final challenge may be heteroscedasticity in the error term of the independent variables. In order to deal with this potential problem, we use SPSS to first test our model for heteroscedasticity. Should we find this to be present, we will construct heteroscedasticity-robust standard errors in order to estimate the t-statistics and p-values for the beta estimates of our model. Using this method will ensure our results are valid even in the presence of heteroscedasticity.

As such, though there are potential challenges that could bias our regression results, we are dealing with those potential issues in an appropriate manner to ensure the integrity and robustness of our final results and output.

Now that we have thoroughly outlined our methodology, we move on to the analysis of our data and the results of our model.

3.5.3 Heteroskedasticity

After examining scatterplots of our variables, we performed a Breusch-Pagan Test and a Koenker test to test for statistically significant heteroskedasticity. As there are no standard functions for these tests in SPSS, we used a macro made available by Garcia-Granero (2002) (see Appendix 3). The Breusch-Pagan test regresses squared residuals on the independent variables and returns a p-value that, if below the chosen significance level, allow us to reject the null hypothesis of homoskedasticity. The Koenker test is more appropriate for smaller sample sizes, but is an added benefit of Garcia-Granero's macro, and largely yields results consistent with the Breusch-Pagan test. Our tests showed statistically significant heteroscedasticity in all datasetss. As a result, the standard errors in our OLS regression will likely be biased. To account for this, we will employ a heteroskedasticity-consistent standard error (HCSE) estimator of OLS parameter estimates (Hinkley, 1997; Long & Erwin, 2000; MacKinnon & White, 1985; in Hayes & Cai, 2007)

In the HCSE estimator approach, the regression model is estimated using OLS, but the standard errors are estimated in a method that does not assume homoskedasticity. While several SCSE estimators have been proposed over the last 30 years, the method commonly referred to as HC3 is often found to be the most accurate (MacKinnon & White, 1985; Hayes & Cai 2007; Cribari-Neto, Ferrari & Oliveira, 2005). The HC3 method can however, have a liberal bias in very small samples (Long & Ervin, 2000; Sudmant & Kennedy; in Hayes & Cai, 2007). For a detailed description of the HC3 approach, and others, see MacKinnon & White (1985).

As our sample is sufficiently large, we will be using the HC3 method in our analysis. Again, this is not possible using the standard features of SPSS, but Hayes & Cai conveniently published a SPSS macro for different HCSE estimators in their 2007 paper. We will use this macro in our regressions (see Appendix 3).

4. Analysis

As we now have established the theoretical background for our hypotheses development, as well as the appropriate research design and methodology, we turn to the specification of our model and the results of our analysis. In this section, we first present the model specification, then the descriptive statistics for our variables of interest, before turning to the results of our regression models, and whether these results provide support for our hypotheses and overall research question.

4.1 Specification of the Regression Model

We now specify the regression models we intend to run in order to investigate our hypotheses. Our hypotheses are proposed over different time periods. Similarly, the regressions will be run over those time periods. Further details on the chosen regression variables and functional relationships can be found in section 3.3 of our thesis.

The full specification of our model is as follows:

$$Firm\ Performance_{Y1-3,\ t+1} = \beta_0 + \beta_1 Innovation_{t-1} + \beta_2 Firm\ Leverage_{t+1} + \beta_3 Firm\ Leverage^2_{t+1} + \beta_4 Firm\ Liquidity_{t+1} + \beta_5 Firm\ Size_{t+1} + \beta_6 Proportion\ of\ Fixed\ Assets_{t+1} + \beta_7 Prior\ Performance_t + \beta_8 Industry\ Dummy + \varepsilon$$

The innovation variable will vary with our hypothesis, as previously outlined. However, our controls and other independent variables will remain constant across the hypotheses. We note here that for regressions using 2008 and 2009 SNF data, we are unable to control for prior sales growth. For our CIS2006-2008 regression on SNF 2008 data, we are also unable to include prior profitability.

For abbreviation, further specifications will refer to $\beta_2 - \beta_8$ simply as the *Control Variables.*

H1: Innovators will outperform non-innovators during and after a recession.

This hypothesis concerns itself with the binary innovators versus non-innovators dichotomy well known from existing innovation literature. As such, this regression analysis will define its focus variable as a dummy variable for innovation activities during the previous CIS time period.

$$Firm\ Performance_{Y1-3,\ t+1} = \beta_0 + \beta_1 InnovationDummy_{Yes/No,\ t-1} + [Control\,Variables] + \varepsilon$$

This will yield results that will either to corroborate or contradict existing literature on the performance of innovative versus non-innovative firms.

H2: More innovative firms will outperform less innovative firms during and after recessions.

Our second hypothesis concerns itself with degree of innovativeness. For this purpose, we create additional dummy variables based on the CIS responses that indicate the quartile of innovation activity a firm belongs to. We define the first quartile as the 25% of innovating firms who perform the most innovation activities, followed by the second, third, and fourth (and bottom) quartile. This allows us to say something about the degree of innovativeness of each firm during the CIS period. Our regression model then looks very similar to the one above, except using a dummy variable for each quartile of innovation activity.

$$Firm\ Performance_{Y1-3,\ t+1} = \beta_0 + \beta_{1-4} Innovation\ Quartile\ Dummy_{Q1-4,\ t-1} + [Control\,Variables] + \varepsilon$$

The first model will investigate whether the innovation quartile of a firm similarly matters for performance (indicated in the above specification by the Q4, Q3, Q2 and Q1 subscripts, indicating the fourth, third, second and first quartile, respectively). These model will indicate whether there is merit to pursuing innovation across multiple areas simultaneously in order to improve firm performance.

Type of Innovation and Firm Performance

The final exploratory piece of analysis concerns itself with the relative effect of the different innovation types outlined in the Oslo Manual. This model uses a dummy for each of the four types of innovation.

$$Firm\ Performance_{Y1-3,\ t+1} = \beta_0 + \beta_1 Product\ Innovation\ Dummy_{t-1} + \beta_2 Process\ Innovation\ Dummy_{t-1} + \beta_3 Market\ Innovation\ Dummy_{t-1} + \beta_4 Organisational\ Innovation\ Dummy_{t-1} + [Control\ Variables]_{t+1} + \varepsilon$$

This will allow us to determine whether certain types of innovation produce better results than others.

With these models, we are confident in our ability to provide robust results that contribute to the innovation literature, in particular during financial crises and recessions.

Though we expect to see some effect by type of innovation, it is uncertain how this effect will change through the different parts of the business cycle, which is what the above hypotheses attempt to determine.

In addition to the hypotheses outlined above, based on our literature review, we expect to find the following relationships in the data:

Prior profitability will be positively related to firm performance during the period of study.

Prior sales growth will be negatively related to firm performance during the recession.

Firm leverage will be negatively related to firm performance during the recession.

Firm size will be positively related to firm performance during the recession.

Liquidity will be positively related to firm performance during the recession.

Proportion of fixed assets will be positively related to firm performance during the recession.

4.2 Descriptive Statistics

In order to provide improved context to our results, we first look at how firm performance has developed throughout the crisis in Norway. Drawing on previous theory of business cycles and recessions, we can see how Norway's economy, as measured in real GDP and real GDP growth, developed between 2002 and 2012.

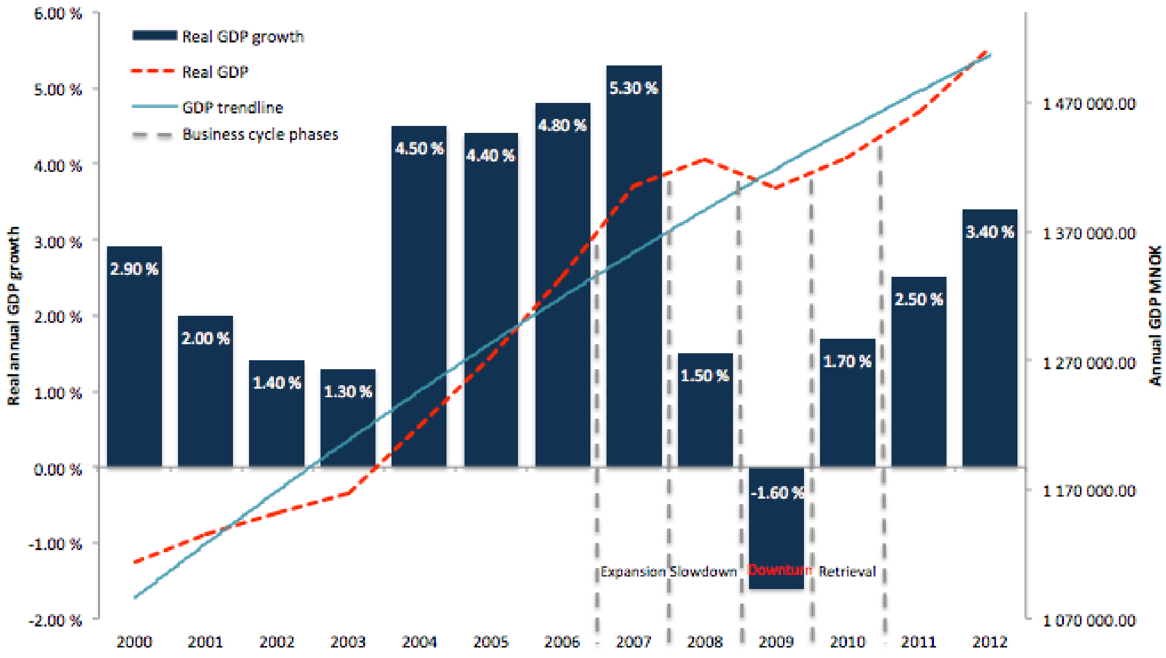

Figure 7: Norwegian GDP 2000 to 2012 (Brynhildsrud, 2013)

Recalling the impact of the recession on the Norwegian economy, we see a significant decline in GDP growth during 2008 and 2009, before returning to slowly increasing economic performance during 2010, 2011 and 2012. Now, we have a contextual lens through which to view the descriptive statistics of our datasets.

The dependent performance variables are perhaps most related to the above graph. Looking at Figure 8, we get an overview of how the data indicate that firm ROA figures, and EBITDA margins changed over the course of the recession.

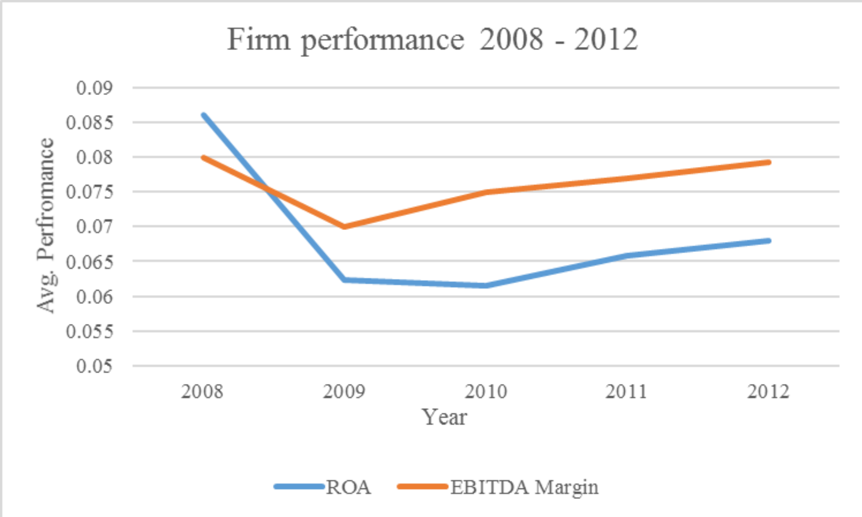

Figure 8: Firm performance 2008-2012

As one might expect, these figures follow the data from SSB closely. The impact of the financial crisis on the financial performance of Norwegian firms is quite clear.

Next, we look at our sample of Norweian firms, and their innovation activity before and during the crisis:

	CIS 06-08		CIS 08-10	
Innovators	2322	43.60%	1385	50.18%
Innovation Degree				
Quartile 1	512	22.05%	344	24.84%
Quartile 2	473	20.37%	316	22.82%
Quartile 3	548	23.60%	306	22.09%
Quartile 4	789	33.98%	419	30.25%
Innovation Type				
Product	1367	25.67%	842	30.51%
Process	1109	20.82%	584	21.16%
Market	984	18.48%	680	24.64%
Organisation	1022	19.19%	695	25.18%
Sample size	5326	5326	2760	2760

Table 4: Innovation activity of sample

The percentage of firm's innovating, seems to rise significally over the time period. Innovating firms also seem to increase their innovation activity, as the percentage of firm in the highest quartile of innovators increases. Process innovations experiences the least growth of the four tupes of innovation in the survey.

4.3 Analysis Results

Beyond the full-specification models outlined above, we intend to run a number of regressions with the goal of viewing how the explanatory power of the model, as measured by its adjusted R^2, changes with the inclusion of the innovation variable for each regression. We define the models as follows:

(1) Control Model:

$$Firm\,Performance_{Y1-3,\ t+1} = \beta_0 + [Control\,Variables]_{t+1} + \varepsilon$$

(2) Innovators versus Non-Innovators:

$$Firm\,Performance_{Y1-3,\ t+1} = \beta_0 + \beta_1 InnovationDummy_{Yes/No} + [Control\,Variables]_{t+1} + \varepsilon$$

(3) Degree of Innovation:

$$Firm\,Performance_{Y1-3,\ t+1} = \beta_0 + \beta_{1-4} Innovation\,Quartile\,Dummy_{Q1-4,\ t-1} + [Control\,Variables]_{t+1} + \varepsilon$$

(4) Type of Innovation:

$$Firm\,Performance_{Y1-3,\ t+1} = \beta_0 + Innovation\,Type\,Dummy + [Control\,Variables]_{t+1} + \varepsilon$$

Model 2 is concerned with Hypothesis 1, Model 3 with Hypothesis 2, and Model 4 with our exploratory investigation of innovation type and its effect on firm performance. We note that we initially included prior innovation activity from the CIS 2006-2008 dataset as a control for the regressions using the CIS 2008-2010 dataset, though we never found this to be a statistically significant control that affected the explanatory power of the model, and have therefore omitted it from the analysis presented in this thesis. Additionally, our sales growth model consistently had very weak explanatory power as measured by R^2, and as such we do not present the regression output for these models unless important statistically significant findings are reported by the model. The full regression output of all our models can be found in the Appendix 1.

With our model specifications in place, we turn to look at the different CIS datasets and regression results, and look first at our pre-recession innovation activity and its impact on firm performance during the recession.

4.3.1 Pre-Recession Innovation and Firm Performance During Recessions

We first look at the effect of pre-recession innovation activities on firm performance during recessions, using the CIS 2006-2008 survey and accounting data from 2008, 2009 and 2010. The regression results can be seen in Table 5.

CIS 2006-2008: CONTROLS ONLY

	ROA			EBITDA Margin		
	2008	2009	2010	2008	2009	2010
Control Variables						
Leverage	0.302***	0.445***	0.271***	0.302***	0.161***	0.061
	(3.843)	(6.995)	(4.800)	(3.843)	(3.526)	(1.239)
Leverage^2	-0.277***	-0.390***	-0.256***	-0.277***	-0.137***	-0.081**
	(-4.822)	(-7.999)	(-5.510)	(-4.822)	(-4.171)	(-2.277)
Liquidity	0.166***	0.127***	0.107***	0.166***	0.074***	0.068***
	(12.729)	(9.068)	(8.430)	(12.729)	(7.104)	(5.156)
Size	0.009***	0.009**	0.010***	0.009***	0.009***	0.004***
	(5.816)	(6.883)	(6.820)	(5.816)	(6.239)	(2.804)
Proportion of Fixed Assets	0.065***	-0.021**	-0.030***	0.065***	0.034***	0.034***
	(4.615)	(-2.185)	(-3.138)	(4.615)	(3.0739	(2.888)
Prior Performance (Sales Growth)	-	0.325***	0.357***	-	0.581***	0.609***
		(11.958)	(12.439)		(18.648)	(20.400)
Constant	-0.217***	-0.261***	-0.227**	-0.217***	-0.192***	-0.090
	(-5.943)	(-7.444)	(-2.348)	(-5.943)	(-5.791)	(-0.513)
Industry Dummy	Yes	Yes	Yes	Yes	Yes	Yes
Observations	5326	5093	4874	5326	5093	4874
R-Square	0.172	0.275	0.276	0.172	0.447	0.454
F-value	13.866	17.009	17.408	13.866	35.739	34.771

*Note: *** p < 0.01, ** p < 0.05, * p <0.10. Robust standard errors in brackets.*

Table 5: CIS 2006-2008, SNF 2008-2010 Regression results - Controls

CIS 2006-2008: INNOVATORS VERSUS NON-INNOVATORS

	ROA			EBITDA Margin		
	2008	2009	2010	2008	2009	2010
Focus Variable						
Innovation Dummy 2006-2008	-0.018***	-0.009**	-0.004	-0.016***	-0.005	0.001
	(-4.588)	(-2.335)	(-1.029)	(-3.958)	(-1.587)	(0.248)
Control Variables						
Leverage	0.485***	0.446***	0.271***	0.303***	0.162***	0.062
	(7.660)	(7.017)	(4.810)	(3.853)	(3.5439	(1.241)
Leverage^2	-0.443***	-0.391***	-0.256***	-0.277***	-0.137***	-0.081**
	(-9.488)	(-8.021)	(-5.521)	(-4.838)	(-4.189)	(-2.280)
Liquidity	0.204***	0.127***	0.106***	0.164***	0.074***	0.068***
	(15.778)	(9.027)	(8.386)	(12.643)	(7.071)	(5.135)
Size	0.008***	0.010***	0.010***	0.010***	0.009***	0.005***
	(5.376)	(7.182)	(6.842)	(6.178)	(6.364)	(2.785)
Proportion of Fixed Assets	-0.048***	-0.021**	-0.030***	0.065***	0.034***	0.034***
	(-4.749)	(-2.159)	(-3.123)	(4.725)	(3.091)	(2.896)
Prior Performance	-	0.324***	0.357***	-	0.580***	0.609***
		(11.891)	(12.420)		(18.605)	(20.394)
Constant	-0.187***	-0.265***	-0.230**	-0.254***	-0.195***	-0.091
	(-5.628)	(-7.540)	(-2.387)	(-6.292)	(-5.823)	(-0.516)
Industry Dummy	Yes	Yes	Yes	Yes	Yes	Yes
Observations	5326	5093	4874	5326	5093	4874
R-Square	0.202	0.276	0.276	0.174	0.447	0.454
F-value	18.497	16.761	17.193	13.638	35.304	34.328

*Note: *** p < 0.01, ** p < 0.05, * p <0.10. Robust standard errors in brackets.*

Table 6: CIS 2006-2008, SNF 2008-2010 - Regression results: Innovation dummy

From model (1), the control variables alone provide good explanatory power with an R^2 hovering around 27-28% for the ROA model, 44-45% for EBITDA model, and around 2-3% for the sales growth (SAGR) model. The jump in explanatory power from 2008 to 2009 is of course due to adding prior performance as a control variable.

Adding the binary innovation dummy, shown in Table 6, we see only a small increase in explanatory power of around 0.1%. As this change in explanatory power is so small (this very small change in R^2 is consistent for the other models in our analysis) we naturally questioned whether the change in R^2 had statistical significance. A variable may have a statistically significant coefficient, but the change in explanatory power may not be significant. In order to test this, we used SPSS to run a stepwise regression model, analysing the statistical significance of the change in R^2. We note here that in order to run the stepwise regression, we have to use the native OLS estimators in SPSS, as our heteroskedasticity-consistent regression model macros do not allow for stepwise regressions. Though this may lead to some hetereoskedasticity-based bias, we consistently found that if the innovation variable was statistically significant in the heteroskedasticity-consistent regression models (whether innovation dummy, quartile, or type), then the change in explanatory power was found to be statistically significant in the stepwise OLS regression. As such, we are confident that the coefficients and effects presented in this analysis are true and statistically relevant, despite providing only small changes in the models' explanatory power.

Now that we have established the statistical validity and importance of our findings despite the seemingly small change in R^2, we turn to the results of our regression. In Table 6, we find that the innovation dummy is actually negative, and heavily significant for both ROA and EBITDA models in 2008 and for the ROA model 2009. These regressions therefore not only find no support for the hypotheses of H1a) and H2a), but suggests the literal opposite with strong statistical significance. As for sales growth, innovation was not a statistically significant explanatory variable. We now move onto model (3), shown in Table 7.

CIS 2006-2008: DEGREE OF INNOVATION

	ROA			EBITDA Margin		
	2008	2009	2010	2008	2009	2010
Focus Variable						
Innovation Dummy 2006-2008						
1st Quartile	-0.030***	-0.009	-0.014**	-0.036***	-0.004	-0.011
	(-4.263)	(-1.370)	(-2.192)	(-4.568)	(-0.713)	(-1.606)
2nd Quartile	-0.019***	-0.004	-0.005	-0.022***	-0.004	-0.007
	(-2.606)	(-0.621)	(-0.869)	(-3.101)	(-0.634)	(-1.216)
3rd Quartile	-0.014**	-0.014**	-0.005	-0.015**	-0.009	-0.002
	(-2.259)	(-2.185)	(-0.903)	(-2.146)	(-1.479)	(-0.416)
4th Quartile	-0.014**	-0.007	0.003	-0.003	-0.003	0.009**
	(-2.444)	(-1.462)	(0.622)	(-0.603)	(-0.850)	(1.993)
Control Variables						
Leverage	0.483***	0.446***	0.269***	0.299***	0.162***	0.059
	(7.623)	(7.004)	(4.782)	(3.811)	(3.534)	(1.201)
Leverage^2	-0.442**	-0.391***	-0.255***	-0.275***	-0.137***	-0.080**
	(-9.456)	(-8.004)	(-5.508)	(-4.805)	(-4.177)	(-2.254)
Liquidity	0.204***	0.127***	0.106***	0.164***	0.073***	0.068***
	(15.781)	(9.011)	(8.320)	(12.631)	(7.055)	(5.095)
Size	0.008***	0.010***	0.010***	0.011***	0.009***	0.005***
	(5.502)	7.111	(6.924)	(6.408)	(6.307)	(3.002)
Proportion of Fixed Assets	-0.048***	-0.020**	-0.029***	0.067***	0.034***	0.035***
	(-4.689)	(-2.151)	(-3.081)	(4.854)	(3.107)	(2.966)
Prior Performance		0.324***	0.356***		0.580***	0.608***
		(11.898)	(12.406)		(18.596)	(20.365)
Constant	-0.192***	-0.264***	-0.231**	-0.263***	-0.194***	-0.094
	(-5.716)	(-7.484)	(-2.453)	(-6.501)	(-5.769)	(-0.537)
Industry Dummy	Yes	Yes	Yes	Yes	Yes	Yes
Observations	5326	5093	4874	5326	5093	4874
R-Square	0.202	0.276	0.277	0.177	0.448	0.455
F-value	17.605	16.058	16.662	13.000	33.688	33.171

*Note: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$. Robust standard errors in brackets.*

Table 7: CIS 2006-2008, SNF 2008-2010 - Regression results: Degree of innovation

In Table 7, we see a similarly small increase in explanatory power of about 0.2%. Controlling for degree of innovation in this manner shows not only that innovation has a negative effect on firm performance, but also that the more innovation a firm engages in prior to the recession, the harder its performance falls during it, as shown by the size of the regression coefficients. As it turns out, being in the top quartile of firms engaging in innovation activities has more than two times the negative effect as being in the second or third quartile, leading us to find no support for our hypotheses. As with the innovation dummy, there was no significant effect of innovation quartile on sales growth. Again, our hypotheses find no support, with negative coefficients and statistical significance suggesting the opposite of our expected findings to be true during recessions.

4.3.2 Pre-Recession Innovation and Firm Performance Post-Recession

We now turn to pre-recession innovation, and how it affects performance as the economy recovers during the years of 2011 and 2012. We use CIS 2006-2008 and accounting data from SNF 2011 and 2012, and present the control model (1) in Table 8:

CIS 2006-2008: CONTROLS ONLY

	ROA		EBITDA Margin	
	2011	2012	2011	2012
Control Variables				
Leverage	0.333***	0.366***	0.063	0.108**
	(6.882)	(7.107)	(1.414)	(2.180)
Leverage^2	-0.269***	-0.318***	-0.057*	-0.109***
	(-6.655)	(-7.563)	(-1.800)	(-3.085)
Liquidity	0.110***	0.096***	0.075***	0.064***
	(8.260)	(7.911)	(6.035)	(4.999)
Size	0.003**	0.003**	0.001	0.000
	(2.376)	(2.561)	(0.265)	(0.020)
Proportion of Fixed Assets	-0.026***	-0.007	0.043***	0.046***
	(-2.910)	(-0.713)	(3.438)	(3.664)
Prior Performance (ROA)	0.389***	0.431***	0.600***	0.666***
	(15.679)	(14.424)	(19.336)	(20.177)
Constant	-0.108***	-0.119***	-0.020	-0.038
	(-4.304)	(-3.006)	(-0.531)	(-0.271)
Industry Dummy	Yes	Yes	Yes	Yes
Observations	4722	4556	4722	4556
R-Square	0.293	0.281	0.441	0.465
F-value	16.018	15.686	31.021	27.359

*Note: *** p < 0.01, ** p < 0.05, * p <0.10. Robust standard errors in brackets.*

Table 8: CIS 2006-2008, SNF 2011-2012 - Regression results: Controls

CIS 2006-2008: INNOVATORS VERSUS NON-INNOVATORS

	ROA		EBITDA Margin	
	2011	2012	2011	2012
Focus Variable				
Innovation Dummy 2006-2008	-0.000	-0.008**	-0.001	0.001
	(-0.081)	(-2.084)	(-0.387)	(0.412)
Control Variables				
Leverage	0.333***	0.365***	0.063	0.108**
	(6.880)	(7.100)	(1.412)	(2.182)
Leverage^2	-0.269***	-0.318***	-0.057*	-0.109***
	(-6.653)	(-7.563)	(-1.799)	(-3.086)
Liquidity	0.110***	0.096***	0.075***	0.064***
	(8.270)	(7.872)	(6.016)	(5.012)
Size	0.003**	0.004***	0.001	-0.000
	(2.340)	(2.811)	(0.297)	(-0.024)
Proportion of Fixed Assets	-0.026***	-0.007	0.043***	0.046***
	(-2.906)	(-0.665)	(3.449)	(3.654)
Prior Performance (ROA)	0.389***	0.430***	0.599***	0.666***
	(15.662)	(14.397)	(19.356)	(20.168)
Constant	-0.108***	-0.125***	-0.020	-0.037
	(-4.279)	(-3.151)	(-0.543)	(-0.263)
Industry Dummy	Yes	Yes	Yes	Yes
Observations	4722	4556	4722	4556
R-Square	0.293	0.282	0.441	0.465
F-value	15.739	15.694	30.490	27.159

*Note: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$. Robust standard errors in brackets.*

Table 9: CIS 2006-2008, SNF 2011-2012 - Regression results: Innovators versus Non-Innovators

Adding the innovation dummy in Table 9 has a negligible effect on the explanatory power of the models. As the time lag between CIS 2006-2008 gets larger, the significance of our findings also decrease, and we find little evidence of an effect of pre-recession innovation on post-recession firm performance, though innovation is negative and statistically significant in 2012. Still, we find no support for H1b) in this analysis.

CIS 2006-2008: DEGREE OF INNOVATION

	ROA		EBITDA Margin	
	2011	2012	2011	2012
Focus Variable				
Innovation Dummy 2006-2008				
1st Quartile	-0.013**	-0.024***	-0.011*	-0.006
	(-2.179)	(-3.023)	(-1.663)	(-0.889)
2nd Quartile	-0.001	-0.002	-0.004	-0.001
	(-0.219)	(-0.339)	(-0.683)	(-0.247)
3rd Quartile	0.009	-0.012*	0.008	0.003
	(1.538)	(-1.795)	(1.307)	(0.444)
4th Quartile	0.001	-0.008	-0.001	0.006
	(0.149)	(-0.113)	(-0.185)	(1.289)
Control Variables				
Leverage	0.331***	0.364***	0.061	0.107**
	(6.820)	(7.073)	(1.376)	(2.162)
Leverage^2	-0.267***	-0.318***	-0.056*	-0.108***
	(-6.600)	(-7.550)	(-1.761)	(-3.063)
Liquidity	0.110***	0.095***	0.075***	0.064***
	(8.238)	(7.811)	(5.980)	(5.010)
Size	0.003***	0.004***	0.001	0.000
	(2.616)	(2.958)	(0.471)	(0.128)
Proportion of Fixed Assets	-0.026***	-0.006	0.043***	0.047***
	(-2.826)	(-0.585)	(3.493)	(3.709)
Prior Performance (ROA)	0.388***	0.428***	0.599***	0.665***
	(15.640)	(14.375)	(19.308)	(20.098)
Constant	-0.114***	-0.129***	-0.026	-0.041
	(-4.496)	(-3.256)	(-0.679)	(-0.292)
Industry Dummy	Yes	Yes	Yes	Yes
Observations	4722	4556	4722	4556
R-Square	0.295	0.284	0.442	0.466
F-value	15.193	15.313	29.063	26.440

*Note: *** p < 0.01, ** p < 0.05, * p <0.10. Robust standard errors in brackets.*

Table 10: CIS 2006-2008, SNF 2011-2012 - Regression results: Degree of innovation

Model (3) in Table 10 shows similar findings to those in Table 9, though the negative effect of pre-recession innovation activities seems to persist into the retrieval phase of the recession for the top quartile of innovative firms. Again, 2012 exhibits a stronger statistical relationship to pre-recession innovation than does 2011, suggesting some year effect that increases the statistical significance of pre-recession innovation during this particular year. This effect is strong only on ROA, whereas post-recession EBITDA margin shows a weakly or non-significant relationship with pre-recession innovation. Table 10 also shows a larger increase in the explanatory power of the model. Again, we find no support for our hypotheses regarding pre-recession innovation and post-recession performance.

4.3.3 Innovation During the Recession and Post-Recession Firm Performance

Turning our attention now to the innovation activities that took place during the recession, we investigate the effect on post-recession performance. Using the CIS 2008-2010 data, we run regressions on SNF data from 2010, 2011 and 2012. Looking first at our control model (1) in Table 11:

CIS 2008-2010: CONTROLS ONLY

	ROA			EBITDA Margin		
	2010	2011	2012	2010	2011	2012
Control Variables						
Constant	-0.338***	-0.122***	-0.157***	-0.248**	-0.072	-0.050
	(-2.794)	(-2.828)	(-3.871)	(-2.388)	(-1.635)	(-0.914)
Leverage	0.337***	0.363***	0.454***	0.131**	0.088	0.118
	(3.900)	(4.816)	(5.917)	(2.020)	(1.466)	(1.561)
Leverage^2	-0.317***	-0.298***	-0.394***	-0.141***	-0.084*	-0.116**
	(-4.358)	(-4.625)	(-6.234)	(-2.806)	(-1.787)	(-2.095)
Liquidity	.0.074***	0.129***	0.093***	0.035**	0.089***	0.066***
	(5.472)	(7.204)	(5.453)	(2.488)	(5.983)	(3.564)
Size	0.011***	0.003*	0.003*	0.006***	0.004**	0.001
	(5.696)	(1.750)	(1.713)	(3.310)	(2.060)	(0.362)
Proportion of Fixed Assets	-0.030**	-0.026**	0.002	0.022*	0.034**	0.057***
	(-2.355)	(-1.998)	(0.188)	(1.669)	(2.212)	(3.287)
Prior Performance	0.455***	0.406***	0.444***	0.685**	0.580***	0.691***
	(13.808)	(11.090)	(10.305)	(17.267)	(13.731)	(15.074)
Industry Dummy	Yes	Yes	Yes	Yes	Yes	Yes
Observations	2760	2695	2615	2760	2695	2615
R-Square	0.339	0.323	0.302	0.552	0.506	0.478
F-value	13.484	10.322	9.905	31.459	21.676	20.197

*Note: *** p < 0.01, ** p < 0.05, * p <0.10. Robust standard errors in brackets.*

Table 11: CIS 2008-2010, SNF 2010-2012 - Regression results: Controls

For H1c) and H2c), model (2) (innovators vs. non-innovators) yields no statistical significance, and we will not reprint the regression outputs here, though they can be found in Appendix 1 if of interest. In Table 12, we see model (3), and find a small effect of degree of innovation, again a small negative effect for the first quartile only, though with statistical significance:

CIS 2008-2010-: DEGREE OF INNOVATION

	ROA		
	2010	2011	2012
Focus Variable			
Innovation Dummy 2008-2010			
1st Quartile	-0.002	-0.004	-0.019**
	(-0.201)	(-0.496)	(-2.405)
2nd Quartile	0.006	0.011*	0.007
	(0.880)	(1.680)	(1.005)
3rd Quartile	0.003	0.001	-0.007
	(0.523)	(0.083)	(-1.072)
4th Quartile	0.006	-0.005	0.005
	(1.038)	(-0.945)	(0.645)
Control Variables			
Leverage	0.336***	0.363***	0.451***
	(3.889)	(4.816)	(5.910)
Leverage^2	-0.316***	-0.298***	-0.393***
	(-4.345)	(-4.626)	(-6.249)
Liquidity	0.074***	0.129***	0.092***
	(5.442)	(7.196)	(5.405)
Size	0.011***	0.003*	0.003*
	(5.477)	(1.713)	(1.944)
Proportion of Fixed Assets	-0.030**	-0.025**	0.004
	(-2.375)	(-1.981)	(0.296)
Prior Performance (ROA)	0.456***	0.406***	0.442***
	(13.807)	(11.062)	(10.281)
Constant	-0.336***	-0.122***	-0.165***
	(-2.774)	(-2.809)	(-4.021)
Industry Dummy	Yes	Yes	Yes
Observations	2760	2695	2615
R-Square	0.339	0.324	0.305
F-value	12.831	10.017	9.764

*Note: *** p < 0.01, ** p < 0.05, * p <0.10. Robust standard errors in brackets.*

Table 12: CIS 2008-2010, SNF 2010-2012 - Regression results: Degree of innovation

Again, there is no support for either hypothesis H1c) or H2c), with a suggestion of continued negative effects from being in the first quartile of innovators during the CIS period 2008-2010 as well 2006-2008.

Now, we turn to Hypothesis 3, looking at the effect of types of innovation on firm performance.

4.3.4 Type of Innovation Activity and Firm Performance

The CIS datasets allow us to look at product innovation, process innovation, market innovation, and organisational innovation activities. Though we did not have any particular theories or expectations with regards to which type would be better at different times during a recession, we have found quite some interesting relationships between type of innovation activity and firm performance over the time period. As this analysis concerns itself with innovators only, we have a new control model (1) shown in Tables 13-15, as well as the output from model (4) in Tables 16-19. As before, we present only the years where we find statistically significant relationships, after the control model:

ROA: CONTROLS ONLY

	ROA					ROA		
	CIS 2006-2008					CIS 2008-2010		
	2008	2009	2010	2011	2012	2010	2011	2012
Control Variables								
Leverage	0.546***	0.482***	0.244***	0.282***	0.393***	0.222**	0.283***	0.468***
	(5.228)	(4.415)	(3.272)	(3.922)	(5.235)	(2.058)	(2.973)	(5.587)
Leverage^2	-0.486***	-0.418***	-0.235***	-0.231***	-0.349***	-0.222***	-0.251***	-0.408***
	(-6.171)	(-4.768)	(-3.836)	(-3.961)	(-5.692)	(-2.387)	(-3.046)	(-5.575)
Liquidity	0.211***	0.122***	0.113***	0.140***	0.103***	0.103***	0.128***	0.096***
	(9.748)	(6.040)	(5.296)	(6.546)	(5.125)	(5.471)	(4.822)	(3.591)
Size	0.012***	0.011***	0.013***	0.006***	0.006***	0.011***	0.005*	0.007***
	(5.715)	(5.364)	(5.880)	(2.848)	(3.168)	(5.206)	(1.696)	(2.939)
Proportion of Fixed Assets	-0.069***	-0.039***	-0.044***	-0.055***	-0.020	-0.034**	-0.037*	-0.003
	(-3.940)	(-2.603)	(-2.943)	(-3.657)	(-1.344)	(-2.024)	(-1.869)	(-0.162)
Prior Performance	-	0.353***	0.386***	0.388***	0.431***	0.468***	0.485***	0.475***
		(9.280)	(10.872)	(9.663)	(10.015)	(10.654)	(10.880)	(8.774)
Constant	-0.285***	-0.272***	-0.618	-0.137***	-0.177***	-0.224***	-0.130**	-0.225***
	(-5,255)	(-5.274)	(-0.827)	(-3.367)	(-4.077)	(-5.080)	(-2.476)	(-4.256)
Industry Dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	2322	2217	2119	2052	2000	1385	1358	1319
R-Square	0.192	0.306	0.307	0.338	0.312	0.400	0.391	0.350
F-value	7.343	8.368	9.810	9.527	9.903	8.678	10.446	8.360

*Note: *** p < 0.01, ** p < 0.05, * p <0.10. Robust standard errors in brackets.*

Table 13: Regression results: Controls - ROA

EBITDA MARGIN: CONTROLS ONLY

	EBITDA Margin					EBITDA Margin		
	CIS 2006-2008					CIS 2008-2010		
	2008	2009	2010	2011	2012	2010	2011	2012
Control Variables								
Leverage	0.466***	0.236***	0.162**	0.055	0.133*	0.165	0.116	0.225***
	(4.173)	(2.728)	(2.224)	(0.751)	(1.778)	(1.538)	(1.124)	(3.032)
Leverage^2	-0.400***	-0.194***	-0.162***	-0.057	-0.146***	-0.159*	-0.119	-0.209***
	(-4.562)	(-2.990)	(-2.985)	(-1.046)	(-2.665)	(-1.900)	(-1.370)	(-3.563)
Liquidity	0.170***	0.073***	0.088***	0.102***	0.060***	0.058**	0.087***	0.084***
	(7.273)	(4.096)	(3.919)	(5.233)	(2.878)	(2.385)	(3.553)	(2.280)
Size	0.015***	0.010***	0.008***	0.003	-0.001	0.009***	0.007**	0.006**
	(6.422)	(4.482)	(3.457)	(1.012)	(-0.310)	(4.093)	(2.321)	(2.004)
Proportion of Fixed Assets	0.034	0.046***	0.024	0.012	0.060***	-0.004	0.007	0.051**
	(1.631)	(2.787)	(1.236)	(0.908)	(3.381)	(-0.213)	(0.322)	(2.323)
Prior Performance	-	0.534***	0.536***	0.549***	0.602***	0.677***	0.570***	0.608***
		(11.565)	(11.976)	(11.420)	(12.496)	(13.301)	(8.628)	(8.950)
Constant	-0.370***	-0.203***	-0.314	-0.052	0.006	-0.199***	-0.154***	-0.152***
	(-6.708)	(-3.524)	(-0.618)	(-0.840)	(0.098)	(-4.002)	(-2.585)	(-2.623)
Industry Dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	2322	2217	2119	2052	2000	1385	1358	1319
R-Square	0.155	0.394	0.393	0.386	0.414	0.538	0.490	0.465
F-value	6.576	15.041	12.919	14.465	13.054	12.677	11.675	11.865

*Note: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$. Robust standard errors in brackets.*

Table 14: Regression results: Controls - EBITDA Margin

SALES GROWTH: CONTROLS ONLY

	Sales Growth					Sales Growth		
	CIS 2006-2008					CIS 2008-2010		
	2008	2009	2010	2011	2012	2010	2011	2012
Control Variables								
Leverage	-	-1.482	-0.899	0.355*	0.609***	0.503**	0.385**	0.270
		(-1.441)	(-0.826)	(1.961)	(3.594)	(2.116)	(2.035)	(1.551)
Leverage^2	-	1.380	0.925	-0.171	-0.386***	-0.339**	-0.235	-0.196
		(1.530)	(0.965)	(-1.164)	(-3.755)	(-1.983)	(-1.490)	(-1.635)
Liquidity	-	-0.016	0.161	0.035	0.258**	-0.081	-0.000	0.180
		(-0.131)	(1.352)	(0.643)	(2.302)	(-1.941)	(-0.002)	(0.996)
Size	-	0.020	0.044***	0.023***	0.046***	0.005	0.015*	0.035
		(1.552)	(3.121)	(3.883)	(2.700)	(0.740)	(1.866)	(1.426)
Proportion of Fixed Assets	-	-0.072	-0.092**	-0.088**	0.079	-0.055	-0.059	0.068
		(-0.783)	(-2.269)	(-2.373)	(0.761)	(-1.092)	(-1.343)	(0.641)
Prior Performance	-	-	-0.129	0.037	-0.059	-0.168	0.047	-0.062
			(-1.504)	(0.709)	(-1.147)	(-0.951)	(0.896)	(-1.540)
Constant	-	0.051	-0.769	-0.549***	-1.171***	-0.253**	-0.387**	-0.807*
		(0.186)	(-0.181)	(-4.754)	(-3.449)	(-2.048)	(-2.352)	(-1.697)
Industry Dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	-	2217	2119	2052	2000	1385	1358	1319
R-Square	-	0.053	0.023	0.116	0.067	0.019	0.183	0.090
F-value	-	8.523	3.045	2.127	3.070	1.923	2.449	1.842

*Note: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$. Robust standard errors in brackets.*

Table 15: Regression results: Controls - Sales Growth

We first examine the ROA model (4) for relationships:

TYPE OF INNOVATION

	ROA		ROA
	CIS 2006-2008		CIS 2006-2008
	2011	2012	2012
Focus Variable			
Innovation Dummy			
Product Innovation	-0.004	-0.007	-0.001
	(-0.732)	(-1.252)	(-0.076)
Process Innovation	0.004	-0.006	-0.007
	(0.826)	(-0.963)	(-1.016)
Market Innovation	-0.015***	-0.013**	-0.002
	(2.824)	(-2.073)	(-0.322)
Organisational Innovation	-0.001	-0.008	-0.014**
	(-0.185)	(-1.289)	(-2.177)
Control Variables			
Leverage	0.277***	0.391***	0.463***
	(3.842)	(5.220)	(5.663)
Leverage^2	-0.229***	-0.349***	-0.404***
	(-3.931)	(-5.703)	(-5.652)
Liquidity	0.137***	0.104***	0.096***
	(6.482)	(5.197)	(3.571)
Size	0.007***	0.007***	0.008***
	(3.320)	(3.541)	(3.290)
Proportion of Fixed Assets	-0.055***	-0.012	-0.000
	(-3.681)	(-0.760)	(-0.008)
Prior Performance (ROA)	0.385***	0.428***	0.470***
	(9.608)	(9.970)	(8.687)
Constant	-0.144***	-0.177***	-0.213***
	(-3.546)	(-4.098)	(-4.233)
Industry Dummy	Yes	Yes	Yes
Observations	2052	2000	1319
R-Square	0.341	0.316	0.354
F-value	9.544	10.822	8.260

*Note: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$. Robust standard errors in brackets.*

Table 16: Regression results: Type of innovation - ROA

From our ROA model shown in Table 16, we see two main relationships – the first is that pre-recession market innovations are highly correlated with ROA underperformance during the retrieval period of the recession. Further, a focus on organisational innovation during the recession is negatively related with post-recession performance, perhaps suggesting that a forced reorganisation is not necessarily a good idea.

TYPE OF INNOVATION

	EBITDA Margin				EBITDA Margin
	CIS 2006-2008				CIS 2008-2010
	2008	2009	2010	2011	2011
Focus Variable					
Innovation Type Dummy					
Product Innovation	-0.007	0.001	-0.012**	0.001	0.005
	(-1.146)	(0.275)	(-2.304)	(0.162)	(0.701)
Process Innovation	-0.001	0.002	-0.009*	-0.001	0.003
	(-0.236)	(0.485)	(-1.799)	(-0.176)	(0.558)
Market Innovation	-0.018***	-0.000	-0.005	-0.016***	-0.006
	(-2.952)	(-0.048)	(-0.877)	(-3.234)	(-0.977)
Organisational Innovation	-0.015**	-0.002	-0.008	0.001	-0.007
	(-2.412)	(-0.514)	(-1.515)	(0.249)	(-1.136)
Control Variables					
Constant	-0.353***	-0.199***	-0.164***	-0.057	-0.155***
	(-5.896)	(-3.454)	(-3.571)	(-0.929)	(-2.691)
Leverage	0.482***	0.234***	0.161**	0.056)	0.114
	(4.258)	(2.697)	(2.219)	(0.769)	(1.113)
Leverage^2	-0.415***	-0.193***	-0.163***	-0.059	-0.115
	(-4.619)	(-2.967)	(-3.006)	(-1.091)	(-1.332)
Liquidity	0.161***	0.072***	0.087***	0.100***	0.087***
	(6.989)	(4.104)	(3.812)	(5.159)	(3.536)
Size	0.017***	0.010***	0.009***	0.004	0.008**
	(7.000)	(4.616)	(3.710)	(1.233)	(2.439)
Proportion of Fixed Assets	0.032	0.045***	0.026	0.018	0.007
	(1.528)	(2.743)	(1.334)	(0.893)	(0.329)
Prior Performance (EBITDA Margin)	-	0.532***	0.535***	0.545***	0.570***
		(11.548)	(12.004)	(11.353)	(8.667)
Industry Dummy	Yes	Yes	Yes	Yes	Yes
Observations	2322	2217	2119	2052	1358
R-Square	0.167	0.393	0.396	0.389	0.491
F-value	8.707	14.326	13.035	14.538	11.166

*Note: *** p < 0.01, ** p < 0.05, * p <0.10. Robust standard errors in brackets.*

Table 17: Regression results: Type of innovation - EBITDA Margin

We find more statistically significant relationships in our EBITDA model in Table 17, perhaps suggesting that type of innovation is more related to margins than to ROA. We see immediately the strong negative relationships between market and organisational innovation pre-crisis and performance during 2008. However, as the economy resumes growth toward the end of the downturn in 2010, product innovation undertaken both prior to and during the recession have significant negative effects on margins. Finally, in 2011, pre-recession market innovations seem to have a strong relationship with underperforming margins.

TYPE OF INNOVATION

	Sales Growth CIS 2006-2008		Sales Growth CIS 2008-2010	
	2009	2010	2010	2011
Focus Variable				
Innovation Type Dummy				
Product Innovation	0.074*	0.071	0.058	0.049***
	(1.945)	(1.397)	(0.691)	(2.694)
Process Innovation	0.036	0.109***	-0.048	0.006
	(1.034)	(2.036)	(-0.538)	(0.276)
Market Innovation	0.023	0.009	-0.088	-0.005
	(0.775)	(0.207)	(-0.845)	(-0.279)
Organisational Innovation	-0.008	0.028	0.129	-0.007
	(-0.221)	(0.386)	(1.1699	(-0.337)
Control Variables				
Constant	0.205	-0.773***	-0.144	-0.390**
	(0.498)	(-4.029)	(-0.774)	(-2.414)
Leverage	-1.483	-0.899	0.496**	0.388**
	(-1.440)	(-0.825)	(2.038)	(2.051)
Leverage^2	1.389	0.933	-0.317*	-0.229
	(1.532)	(0.974)	(-1.833)	(-1.441)
Liquidity	-0.034	0.145	-0.055	0.001
	(-0.282)	(1.324)	(-0.984)	(0.013)
Size	0.022	0.044***	-0.004	0.014*
	(1.489)	(2.623)	(-0.315)	(1.811)
Proportion of Fixed Assets	-0.093	-0.121***	-0.053	-0.058
	(-1.008)	(-2,763)	(-1.010)	(-1.311)
Prior Performance (Sales Growth)	-	-0.135	-0.169	0.046
		(-1.518)	(-0.965)	(0.892)
Industry Dummy	Yes	Yes	Yes	Yes
Observations	2217	2119	1385	1358
R-Square	0.058	0.026	0.023	0.187
F-value	3.337	3.008	1.738	2.859

*Note: *** p < 0.01, ** p < 0.05, * p <0.10. Robust standard errors in brackets.*

Table 18: Regression results: Type of innovation - Sales Growth

Finally, looking at the sales growth model in Table 18, we see more positive relationships. Pre-recession product innovation has a weakly positive effect on performance just as the economy enters the recession in 2009. This positive effect is similar, though smaller, in 2011 for product innovation undertaken during the recession. We also see here that pre-recession process innovation is positively related to sales growth in 2010, though this pattern does not hold for 2011 and 2012, and process innovations during the recession seem to have no significant effect on sales growth unveiled by firm performance up to and including 2012.

4.4 Summary of Findings

In our analysis, we first looked at pre-recession innovation and its effect on firm performance during the recession. In summary, we find no support at all for either Hypothesis 1 or Hypothesis 2 during this timeframe, and arrive at similar conclusions for pre-recession innovation on post-recession performance, and for the performance effects of innovation during the recessions. Given our data, there is no reason to believe that innovators outperform non-innovators during or after recessions, whether the innovation takes place prior to or during the recession. We therefore summarily reject Hypothesis 1 and 2 across all sub-hypotheses. The analysis indeed suggest the opposite of our expected findings – innovators underperform non-innovators both during and after recessions, regardless of the timing of their innovation activities. This underperformance is also related to the degree of innovation activities performed – the higher the degree of innovation undertaken, the more negative results were in terms of both ROA and EBITDA margin.

Looking at types of innovation activities, there are clear indications that the type of innovation undertaken matters, though there seem to be few consistent patterns and clear conclusions to be drawn from these data. Of note is the significant time lag that these types of innovation seem to have. Pre-recession choice of innovation activities seems to be able to affect post-recession performance quite significantly, and in some cases more strongly and significantly than innovation undertaken during the recession. In summary, we find that pre-recession market innovation and organisational innovation during the crisis negatively affects ROA after the recession. Pre-recession market innovation is also negatively related to EBITDA margins both at the beginning of the recession, and during the retrieval period. Pre-recession product innovation is also negatively related to EBITDA margins in 2010, just as the economy was starting to grow again. Pre-recession process innovation positively affects sales growth as the economy began to grow again in 2010, and product innovation during the recession seems to contribute to over-performance in terms of sales growth towards the end of the recession and into the retrieval period. That being said, we cannot conclude on any persistent effects based on type of innovation that consistently affects firm performance during recessions, other than the indications of the relationships outlined here.

In terms of control variables, we find that, as expected, leverage is negatively related to firm performance across the entire time period in terms ROA, though this relationship is decreasing in statistical significance and size of coefficients for EBITDA margins as the Norwegian economy enters the retrieval period of the recession.

Liquidity is positively related with ROA and EBITDA margins during the recession and after the recession with strong statistical significance, though the coefficient is decreasing through post-recession performance, suggesting that it is more important during economic downturns than during normal times. Liquidity was not related to sales growth.

Size was positively related to ROA and EBITDA, again with decreasing coefficients and statistical significance over time. For sales growth, however, size exhibits increasing statistical significance and size of coefficients as the economy enters the retrieval period.

Proportion of fixed assets is negatively related to ROA, with decreasing statistical significance and coefficients over time. For EBITDA margins, the proportion of fixed assets exhibits a positive relationship, and remains statistically significant for the entire period, with increasing coefficients over time. This control was not related to sales growth.

Finally, prior performance was an extremely important control variable for our ROA and EBITDA margin models, exhibiting very high and increasing coefficients and statistical significance at the 1% level for all years and models under the analysis. As the coefficients increase quite significantly in size as the economy recovers, this suggests a temporary reduction in the importance of prior performance during recessions. Prior sales growth was not found to be a statistically significant predictor in our sales growth models, however.

5. Discussion

Building on the results from the previous section, we will now move onto the discussion of the results. We will try to uncover what strategic and managerial implications these results indicate, and will position this discussion within the theoretical background of innovation and firm performance discussed in the Theory and Literature Review section of this thesis. We then present what the theoretical implications may be, as well as potential directions for future studies into the innovation-performance link during recessions. Finally, briefly elaborate on the limitations of our results not previously discussed in our methodology chapter.

5.1 Discussion of Analysis Results

In this section, we discuss the outcomes of our analysis. We first discuss the overall rejection of our hypotheses as a whole, and the possible reasons for why we fail to see positive innovation effects during recessions. We then turn more specifically to the time periods investigated by our hypotheses, and what the results mean for these. We close out this sub-section by discussing the effects of the various types of innovation and the likely mechanisms explaining those results.

5.1.1 Rejecting Hypotheses 1 and 2

As outlined in the analysis, we found no support for our hypotheses surrounding pre-recession innovation activity and post-recession performance, for either of our performance variables. Walker’s (2005) review of innovation-performance studies found that 56.19% of studies supported a positive relationship, though this still leaves 43.81% of those empirical findings not supporting this thesis. Our findings contradict this positive relationship, though none of the studies in Walker’s 2005 review considered the recession perspective. Our hypothesis was based on an assumption that innovation activity was in some sense related to flexibility and adaptability, which one imagines to be important firm characteristics for performing well in recessions. Instead, we see that innovation activity may lead to negative performance during the crisis.

Viewed simply as a rejected hypothesis, one might conclude that the recession acted as an equaliser between firms, such that the innovation advantages found by previous literature in normal times may cease to exist. This is also supported by Bjørkli and Sandberg (2012), who found that competitive advantages become less stable during recessions – a firm that performs well pre-crisis due to its advantage from innovations may thus lose this advantage during the recession, equalising its performance with its non-innovating peers. Also, as Knudsen and Lien (2014) suggest, innovating firms may need to borrow in order to maintain its innovation investments. Though we control well for capital structure effects, we are unable to control for any potential firm-specific agency costs of increased debt, such as debt overhang problems (Myers and Majluf, 1984) that can impact performance. These firm-specific agency costs, especially debt overhang problems, are also likely to be more pronounced in credit-constrained markets, such as during recessions.

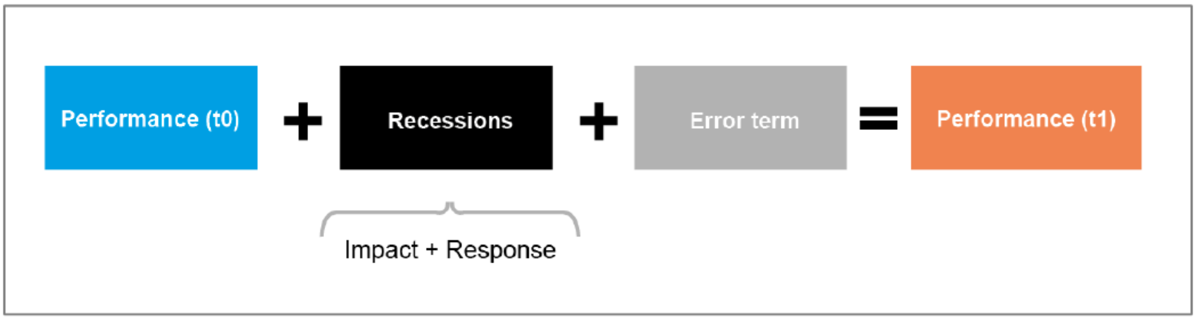

Figure 9: Impact of recessions (Knudsen, 2014)

Recalling Knudsen's (2014) impact/response model during recessions, shown in figure 9 response actions are naturally an important component of firm performance. These potential response actions – cost cutting, restructuring, new projects – may look different for non-innovators and innovators. Innovative firms, forced to maintain their innovation investments (Knudsen and Lien, 2014), may have less options, lessening the ability to improve performance during recessions. This may stem from less access to credit for innovation investments, lack of physical assets as collateral, inability to quickly cut costs, for instance. If there is such a systematic difference in the response actions available to innovators versus non-innovators, this model posits a possible explanation for why we do not find positive performance effects from innovation. Indeed, it might even be extended to provide a potential explanation for the underperformance of innovating firms.

Further, innovative firms may be more likely to have relatively new product market interactions (products, processes, service offerings, etc.). As outlined by Field and Pagoulatos (1997, in Knudsen, 2015), marginal customers from periods of high sales growth are generally the first to leave during recessions. This argument may perhaps be expanded to cover new product market interactions as well, in which case this could explain the equalisation of performance with non-innovating peers. Additionally, if we view innovation as a de facto dynamic capability, Eisenhardt and Martin (2000) find that such dynamic capabilities decrease in importance during periods of rapid market change, such as recessions. This could also help explain the rejection of our hypotheses here. A final potential explanation is that innovation activities could have a significant time lag before they produce positive effects, longer than the one examined in hypotheses 1a) and 2a). If this were the case, we would not expect innovation activities during the CIS 2006-2008 period to affect performance in the years immediately after, but rather in the post-recession years.

5.1.2 Pre-Recession Innovation and Firm Performance During Recessions

Now, of course, we not only rejected the hypotheses surrounding pre-crisis innovation and performance during the recession, but found statistically significant negative effects of pre-recession innovation on firm performance, though this negative effect abates as the economy begins to grow again in 2010. Indeed, moving from a pre-recession non-innovator to becoming an innovator is, in our model, related to a 1-2% decrease in ROA, -3% if you are in the top quartile of innovators. EBTIDA margins were slightly less affected, but still show a -1.6% effect in 2008, or a -3.6% effect if you are in the top innovating quartile. The above explanations may shed light on why the hypotheses were rejected, but we need more to understand the negative relationship that we find in our data. While the marginal customer argument may be one possible explanation for underperformance, this argument was originally related to sales growth – for our sales growth models, we found no relationship between pre-recession innovation and performance. It was for the ROA and EBITDA margins that the negative effect was most pronounced and statistically significant.

So what are the possible reasons for such a marked underperformance of innovating firms during the recessionary period? One simple managerial explanation might simply be that innovation projects pre-crisis are undertaken with earnings projections that do not anticipate a financial downturn. When the recession hits, these projects cease to be profitable, leading to poor performance during the recession years. This pure economical argument based on a firm's business case for innovation is perhaps the simplest logical explanation for the underperformance of pre-recession innovators during the crisis. That being said, it assumes a relatively short time lag between innovation activity and performance outcomes, which we are unable to confirm or deny in our study.

Based on our theory and literature review, there are several possible theoretical explanations. One such explanation is related to simple maintenance of innovation investments. If, as argued above based on Knudsen and Lien (2014), there are, on the aggregate, leverage increases in order to maintain pre-recession innovation activities during the recession, and such leverage increases create excessive agency and debt overhang costs specific to the innovating firm, then this could be lead to systematic underperformance by innovators during recessions. This seems plausible, as credit for physical assets that can act like collateral may be easier to access than credit for innovation activities as credit is constrained during recessions.

Another possible explanation is simply the spill-over effects outlined by Teece et al. (1997). The recession may make a firm unable to reap the benefits of their pre-recession innovation in a timely fashion, eroding potential first-mover advantages or rents that the innovator might have had in a normal economic climate. Thus, the innovator would have incurred the costs of innovating, but has not received the assumed benefit – a benefit that competitors may be able to acquire or take advantage of without incurring the full costs. Such a situation would also lead to a systematic underperformance of innovators during a recession.

This is also related to Cohen and Levinthal's (1990) ideas surrounding absorptive capacity – it is possible that non-innovators have a high enough absorptive capacity to make innovation activities unattractive, especially during economic downturns. Our findings are exactly the opposite in innovation than what Geroski, Machin and Van Reenen (1993) expect. Whereas they theorise that innovators have higher absorptive capacity than non-innovators, and thus would be less affected economic downturns, we find empirically that innovators are more affected than their non-innovating peers.

Further, a firm may have a competitive advantage (or disadvantage) in innovation capability prior to the recession. Returning to Peteraf (1993) and the four criteria for a competitive advantage under the resource based view, there is reason to believe that even if these criteria were present pre-recession, a recession may very well change these criteria, thus rendering a competitive advantage relatively less important and stable. A recession can reduce resource heterogeneity as firms may merge in pursuit of efficiency. As noted in Knudsen and Lien (2015), the efficiency of resource markets breaks down during recessions, and some firms may be able to obtain resources on the cheap. While this this maintains the ex ante limits to competition, it can increase resource mobility, perhaps especially the mobility of knowledge workers in an economy, crucial to innovation. A recession might also significantly change the ex post expected benefits of a resource, invalidating significant investments into resources, such as innovation activities. Such a change, if it were persistent for innovators across the economy, could help explain the underperformance of innovators during recessions.

This is, of course, assuming that the firm had a competitive advantage in innovation in the first place – there is no guarantee that a firm that engages in innovation are actually good at it. Indeed, the persistent poor performance of the top quartile of innovators does suggest that engaging in more innovation activities is not at all a recipe for success. An important consideration here is March (1991) and Utiola et al.’s (2009) theory and empirical evidence, respectively, regarding the idea of an optimal exploration-exploitation focus. As with optimal size, there are a host of factors likely to affect optimal exploration (i.e., innovation) focus, which we will not delve into. We do note, however, that a recession may change what the optimal exploration focus will be for each individual firm. This exploration focus is likely embedded in culture, departments and institutions within the firm, and as such may be very hard to change quickly in response to a recession. Viewing the underperformance of innovators through this lens of optimal exploration focus, our analysis of innovator performance may lead to the conclusion that the optimal exploration focus of a firm decreases during a recession. This would move the best innovators off of their pre-recession optimal (or near-optimal) exploration focus, and those who under-innovated come closer to the new optimal exploration focus, leading to a relative underperformance of those firms who innovated more than their peers.

Firms that undertake innovation activities, especially those who undertake a great deal of them, may also just be responding to market pressures, as well as pressure from investors, rather than it being part of a well-thought out and carefully considered innovation strategy. A poorly performing firm may feel pressured to renew itself, its product, or its market focus, thus leading it to undertake more than the optimal amount of innovation. This effect likely exists even in normal economic climates, and would be particularly strong during recessions. This would mean that these firms will answer yes to a great deal of the CIS questions, and may help explain why the top innovation quartile consistently underperforms firms that innovate less, as well as non-innovators. And naturally, performing innovation activities is not enough to guarantee the positive performance relationship outlined in the empirical research on innovation – these activities must also be performed well in order to generate those hoped-for positive performance results. It seems unlikely that a firm with limited resources that engages in a great deal of innovation activities will be able to excel across the board. This dilution of resources and management focus may therefore contribute to explaining why the top quartiles of innovators underperform relative to firms in lower innovation quartiles, who may have a more focused and specialised innovation strategy in place.

5.1.3 Pre-Recession Innovation and Firm Performance Post-Recession

For the effect of pre-recession innovation on post-recession performance, we still reject our hypotheses, finding no statistically significant positive relationship. As such, many of the arguments outlined for the simple hypothesis rejection above remain relevant – firms with innovation advantages lost during the recession may not have had sufficient time to regain these, debt overhang issues may persist, and marginal customers may not yet have returned. Assuming that in 2011 and 2012 the economy was still not fully back on track despite growing again, we find a plausible explanation for why we find no positive performance effects during the time period we have designated as post-recession. In our analysis, we saw that both the size of the effect and the statistical significance of the negative performance effect of pre-recession innovation decreased as the economy began to grow again in 2010. From this, one might expect the effect to turn positive with a statistical significance post-recession, especially if we accept the premise of time lag between innovation activity and performance outcomes that fits the time frame from pre-recession to post-recession. However, we do not observe such positive effects, even after the recession. This might be because non-innovators have had a longer time to take advantage of spill-over effects, during the recessionary period when the innovating firms were unable to reap the benefits of their innovation. This would nullify any benefit the innovator could potentially realise in normal times.

Another potential reason why we do not see a positive innovation effect as the economy recovers is that there might simply be too great of a time lag between the innovation and the post-recessionary time period (though one can imagine this time lag differing across types of innovation, industry, and a number of other factors). Thus, any positive effect from pre-recession innovation that would be realised during normal economic times is thus obscured from view by the recessionary impacts during the actual time lag from innovation activity to performance outcomes.

Looking at the overall results for post-recession performance, we see only weak negative effects on ROA in 2012, with few effects on sales growth or EBITDA margins, suggesting that returning economic growth reduces the negative effect of innovation activities. This would suggest, as one might expect, that the negative effect of innovation activities is recession-specific, rather than general. We do note, however, that the top quartile of innovators continues to see strong negative ROA effects, even post-recession. This indicates that an over-commitment or an over-investment into innovation can have severe, negative, and long-lasting impact on firm performance should a recession occur soon after those innovation activities have been performed.

2012 appears to exhibit stronger negative performance characteristics for innovation activities, both for pre-recession innovation and innovation undertaken during the recession. Pre-recession innovation has a negative effect primarily on ROA (not statistically significant for EBTIDA margins or sales growth), and the negative effect in 2012 (-2.4%) was almost twice that of 2011 (-1.3%). We do not have any basis for hypothesising about why this year in particular exhibits such negative performance effects of innovation activities, though we expect that some characteristic of the Norwegian economy related to the performance effect of innovation changed drastically from 2011 to 2012.

5.1.4 Innovation During the Recession and Post-Recession Firm Performance

Having seen that pre-recession innovation has little effect on post-recession performance, aside from continued negative effects for the top quartile of innovators only, we turn now to innovation activities that occurred during the recession, and its effect on post-recession performance. If the innovation-performance time lag was shorter than the time period from pre-recession to post-recession, then we should perhaps expect to see a positive effect for a shorter time frame. However, the only effect we observe is a negative ROA effect of being in the top innovation quartile for 2012 only. This suggests that innovation in general does not offer any significant positive effects, though the thesis that the downside of innovating is limited to recessionary years is strengthened. Again, it appears to be something in particular about 2012 that strengthens both the significance and size of the negative ROA effect of innovation.

Returning to Geroski, Machin and Van Reenen's (1993) suggestion that innovating firms should be comparatively less affected by economic shocks due to their absorptive capacity, we find no supporting evidence, even for innovation during the recession. Knudsen and Lien (2015) find a similar ability of innovators to take advantage of recessionary breakdowns of human capital resource markets in their hiring and training practices. While our findings do not contradict Knudsen and Lien's the same way they do Geroski, Machin and Van Reenen's, we find no evidence that innovators are able to turn such advantages in the human capital resource markets into tangible ROA, EBITDA, or sales growth performance, at least in the time period we have analysed.

Knudsen and Lien (2014) suggest that recessions will force credit constrained firms to either cut investments into R&D and innovation, whereas less credit constrained firms may be able to borrow in order to maintain their investments. In addition to the capital structure effects previously discussed, it seems that this dynamic would indicate that fewer firms are able to innovate during recessions, and that those who maintain their innovation activities will tend to perform better than those who are forced to cut in their R&D and innovation. This could produce an upwards bias of post-recession firm performance for firms that innovate during the recession, due to the persistence of profitability effects. Thus, if innovation is negatively related to firm performance during normal economic times as well, this upwards bias may conceal such a relationship that might have been uncovered in the 2011 and 2012 accounting data. Though it would go against much of the established literature if this were the case, there might be a country effect associated with Norway or characteristics of the Norwegian economy that could lead to this result.

5.1.5 Type of Innovation Activity and Firm Performance During Recessions

Now that we have discussed the apparent effects of innovation before and during the recession on firm performance, we arrive arrive at the important strategic decision for managers about specialisation. This, we believe, is an important decision in innovation activities in just the same way it is with regards to competitive strategy. It seems impossible to imagine a firm that is a simultaneous top performer in product and service innovation, process innovation, market innovation, and organisational innovation. The firms who consistently reap the benefits of innovation are more than likely very good at a certain type of innovation, rather than being good innovators across the board. Though we have not been able to verify this fact with statistical analysis in this thesis, this conclusion is strongly supported by the persistent negative ROA effect of being in the top innovation quartile, which measures the aggregate level of innovation activities across all types.

Looking at the results, there are three main findings. The first is that market innovation, whether before or during the recession, is negatively related with ROA and EBITDA performance. This relates to offering products or services to new markets, or the same market in new ways, and can in times or recession be seen as ‘scrambling for customers.’ Firms that are forced to scramble for customers in this way may be poorly performing to begin with, further adding a negative performance bias to this type of innovation activity. It may also be that new ways of delivering products to the market, or entering new markets, is a much more dangerous proposition during recessions. Generally speaking, such market innovation is likely to involve activities outside of the expertise of the firm in question, with a certain learning curve. This learning curve may lead to sub-optimal use of resources, and thus low returns. Further, entering new markets have high costs, explaining the negative relationship with EBITDA margins. For these reasons, it makes sense that this has a negative impact on firm performance during recession, where these effects are likely to be accentuated.

Though we do not have data or theories on this to refer to, it would be interesting to analyse whether this is in fact a recession-linked phenomenon, or if it is a general relationship between performance and market innovation. The fact that these effects are visible in 2008, prior to the recession fully hitting Norway, and in 2010 and 2011, when the economy was in retrieval, may perhaps suggest that the latter is true.

The second main finding surrounding the types of innovation is that sales growth toward the end of the recession is positively related to product innovation both prior to and during the recession. This comes as no surprise – new products are perhaps most likely to be positively related to performance outside of recessions, where the risk to the customer from trying a new product is lower. If this is correct, then it implies that managers should carefully time the release of new products when a recession is underway or has recently passed. What is perhaps more surprising is that process showed some positive sales growth effect, though in 2010 only. This effect is very large and statistically significant at the 1% level. The regression output indicates that a pre-recession process innovator can expect a sales growth 10.9% higher than someone who does not innovate on process as the economy returns to growth in 2010. This is surprising, as we would expect an improved process to be more closely related to EBITDA margins than to sales growth. However, as this effect is only visible in 2010, and only for pre-recession process innovation, we are unable to conclude that this is a strong and persistent effect with concrete managerial implications. More than likely, as with innovation activities in general in 2012, there exists a certain year effect that our model is unable to account for, and something may have happened in 2010 that increases the importance of process innovation for sales growth figures.

Thirdly, we find that product innovation, both prior to and during the recession, is negatively related to EBITDA margins in 2010. As opposed to with process innovation, the effect here is statistically significant both for CIS 2006-2008 and for CIS 2008-2010. That being said, it is still an effect we see only for a single year, further suggesting particular year effects on certain types of innovation activities. Again, though, this makes sense – new products may increase sales, but along with the increased sales growth comes the costs of selling new products (e.g. marketing, SG&A costs), teaching customers about the product, the learning curve in efficient production, and other margin-squeezing factors. Thus, this is not a particularly revolutionary finding, but of interest to both academics and managers none the less.

Though it is unlikely to have a large impact on our results, it is important to note here that organisational innovation is a part of the CIS questionnaire, and as such, poorly performing firms who are forced into restructuring may have responded positively to questions surrounding organisational innovation, perhaps leading to a downward performance bias of innovators as a whole. This could also explain the negative EBTIDA effects in 2008 (perhaps stemming from restructuring costs) and negative ROA effects in 2012 (it might be more difficult to efficiently manage resources and assets under newly restructured firms and management). This is perhaps a challenge in the measurement of innovation in other studies as well. Researchers should carefully consider what is actually measured in the innovation variables investigated and be aware of the effects they may reflect that are not necessarily related to active and positive innovation activities.

5.1.6 Control Variables

For control variables, our findings are more in congruence with existing literature, as outlined in the Analysis section. Of interest, very few of the controls were systematically related to sales growth during the recessionary years. This could stem from the low explanatory power of the sales growth model, indicating an omitted variable bias for sales growth in particular. Still, it is likely that sales growth mechanisms change significantly during recessions. We see that shows a positive effect of with increasing coefficient over time as the economy recovers in 2010-2012, supporting the idea that the determinants of sales growth differ from normal times during the recession. Size likely matters for sales growth as the economy recovers, as large firms are more likely to have budgets to push products or services and capture market share at the expense of smaller competitors as the economy recovers.

We also note that a firm's proportion of fixed assets is negatively related to ROA during the recessionary years, though this relationship lessens as the economy recovers. This is likely because sales fall due to demand reductions more quickly than a firm can adjust its asset base. As sales grow to pre-crisis levels, this relationship evaporates. During recessions, however, this effect looks quite a lot like leverage. It is therefore important consideration for managers and investors alike, though, of course, our study is unable to account for risk-adjusted returns.

A firm's proportion of fixed assets is, inversely to the ROA relationship, positively related to EBITDA margin. This makes sense – a firm with a high proportion of fixed assets will have a higher proportion of its costs in depreciation and amortisation, inflating the EBITDA performance, even in the face of demand and sales reductions. Still, this indicates positively about the cash generation capability of firms with higher proportions of fixed assets, even if accounting measures of profit (i.e., the net income input in the ROA performance measure) are lower for these firms.

5.2 Theoretical Implications and Direction for Future Studies

The findings presented here fly in the face other empirical innovation studies and innovation theory, and what little is written about innovators during recessions (Geroski, Machin & Van Reenen, 1993; Knudsen and Lien, 2015). We not only reject our hypotheses based on prevailing literature about innovation, but find the opposite of what was expected. This raises more questions than it answers, as, though we have attempted to explain our findings using existing theory, the underlying mechanisms for our findings are still hidden from empirical view. This clearly positions innovation during recessions as a research area that is begging for academic attention and further empirical studies.

There are many important directions for future studies to analyse. One is as simple as expanding the analysis to span accounting data for the entire recessionary period, from the high-growth boom prior to the recession, through the recessionary trough, and return to prior economic growth and performance. This would allow for a more accurate comparison of recession effects versus innovation in a normal economic climate. Our results, through the change in the size of the coefficients and statistical significance, clearly indicate that there is a concrete recession effect, but the comparison to innovation in normal times would be instructive. And once the recession has passed, does the coefficient turn positive and significant, or does innovation become a statistically insignificant factor in firm performance? Such a study could also show which of the effects found in this thesis are recession-specific, and which are more general, as one might reasonably expect with for instance product innovation on EBITDA margins.

Further, one could analyse the impact of innovation activities across different recessions. Would we, for instance, find similar innovation-performance patterns if we were to analyse the dot-com crisis of 2001 in Norway with similar data? Perhaps certain recessionary characteristics affect the effect of innovation on performance – determining these characteristics would be crucial to managers of firms in knowledge industries, and would be an important investigative avenue for researchers seeking to understand either recessions in general, or firm performance during recessions.

A natural extension of such an analysis would be to consider recessions, firm performance and innovation in other countries for comparison. The CIS is administered by Eurostat, and innovation data is collected from the vast majority of EU countries. As such, the innovation data is available, and public accounting data matched by a national bureau of statistics, as was the case in our study, would allow for direct comparisons of effects of innovation originating from the same crisis in different countries. For a larger country analysis, country could be an important control variable, and our findings may not be applicable abroad. Further, if country effect is the explanation for our findings here in Norway, rather than generalizable recessionary effects on innovation, then an analysis of country characteristics that affect innovation-performance link during recessions would be a tremendously interesting study. Indeed, it would be an interesting to look more closely at Filippetti & Archibugi’s (2010) classification of national systems of innovation and country-specific recession characteristics in order to understand the mechanisms underlying our findings.

As we see indications of specific year effects in our analysis, this is also a ripe area for empirical investigation. What about 2012, for instance, was it that accentuated the negative effects of innovation activities on performance? Matching the datasets used in this thesis across time could also lend itself to a more detailed econometric time series analysis, which could give further insights into the characteristics of high-performing innovators versus low-performing innovators. By classifying innovators according to performance rather than amount of innovation activity undertaken as in our study, and by using a time-matched dataset, future studies can uncover the characteristics that lead to superior innovation performance during recessions. This is possible with the same datasets we used, as these have a wealth of accounting data beyond what was used in this thesis.

Industry effects has been found to be an important factor in determining firm performance, both in normal times and during recessions. It stands to reason that industry is also an important factor to investigate when it comes to the innovation-performance link during recessions. We simply controlled for industry in our study, but a more detailed industry-by-industry analysis could help identify the industry characteristics that affect the innovation-performance link. This kind of empirical investigation is also of key managerial and academic interest in helping understand firm performance and innovation during recessions.

Future studies should also seek uncover the mechanisms through which innovation during recessions lead to underperformance. Innovation activities do not lead to identical performance outcomes for all innovators, and what leads to these differences is an important analysis to conduct. Part of such an investigation can be done using the datasets we used, though a thorough qualitative study of innovators who underperform non-innovators could also provide valuable insights that accounting data cannot, for instance through evaluations of culture, the strategy in place, adaptability and flexibility, and so forth. On the quantitative side, studies similar to ours can also more closely investigate interaction effects between the control variables and innovation activities, in order to uncover characteristics that increase or decrease the value and performance effect of innovation activities.

There are also a number of other innovation variables in the CIS datasets we obtained from SSB, whose effect on performance could be investigated, such as R&D headcount, spend, market orientation, and innovation purpose. How does R&D spend affect performance during recession? Does purpose-driven innovation outperform innovation that is not purpose-driven during recessions? One could also look more closely at the specific innovation questions, which have been aggregated up in our analysis. Such granular investigations and detailed data provides a fertile ground for future research.

Of course, further granularity is always desired in empirical research. If similar innovation data was available annually, one could much more accurately investigate the time lag between innovation and firm performance, and also better avoid the timing issues that remain a challenge with the three-year CIS period. Additionally, firm age is an important explanatory variable for firm performance that our dataset did not allow us to control for. This data is publically available to researchers, though it was removed in the anonymisation process in our study. A study adding such granularity and data would provide a key confirmation of our findings in this thesis, or challenge them – both important outcomes in further improving the empirical understanding of innovation-performance link during recessions.

5.3 Limitations of Results

Though our analysis found innovation to be a statistically important explanatory variable, and uncovered statistically significant negative performance effects of innovation effects during recessions, the results are not without reproach. We will not recount the limitations discussed in our methodology section, though there are a few reasons to take pinch of salt with our results. In brief, our results do not take into account the effect firm age in performance during recessions, nor were we able to account for year effects, which our results indicate are important. We know these two variables give our study some degree of omitted variable bias, and there is always the possibility that the innovation-performance link works through other mechanisms we are unable to observe through the data we have available.

Another important thing to keep in mind is a firm's motivation to perform innovation. For instance, one might expect product innovations to be designed to increase sales and drive growth. But it could also be that a poorly performing firm is forced to renew its product and copy its competitors. That might be an innovation for the firm, but not for the market – and this would be counted as a product innovation in the CIS questionnaire. So we see two plausible explanations for an innovation – one is to stay ahead of the competition in delivering value to the customer, and the other is being forced to innovate in order to not be left behind and out-innovated by competitors. This is an important distinction. Does innovation lead to poor performance, or does poor performance force firms to innovate? If it is the latter, a recession is likely to strengthen this effect. Our study is unfortunately unable to separate these two, and it may therefor be too bold to state unequivocally that innovation is the driver of an innovator's underperformance, though our results indicate that this may indeed be the case.

6. Conclusion

The intention of our study has been to investigate the effect of innovation prior to and during the recession on firm performance during and after the recession. In order to answer this question, we looked at the performance of innovators as a whole, as well as how innovation and firm performance varied with relative degree of innovation. Finally, we also investigated whether the type of innovation activity a firm engages in matters for its performance.

There has been limited empirical research on the innovation-performance link during recessions prior to this study, though some scholars have proposed hypotheses about an expected positive innovation-performance relationship, and the decisions that firms make regarding their R&D investments during recessions. Our aim with this thesis has been to provide empirical evidence for the size and directionality of the innovation-performance link across different phases of the recession.

Our main discovery was clear negative link between innovation and performance. This was valid for innovation both prior to and during the recession. We not only reject our original hypotheses, in which we postulated a positive performance link, but indeed find that the opposite of our expectation is true. We find that this negative effect was stronger the more a firm innovated, relative to its peers, regardless of whether the innovation took place prior to or during the recession – indeed, from our analysis we see that in several years, it was only the top quartile of innovators that exhibited a statistically significant negative innovation-performance link.

Type of innovation was also found to be a predictor of performance, as expected. Market innovation was found to exhibit a negative performance link on both ROA and EBITDA margins. Product innovation was also found to have a negative effect on EBITDA margins, but positive effects on sales growth. Finally, process innovation exhibited a very strong positive effect on sales growth in 2010 only.

There are a number of possible explanations for the negative performance effect of innovation during recessions. Recessions may change in the optimal exploration focus of firms, leading more firms to over-innovate. Innovating may also create spill-over effects, such that competitors may reap the benefit of a firm’s innovation without incurring the full cost. Further, performing innovation activities does not mean that firms are skilled at innovation – the firms that innovate the most may lack innovation specialisation and expertise. Firms that borrow in order to maintain innovation investments during the recession may experience firm specific negative capital structure effects, such as debt overhang problems. Firms that innovate prior to the recession are also more likely to have new and marginal interactions with other players in their product market, and these new interactions are likely the first to be abandoned during recessions.

Though the statistical significance of our findings is high, there are a number of limiting considerations to keep in mind when interpreting our results. There is a motivational component to innovation that plays an important role we are unable to control or verify. Does market pressures force a poorly performing firm to change, or is innovation motivated by a desire to proactively increase sales and profits? Similarly, a firm that is forced to reorganise or restructure may respond yes to the CIS questions surrounding organisational innovation, which may further create a negative performance bias in the sample of innovating firms. The unknown time lag between innovation activity and performance outcomes also confounds the study, as does the omitted control variables for year effects and firm age.

Despite limitations, we have found strong statistical significance in a negative innovation-performance link during recessions, with several strategic and managerial explanations for this poor performance of innovating firms. We feel confident in its relevance, validity and reliability, both for academics in future research, and for practitioners in managerial positions.

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7. Appendices

7.1 Appendix 1: Regression results

Here, we present the total regression output, presented by dataset and dependent variable. This output shows the regressions both with and without the squared leverage term, for the full and innovators only dataset.

ROA Regression Output CIS2006-2008, SNF 2008

CIS 2006-2008, SNF 2008

	Dependent Variable: ROA									
	Full Dataset						Innovators Only			
	Model						Model			
	(1) Control		(2) Innovators versus Non-Innovators		(3) Degree of Innovation		(1) Control		(4) Type of Innovation	
Focus Variable: Innovation										
Innovator vs. Non-Innovator Dummy	-		-0.018***	-0.018***	-		-		-	
			(-4.453)	(-4.588)						
Innovation Quartile Dummy	-						-		-	
1st Quartile			-		-0.031***	-0.030***				
	-				(-4.336)	(-4.263)	-		-	
2nd Quartile			-		-0.020***	-0.019***				
	-				(-2.676)	(-2.606)	-		-	
3rd Quartile	-		-		-0.013**	-0.014**	-		-	
					(-2.123)	(-2.259)				
4th Quartile	-		-		-0.013**	-0.014**	-		-	
					(-2.188)	(-2.444)				
Innovation Type Dummy										
Product Innovation	-		-		-		-		-0.010	-0.008
									(-1.346)	(1.178)
Process Innovation	-		-		-		-		0.008	0.007
									(1.209)	(1.181)
Market Innovation	-		-		-		-		-0.009	-0.007
									(-1.285)	(-1.056)
Organisational Innovation	-		-		-		-		-0.007	-0.006
									(-1.116)	(-0.951)
Control Variables										
Leverage	-0.106***	0.485***	-0.107***	0.485***	-0.107***	0.483***	-0.105***	0.546***	-0.108***	0.539***
	(-8.031)	(7.619)	(-8.084)	(7.660)	(-8.122)	(7.623)	(-4.667)	(5.228)	(-4.739)	(5.175)
Leverage^2	-	-0.442***	-	-0.443***	-	-0.442**	-	-0.486***	-	-0.482***
		(-9.437)		(-9.488)		(-9.456)		(-6.171)		(-6.144)
Liquidity	0.204***	0.206***	0.202***	0.204***	0.202**	0.204***	0.204***	0.211***	0.120***	0.207***
	(15.582)	(15.892)	(15.475)	(15.778)	(15.478)	(15.781)	(9.262)	(9.748)	(9.017)	(9.527)
Size	0.009***	0.007***	0.010***	0.008***	0.010***	0.008***	0.015***	0.012***	0.016***	0.013***
	(6.753)	(4.801)	(7.293)	(5.376)	(7.429)	(5.502)	(6.889)	(5.715)	(7.236)	(6.011)
Proportion of Fixed Assets	-0.059***	-0.049***	-0.059***	-0.048***	-0.058***	-0.048***	-0.076***	-0.069***	-0.077***	-0.070***
	(-5.697)	(-4.807)	(-5.642)	(-4.749)	(-5.567)	(-4.689)	(-4.253)	(-3.940)	(-4.242)	(-3.940)
Constant	-0.043	-0.179***	-0.051*	-0.187***	-0.057*	-0.192***	-0.142***	-0.285***	-0.082	-0.224***
	(-1.409)	(-5.383)	(-1.679)	(-5.628)	(-1.857)	(-5.716)	(-2.931)	(-5,255)	(-1.538)	(-3.953)
Industry Dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	5326	5326	5326	5326	5326	5326	2322	2322	2322	2322
R-Square	0.159	0.198	0.162	0.202	0.163	0.202	0.151	0.192	0.153	0.194
F-value	16.734	18.468	16.763	18.497	15.953	17.605	6.657	7.343	6.283	6.951

*Note: *** p < 0.01, ** p < 0.05, * p <0.10. Robust standard errors in brackets.*

EBITDA Margin Regression Output CIS2006-2008, SNF 2008

CIS 2006-2008, SNF 2008

	Dependent Variable: EBITDA Margin									
	Full Dataset						Innovators Only			
	Model						Model			
	(1) Control		(2) Innovators versus Non-Innovators		(3) Degree of Innovation		(1) Control		(4) Type of Innovation	
Focus Variable: Innovation										
Innovator vs. Non-Innovator Dummy	-		-0.016***	-0.016***	-		-		-	
			(-3.872)	(-3.958)						
Innovation Quartile Dummy	-						-		-	
1st Quartile			-		-0.036***	-0.036***				
	-				(-4.593)	(-4.568)	-		-	
2nd Quartile			-		-0.022***	-0.022***				
	-				(-3.128)	(-3.101)	-		-	
3rd Quartile	-		-		-0.014**	-0.015**	-		-	
					(-2.061)	(-2.146)				
4th Quartile	-		-		-0.002	-0.003	-		-	
					(-0.463)	(-0.603)				
Innovation Type Dummy										
Product Innovation	-		-		-		-		-0.009	-0.007
									(-1.275)	(-1.146)
Process Innovation	-		-		-		-		-0.001	-0.001
									(-0.176)	(-0.236)
Market Innovation	-		-		-		-		-0.019***	-0.018***
									(-3.087)	(-2.952)
Organisational Innovation	-		-		-		-		-0.016**	-0.015**
									(-2.544)	(-2.412)
Control Variables										
Leverage	-0.068***	0.302***	-0.068***	0.303***	-0.069***	0.299***	-0.070***	0.466***	-0.075***	0.482***
	(-4.703)	(3.843)	(-4.741)	(3.853)	(-4.813)	(3.811)	(-2.880)	(4.173)	(-2.979)	(4.258)
Leverage^2		-0.277***		-0.277***		-0.275***		-0.400***		-0.415***
		(-4.822)		(-4.838)		(-4.805)		(-4.562)		(-4.619)
Liquidity	0.164***	0.166***	0.163***	0.164***	0.0163***	0.164***	0.162***	0.170***	0.154***	0.161***
	(12.261)	(12.729)	(12.181)	(12.643)	(12.170)	(12.631)	(6.332)	(7.273)	(6.077)	(6.989)
Size	0.011***	0.009***	0.012***	0.010***	0.012***	0.011***	0.017***	0.015***	0.019***	0.017***
	(6.951)	(5.816)	(7.236)	(6.178)	(7.471)	(6.408)	(7.148)	(6.422)	(9.767)	(7.000)
Proportion of Fixed Assets	0.058***	0.065***	0.059***	0.065***	0.060***	0.067***	0.027	0.034	0.026	0.032
	(4.080)	(4.615)	(4.201)	(4.725)	(4.333)	(4.854)	(1.292)	(1.631)	(1.226)	(1.528)
Constant	-0.127***	-0.217***	-0.172***	-0.254***	-0.182***	-0.263***	-0.243***	-0.370***	-0.232***	-0.353***
	(-4.183)	(-5.943)	(-4.709)	(-6.292)	(-4.947)	(-6.501)	(-5.072)	(-6.708)	(-4.229)	(-5.896)
Industry Dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	5326	5326	5326	5326	5326	5326	2322	2322	2322	2322
R-Square	0.155	0.172	0.158	0.174	0.161	0.177	0.123	0.155	0.133	0.167
F-value	12.131	13.866	12.025	13.638	11.521	13.000	6.395	6.576	6.606	8.707

*Note: *** p < 0.01, ** p < 0.05, * p <0.10. Robust standard errors in brackets.*

ROA Regression Output CIS2006-2008, SNF 2009

CIS 2006-2008, SNF 2009

Dependent Variable: ROA										
	Full Dataset						Innovators Only			
	Model						Model			
	(1) Control		(2) Innovators versus Non-Innovators		(3) Degree of Innovation		(1) Control		(4) Type of Innovation	
Focus Variable: Innovation										
Innovator vs. Non-Innovator Dummy	-		-0.007*	-0.009**	-		-		-	
			(-1,876)	(-2.335)						
Innovation Quartile Dummy	-						-		-	
1st Quartile			-		-0.009	-0.009				
	-				(-1.311)	(-1.370)	-		-	
2nd Quartile			-		-0.002	-0.004				
	-				(-0.358)	(-0.621)	-		-	
3rd Quartile	-		-		-0.013*	-0.014**	-		-	
					(-1.930)	(-2.185)				
4th Quartile	-		-		-0.005	-0.007	-		-	
					(-0.980)	(-1.462)				
Innovation Type Dummy										
Product Innovation	-		-		-		-		0.001	0.002
									(0.202)	(0.251)
Process Innovation	-		-		-		-		0.005	0.004
									(0.882)	(0.794)
Market Innovation	-		-		-		-		0.001	0.001
									(0.208)	(0.103)
Organisational Innovation	-		-		-		-		-0.012**	-0.009
									(-1.974)	(-1.557)
Control Variables										
Leverage	-0.072***	0.445***	-0.072***	0.446***	-0.072***	0.446***	-0.064***	0.482***	-0.063***	0.479***
	(-5.158)	(6.995)	(-5.168)	(7.017)	(-5.184)	(7.004)	(-2.942)	(4.415)	(-2.901)	(4.396)
Leverage^2	-	-0.390***	-	-0.391***	-	-0.391***	-	-0.418***	-	-0.414***
		(-7.999)		(-8.021)		(-8.004)		(-4.768)		(-4.752)
Liquidity	0.122***	0.127***	0.121***	0.127***	0.121***	0.127***	0.119***	0.122***	0.116***	0.212***
	(8.483)	(9.068)	(8.448)	(9.027)	(8.432)	(9.011)	(5.952)	(6.040)	(5.761)	(5.993)
Size	0.012***	0.009**	0.013***	0.010***	0.013***	0.010***	0.013***	0.011***	0.014***	0.012***
	(8.998)	(6.883)	(9.189)	(7.182)	(9.143)	7.111	(6.624)	(5.364)	(6.933)	(5.586)
Proportion of Fixed Assets	-0.028***	-0.021**	-0.028***	-0.021**	-0.028***	-0.020**	-0.038***	-0.039***	-0.039***	-0.039**
	(-2.858)	(-2.185)	(-2.838)	(-2.159)	(-2.825)	(-2.151)	(-2.604)	(-2.603)	(-2.628)	(-2.562)
Prior Performance (ROA)	0.356***	0.325***	0.253***	0.324***	0.354***	0.324***	0.378***	0.353***	0.377***	0.353***
	(12.524)	(11.958)	(12.471)	(11.891)	(12.473)	(11.898)	(9.544)	(9.280)	(9.594)	(9.322)
Constant	-0.161***	-0.261***	-0.164***	-0.265***	-0.163***	-0.264***	-0.154***	-0.272***	-0.171***	-0.311***
	(-4.989)	(-7.444)	(-5.079)	(-7.540)	(-5.033)	(-7.484)	(-3.1764)	(-5.274)	(-3.507)	(-6.567)
Industry Dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	5093	5093	5093	5093	5093	5093	2217	2217	2217	2217
R-Square	0.238	0.275	0.239	0.276	0.239	0.276	0.272	0.306	0.273	0.307
F-value	15.327	17.009	15.130	16.761	14.511	16.058	7.719	8.368	7.160	7.980

*Note: *** p < 0.01, ** p < 0.05, * p <0.10. Robust standard errors in brackets.*

EBITDA Margin Regression Output CIS2006-2008, SNF 2009

CIS 2006-2008, SNF 2009

	Dependent Variable: EBITDA Margin									
	Full Dataset						Innovators Only			
	Model						Model			
	(1) Control		(2) Innovators versus Non-Innovators		(3) Degree of Innovation		(1) Control		(4) Type of Innovation	
Focus Variable: Innovation										
Innovator vs. Non-Innovator Dummy	-		-0.004	-0.005	-		-		-	
			(-1.432)	(-1.587)						
Innovation Quartile Dummy	-						-		-	
1st Quartile			-		-0.004	-0.004				
	-				(-0.721)	(-0.713)	-		-	
2nd Quartile			-		-0.003	-0.004				
	-				(-0.542)	(-0.634)	-		-	
3rd Quartile	-		-		-0.008	-0.009	-		-	
					(-1.392)	(-1.479)				
4th Quartile	-		-		-0.003	-0.003	-		-	
					(-0.677)	(-0.850)				
Innovation Type Dummy										
Product Innovation	-		-		-		-		0.001	0.001
									(0.183)	(0.275)
Process Innovation	-		-		-		-		0.003	0.002
									(0.554)	(0.485)
Market Innovation	-		-		-		-		-0.000	-0.000
									(-0.012)	(-0.048)
Organisational Innovation	-		-		-		-		-0.004	-0.002
									(-0.830)	(-0.514)
Control Variables										
Leverage	-0.020*	0.161***	-0.020*	0.162***	-0.020*	0.162***	-0.018	0.236***	-0.018	0.234***
	(-1.895)	(3.526)	(-1.904)	(3.5439	(-1.915)	(3.534)	(-0.979)	(2.728)	(-0.961)	(2.697)
Leverage^2	-	-0.137***	-	-0.137***	-	-0.137***	-	-0.194***	-	-0.193***
		(-4.171)		(-4.189)		(-4.177)		(-2.990)		(-2.967)
Liquidity	0.073***	0.074***	0.072***	0.074***	0.072***	0.073***	0.011***	0.073***	0.070***	0.072***
	(6.999)	(7.104)	(6.968)	(7.071)	(6.951)	(7.055)	(4.043)	(4.096)	(4.018)	(4.104)
Size	0.010***	0.009***	0.010***	0.009***	0.010***	0.009***	0.011***	0.010***	0.011***	0.010***
	(7.124)	(6.239)	(7.207)	(6.364)	(7.165)	(6.307)	(5.115)	(4.482)	(5.300)	(4.616)
Proportion of Fixed Assets	0.031***	0.034***	0.031***	0.034***	0.031***	0.034***	0.045***	0.046***	0.044***	0.045***
	(2.788)	(3.0739	(2.803)	(3.091)	(2.822)	(3.107)	(2.743)	(2.787)	(2.740	(2.743)
Prior Performance (EBITDA Margin)	0.588***	0.581***	0.587***	0.580***	0.587***	0.580***	0.546***	0.534***	0.545***	0.532***
	(19.127)	(18.648)	(19.091)	(18.605)	(19.081)	(18.596)	(12.095)	(11.565)	(12.088)	(11.548)
Constant	-0.157***	-0.192***	-0.159***	-0.195***	-0.158***	-0.194***	-0.147***	-0.203***	-0.154***	-0.199***
	(-4.914)	(-5.791)	(-4.946)	(-5.823)	(-4.891)	(-5.769)	(-2.658)	(-3.524)	(-2.780)	(-3.454)
Industry Dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	5093	5093	5093	5093	5093	5093	2217	2217	2217	2217
R-Square	0.442	0.447	0.442	0.447	0.443	0.448	0.385	0.394	0.386	0.394
F-value	35.079	35.739	34.656	35.304	33.110	33.688	14.753	15.041	13.784	14.326

*Note: *** p < 0.01, ** p < 0.05, * p <0.10. Robust standard errors in brackets.*

Sales Growth Regression Output CIS2006-2008, SNF 2009

CIS 2006-2008, SNF 2009

	Dependent Variable: Sales Growth									
	Full Dataset						Innovators Only			
	Model						Model			
	(1) Control		(2) Innovators versus Non-Innovators		(3) Degree of Innovation		(1) Control		(4) Type of Innovation	
Focus Variable: Innovation										
Innovator vs. Non-Innovator Dummy	-		0.016	0.017	-		-		-	
			(0.501)	(0.682)						
Innovation Quartile Dummy	-						-		-	
1st Quartile			-		0.063	0.062				
	-				(1.258)	(1.254)	-		-	
2nd Quartile			-		-0.002	-0.001				
	-				(-0.045)	(-0.026)	-		-	
3rd Quartile	-		-		0.020	0.021	-		-	
					(0.548)	(0.552)				
4th Quartile	-		-		-0.003	-0.002	-		-	
					(-0.117)	(-0.075)				
Innovation Type Dummy										
Product Innovation	-		-		-		-		0.076*	0.074*
									(1.930)	(1.945)
Process Innovation	-		-		-		-		0.033	0.036
									(0.963)	(1.034)
Market Innovation	-		-		-		-		0.021	0.023
									(0.713)	(0.775)
Organisational Innovation	-		-		-		-		0.001	-0.008
									(0.043)	(-0.221)
Control Variables										
Leverage	0.283***	-0.015	0.280***	-0.020	0.283***	-0.011	0.328*	-1.482	0.339*	-1.483
	(3.396)	(-0.035)	(3.373)	(-0.048)	(3.398)	(-0.027)	(1.808)	(-1.441)	(1.843)	(-1.440)
Leverage^2	-	0.224	-	0.226	-	0.221	-	1.380	-	1.389
		(0.635)		(0.638)		(0.624)		(1.530)		(1.532)
Liquidity	-0.013	-0.013	-0.019	-0.020	-0.017	-0.017	-0.020	-0.016	-0.036	-0.034
	(-0.218)	(-0.227)	(-0.333)	(-0.342)	(-0.294)	(-0.303)	(-0.165)	(-0.131)	(-0.299)	(-0.282)
Size	0.024***	0.026***	0.023***	0.025***	0.023***	0.024***	0.011	0.020	0.012	0.022
	(3.682)	(3.499)	(3.431)	(3.438)	(3.280)	(3.264)	(0.934)	(1.552)	(0.949)	(1.489)
Proportion of Fixed Assets	-0.010	-0.014	-0.016	-0.020	-0.018	-0.022	-0.068	-0.072	-0.089	-0.093
	(-0.105)	(-0.148)	(-0.169)	(-0.209)	(-0.191)	(-0.229)	(-0.748)	(-0.783)	(-0.973)	(-1.008)
Constant	-0.624***	-0.566***	-0.479**	-0.420**	-0.467**	-0.410**	-0.333	0.051	-0.181	0.205
	(-4.731)	(-4.166)	(-2.506)	(-2.105)	(-2.432)	(-2.060)	(-1.338)	(0.186)	(-0.415)	(0.498)
Industry Dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	5093	5093	5093	5093	5093	5093	2217	2217	2217	2217
R-Square	0.032	0.033	0.033	0.033	0.033	0.034	0.036	0.053	0.040	0.058
F-value	6.295	6.465	6.188	6.410	5.844	6.068	4.601	8.523	3.315	3.337

*Note: *** p < 0.01, ** p < 0.05, * p <0.10. Robust standard errors in brackets.*

ROA Regression Output CIS2006-2008, SNF 2010

CIS 2006-2008, SNF 2010

	Dependent Variable: ROA									
	Full Dataset						Innovators Only			
	Model						Model			
	(1) Control		(2) Innovators versus Non-Innovators		(3) Degree of Innovation		(1) Control		(4) Type of Innovation	
Focus Variable: Innovation										
Innovator vs. Non-Innovator Dummy	-	-	-0.003	-0.004	-	-	-	-	-	-
			(-0.831)	(-1.029)						
Innovation Quartile Dummy	-	-					-	-	-	-
1st Quartile			-	-	-0.013**	-0.014**				
	-	-			(-2.100)	(-2.192)	-	-	-	-
2nd Quartile			-	-	-0.005	-0.005				
	-	-			(-0.824)	(-0.869)	-	-	-	-
3rd Quartile	-	-	-	-	-0.005	-0.005	-	-	-	-
					(-0.846)	(-0.903)				
4th Quartile	-	-	-	-	0.005	0.003	-	-	-	-
					(0.850)	(0.622)				
Innovation Type Dummy										
Product Innovation	-	-	-	-	-	-	-	-	-0.004	-0.004
									(-0.688)	(-0.600)
Process Innovation	-	-	-	-	-	-	-	-	-0.003	-0.003
									(-0.521)	(-0.601)
Market Innovation	-	-	-	-	-	-	-	-	-0.005	-0.006
									(-0.951)	(-1.091)
Organisational Innovation	-	-	-	-	-	-	-	-	-0.007	-0.007
									(-1.188)	(-1.122)
Control Variables										
Leverage	-0.063***	0.271***	-0.064***	0.271***	-0.064***	0.269***	-0.058***	0.244***	-0.060***	0.243***
	(-5.334)	(4.800)	(-5.342)	(4.810)	(-5.400)	(4.782)	(-3.670)	(3.272)	(-3.737)	(3.248)
Leverage^2	-	-0.256***	-	-0.256***	-	-0.255***	-	-0.235***	-	-0.235***
		(-5.510)		(-5.521)		(-5.508)		(-3.836)		(-3.835)
Liquidity	0.104***	0.107***	0.104***	0.106***	0.103***	0.106***	0.111***	0.113***	0.109***	0.111***
	(8.221)	(8.430)	(8.181)	(8.386)	(8.115)	(8.320)	(5.132)	(5.296)	(4.935)	(5.082)
Size	0.012***	0.010***	0.012***	0.010***	0.012***	0.010***	0.015***	0.013***	0.015***	0.014***
	(7.968)	(6.820)	(7.958)	(6.842)	(8.027)	(6.924)	(6.653)	(5.880)	(6.578)	(5.865)
Proportion of Fixed Assets	-0.033***	-0.030***	-0.033***	-0.030***	-0.032***	-0.029***	-0.044***	-0.044***	-0.044***	-0.043***
	(-3.461)	(-3.138)	(-3.449)	(-3.123)	(-3.403)	(-3.081)	(-2.979)	(-2.943)	(-2.934)	(-2.913)
Prior Performance (ROA)	0.379***	0.357***	0.379***	0.357***	0.378***	0.356***	0.399***	0.386***	0.406***	0.385***
	(13.480)	(12.439)	(13.466)	(12.420)	(13.447)	(12.406)	(11.592)	(10.872)	(11.831)	(10.858)
Constant	-0.167	-0.227**	-0.169*	-0.230**	-0.171*	-0.231**	-0.204***	-0.618	-0.193***	-0.257***
	(-1.633)	(-2.348)	(-1.658)	(-2.387)	(-1.710)	(-2.453)	(-4.736)	(-0.827)	(-3.570)	(-4.707)
Industry Dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	4874	4874	4874	4874	4874	4874	2119	2119	2119	2119
R-Square	0.260	0.276	0.260	0.276	0.261	0.277	0.292	0.307	0.296	0.308
F-value	17.649	17.408	17.417	17.193	16.855	16.662	9.911	9.810	9.406	9.420

*Note: *** p < 0.01, ** p < 0.05, * p <0.10. Robust standard errors in brackets.*

EBITDA Margin Regression Output CIS2006-2008, SNF 2010

CIS 2006-2008, SNF 2010

	Dependent Variable: EBITDA Margin									
	Full Dataset						Innovators Only			
	Model						Model			
	(1) Control		(2) Innovators versus Non-Innovators		(3) Degree of Innovation		(1) Control		(4) Type of Innovation	
Focus Variable: Innovation										
Innovator vs. Non-Innovator Dummy	-	-	-0.001	0.001	-	-	-	-	-	-
			(-0.197)	(0.248)						
Innovation Quartile Dummy	-	-					-	-	-	-
1st Quartile			-	-	-0.010	-0.011				
	-	-			(-1.587)	(-1.606)	-	-	-	-
2nd Quartile			-	-	-0.007	-0.007				
	-	-			(-1.210)	(-1.216)	-	-	-	-
3rd Quartile	-	-	-	-	-0.002	-0.002	-	-	-	-
					(-0.414)	(-0.416)				
4th Quartile	-	-	-	-	0.009**	0.009**	-	-	-	-
					(2.068)	(1.993)				
Innovation Type Dummy										
Product Innovation	-	-	-	-	-	-	-	-	-0.012**	-0.012**
									(-2.345)	(-2.304)
Process Innovation	-	-	-	-	-	-	-	-	-0.008*	-0.009*
									(-1.693)	(-1.799)
Market Innovation	-	-	-	-	-	-	-	-	-0.004	-0.005
									(-0.760)	(-0.877)
Organisational Innovation	-	-	-	-	-	-	-	-	-0.008	-0.008
									(-1.541)	(-1.515)
Control Variables										
Leverage	-0.045***	0.061	-0.045***	0.062	-0.046***	0.059	-0.047***	0.162**	-0.050***	0.161**
	(-4.245)	(1.239)	(-4.246)	(1.241)	(-4.318)	(1.201)	(-2.893)	(2.224)	(-3.032)	(2.219)
Leverage^2	-	-0.081**	-	-0.081**	-	-0.080**	-	-0.162***	-	-0.163***
		(-2.277)		(-2.280)		(-2.254)		(-2.985)		(-3.006)
Liquidity	0.068***	0.068***	0.068***	0.068***	0.067***	0.068***	0.088***	0.088***	0.087***	0.087***
	(5.150)	(5.156)	(5.130)	(5.135)	(5.090)	(5.095)	(3.857)	(3.919)	(3.797)	(3.812)
Size	0.005***	0.004***	0.005***	0.005***	0.005***	0.005***	0.009***	0.008***	0.010***	0.009***
	(3.161)	(2.804)	(3.133)	(2.785)	(3.342)	(3.002)	(3.991)	(3.457)	(4.174)	(3.710)
Proportion of Fixed Assets	0.032***	0.034***	0.032***	0.034***	0.033***	0.035***	0.022	0.024	0.024	0.026
	(2.792)	(2.888)	(2.800)	(2.896)	(2.873)	(2.966)	(1.160)	(1.236)	(1.252)	(1.334)
Prior Performance (EBITDA Margin)	0.612***	0.609***	0.612***	0.609***	0.611***	0.608***	0.542***	0.536***	0.542***	0.535***
	(20.619)	(20.400)	(20.614)	(20.394)	(20.582)	(20.365)	(12.186)	(11.976)	(12.209)	(12.004)
Constant	-0.069	-0.090	-0.070	-0.091	-0.073	-0.094	-0.127***	-0.314	-0.121***	-0.164***
	(0.698)	(-0.513)	(0.392)	(-0.516)	(-0.414)	(-0.537)	(-2.941)	(-0.618)	(-2.767)	(-3.571)
Industry Dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	4874	4874	4874	4874	4874	4874	2119	2119	2119	2119
R-Square	0.453	0.454	0.453	0.454	0.454	0.455	0.387	0.393	0.391	0.396
F-value	35.073	34.771	34.609	34.328	33.547	33.171	13.045	12.919	12.671	13.035

*Note: *** p < 0.01, ** p < 0.05, * p <0.10. Robust standard errors in brackets.*

Sales Growth Regression Output CIS2006-2008, SNF 2010

CIS 2006-2008, SNF 2010

	Dependent Variable: Sales Growth									
	Full Dataset						Innovators Only			
	Model						Model			
	(1) Control		(2) Innovators versus Non-Innovators		(3) Degree of Innovation		(1) Control		(4) Type of Innovation	
Focus Variable: Innovation										
Innovator vs. Non-Innovator Dummy	-	-	0.026	0.026	-	-	-	-	-	-
			(1.028)	(1.035)						
Innovation Quartile Dummy	-	-					-	-	-	-
1st Quartile			-	-	0.106	0.106				
	-	-			(1.022)	(1.023)	-	-	-	-
2nd Quartile			-	-	0.014	0.014				
	-	-			(0.392)	(0.390	-	-	-	-
3rd Quartile	-	-	-	-	-0.013	-0.013	-	-	-	-
					(-0.037)	(-0.739)				
4th Quartile	-	-	-	-	0.015	0.016	-	-	-	-
					(0.558)	(0.583)				
Innovation Type Dummy										
Product Innovation	-	-	-	-	-	-	-	-	0.073	0.071
									(1.433)	(1.397)
Process Innovation	-	-	-	-	-	-	-	-	0.107**	0.109***
									(2.027)	(2.036)
Market Innovation	-	-	-	-	-	-	-	-	0.007	0.009
									(0.148)	(0.207)
Organisational Innovation	-	-	-	-	-	-	-	-	0.031	0.028
									(0.425)	(0.386)
Control Variables										
Leverage	0.173**	-0.102	0.174**	-0.104	0.179**	-0.100	0.297*	-0.899	0.306*	-0.899
	(2.269)	(-0.244)	(2.269)	(-0.249)	(2.306)	(-0.236)	(1.742)	(-0.826)	(1.775)	(-0.825)
Leverage^2	-	0.210	-	0.212	-	0.212	-	0.925	-	0.933
		(0.579)		(0.584)		(0.583)		(0.965)		(0.974)
Liquidity	0.053	0.054	0.057	0.057	0.060	0.060	0.157	0.161	0.145	0.145
	(0.909)	(0.910)	(0.952)	(0.953)	(1.024)	(1.025)	(1.324)	(1.352)	(1.319)	(1.324)
Size	0.038***	0.040***	0.037***	0.039***	0.035***	0.037***	0.038***	0.044***	0.037***	0.044***
	(5.856)	(4.973)	(6.265)	(5.237)	(6.237)	(5.149)	(4.062)	(3.121)	(3.206)	(2.623)
Proportion of Fixed Assets	-0.098***	-0.101***	-0.099***	-0.102***	-0.100**	-0.103***	-0.090**	-0.092**	-0.113***	-0.121***
	(2.784)	(-2.800)	(-2.827)	(02.840)	(-2.856)	(-2.867)	(-2.279)	(-2.269)	(-2.817)	(-2,763)
Prior Performance (Sales Growth)	-0.040	-0.041	-0.041	-0.041	-0.041	-0.042	-0.123	-0.129	-0.128	-0.135
	(-0.652)	(-0.649)	(-0.649)	(-0.647)	(-0.648)	(-0.646)	(-1.457)	(-1.504)	(-1.470)	(-1.518)
Constant	0.016	0.068	0.033	0.086	0.043	0.095	-0.920***	-0.769	-1.008***	-0.773***
	(0.027)	(0.118)	(0.056)	(0.149)	(0.070)	(0.162)	(-3.370)	(-0.181)	(-3.298)	(-4.029)
Industry Dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	4874	4874	4874	4874	4874	4874	2119	2119	2119	2119
R-Square	0.018	0.018	0.018	0.018	0.019	0.019	0.020	0.023	0.023	0.026
F-value	6.267	6.429	6.164	6.322	5.878	6.062	3.378	3.045	3.137	3.008

*Note: *** p < 0.01, ** p < 0.05, * p <0.10. Robust standard errors in brackets.*

ROA Regression Output CIS2006-2008, SNF 2011

CIS 2006-2008, SNF 2011

	Dependent Variable: ROA									
	Full Dataset						Innovators Only			
	Model						Model			
	(1) Control		(2) Innovators versus Non-Innovators		(3) Degree of Innovation		(1) Control		(4) Type of Innovation	
Focus Variable: Innovation										
Innovator vs. Non-Innovator Dummy	-	-	-0.000	-0.000	-	-	-	-	-	-
			(-0.082)	(-0.081)						
Innovation Quartile Dummy										
1st Quartile	-	-	-	-	-0.014**	-0.013**	-	-	-	-
					(-2.368)	(-2.179)				
2nd Quartile	-	-	-	-	-0.001	-0.001	-	-	-	-
					(-0.239)	(-0.219)				
3rd Quartile	-	-	-	-	0.010	0.009	-	-	-	-
					(1.639)	(1.538)				
4th Quartile	-	-	-	-	0.001	0.001	-	-	-	-
					(0.176)	(0.149)				
Innovation Type Dummy										
Product Innovation	-	-	-	-	-	-	-	-	-0.005	-0.004
									(-0.960)	(-0.732)
Process Innovation	-	-	-	-	-	-	-	-	0.004	0.004
									(0.754)	(0.826)
Market Innovation	-	-	-	-	-	-	-	-	-0.016***	-0.015***
									(-2.888)	(2.824)
Organisational Innovation	-	-	-	-	-	-	-	-	-0.002	-0.001
									(-0.418)	(-0.185)
Control Variables										
Leverage	-0.018	0.333***	-0.018	0.333***	-0.018	0.331***	-0.015	0.282***	-0.017	0.277***
	(-1.510)	(6.882)	(-1.512)	(6.880)	(-1.526)	(6.820)	(-0.884)	(3.922)	(-0.988)	(3.842)
Leverage^2	-	-0.269***	-	-0.269***	-	-0.267***	-	-0.231***	-	-0.229***
		(-6.655)		(-6.653)		(-6.600)		(-3.961)		(-3.931)
Liquidity	0.108***	0.110***	0.108***	0.110***	0.107***	0.110***	0.135***	0.140***	0.133***	0.137***
	(7.980)	(8.260)	(7.989)	(8.270)	(7.958)	(8.238)	(6.367)	(6.546)	(6.317)	(6.482)
Size	0.005***	0.003**	0.005***	0.003**	0.005***	0.003***	0.007***	0.006***	0.008***	0.007***
	(4.117)	(2.376)	(4.045)	(2.340)	(4.332)	(2.616)	(3.806)	(2.848)	(4.259)	(3.320)
Proportion of Fixed Assets	-0.030***	-0.026***	-0.030***	-0.026***	-0.030***	-0.026***	-0.058***	-0.055***	-0.057***	-0.055***
	(-3.310)	(-2.910)	(-3.305)	(-2.906)	(-3.215)	(-2.826)	(-3.899)	(-3.657)	(-3.837)	(-3.681)
Prior Performance (ROA)	0.408***	0.389***	0.408***	0.389***	0.407***	0.388***	0.406***	0.388***	0.403***	0.385***
	(16.137	(15.679)	(16.120)	(15.662)	(16.098)	(15.640)	(9.968)	(9.663)	(9.910)	(9.608)
Constant	-0.044*	-0.108***	-0.044*	-0.108***	-0.051**	-0.114***	-0.085**	-0.137***	-0.094**	-0.144***
	(-1.837)	(-4.304)	(-1.826)	(-4.279)	(-2.097)	(-4.496)	(-2.221)	(-3.367)	(-2.433)	(-3.546)
Industry Dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	4722	4722	4722	4722	4722	4722	2052	2052	2052	2052
R-Square	0.272	0.293	0.272	0.293	0.274	0.295	0.325	0.338	0.331	0.341
F-value	15.585	16.018	15.316	15.739	14.780	15.193	9.241	9.527	8.977	9.544

*Note: *** p < 0.01, ** p < 0.05, * p <0.10. Robust standard errors in brackets.*

EBITDA Margin Regression Output CIS2006-2008, SNF 2011

CIS 2006-2008, SNF 2011

	Dependent Variable: EBITDA Margin									
	Full Dataset						Innovators Only			
	Model						Model			
	(1) Control		(2) Innovators versus Non-Innovators		(3) Degree of Innovation		(1) Control		(4) Type of Innovation	
Focus Variable: Innovation										
Innovator vs. Non-Innovator Dummy	-	-	-0.001	-0.001	-	-	-	-	-	-
			(-0.389)	(-0.387)						
Innovation Quartile Dummy										
1st Quartile	-	-	-	-	-0.011*	-0.011*	-	-	-	-
					(-1.703)	(-1.663)				
2nd Quartile	-	-	-	-	-0.004	-0.004	-	-	-	-
					(-0.681)	(-0.683)				
3rd Quartile	-	-	-	-	0.008	0.008	-	-	-	-
					(1.327)	(1.307)				
4th Quartile	-	-	-	-	-0.001	-0.001	-	-	-	-
					(-0.179)	(-0.185)				
Innovation Type Dummy										
Product Innovation	-	-	-	-	-	-	-	-	0.001	0.001
									(0.101)	(0.162)
Process Innovation	-	-	-	-	-	-	-	-	-0.001	-0.001
									(-0.192)	(-0.176)
Market Innovation	-	-	-	-	-	-	-	-	-0.016***	-0.016***
									(-3.253)	(-3.234)
Organisational Innovation	-	-	-	-	-	-	-	-	0.001	0.001
									(0.192)	(0.249)
Control Variables										
Leverage	-0.012	0.063	-0.012	0.063	-0.012	0.061	-0.018	0.055	-0.020	0.056)
	(-1.054)	(1.414)	(-1.061)	(1.412)	(-1.068)	(1.376)	(-1.014)	(0.751)	(-1.103)	(0.769)
Leverage^2	-	-0.057*	-	-0.057*	-	-0.056*	-	-0.057	-	-0.059
		(-1.800)		(-1.799)		(-1.761)		(-1.046)		(-1.091)
Liquidity	0.075***	0.075***	0.075***	0.075***	0.074***	0.075***	0.102***	0.102***	0.099***	0.100***
	(6.003)	(6.035)	(5.984)	(6.016)	(5.948)	(5.980)	(5.243)	(5.233)	(5.122)	(5.159)
Size	0.001	0.001	0.001	0.001	0.001	0.001	0.003	0.003	0.004	0.004
	(0.541)	(0.265)	(0.566)	(0.297)	(0.737)	(0.471)	(1.153)	(1.012)	(1.407)	(1.233)
Proportion of Fixed Assets	0.042***	0.043***	0.042***	0.043***	0.042***	0.043***	0.018	0.012	0.017	0.018
	(3.344)	(3.438)	(3.356)	(3.449)	(3.402)	(3.493)	(0.874)	(0.908)	(0.849)	(0.893)
Prior Performance (EBITDA Margin)	0.602***	0.600***	0.602***	0.599***	0.601***	0.599***	0.553***	0.549***	0.550***	0.545***
	(19.455)	(19.336)	(19.475)	(19.356)	(19.427)	(19.308)	(11.552)	(11.420)	(11.485)	(11.353)
Constant	-0.006	-0.020	-0.007	-0.020	-0.013	-0.026	-0.036	-0.052	-0.044	-0.057
	(-0.182)	(-0.531)	(-0.198)	(-0.543)	(-0.352)	(-0.679)	(-0.612)	(-0.840)	(-0.743)	(-0.929)
Industry Dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	4722	4722	4722	4722	4722	4722	2052	2052	2052	2052
R-Square	0.440	0.441	0.440	0.441	0.441	0.442	0.386	0.386	0.388	0.389
F-value	31.207	31.021	30.667	30.490	29.265	29.063	14.821	14.465	14.423	14.538

*Note: *** p < 0.01, ** p < 0.05, * p <0.10. Robust standard errors in brackets.*

Sales Growth Regression Output CIS2006-2008, SNF 2011

CIS 2006-2008, SNF 2011

	Dependent Variable: Sales Growth									
	Full Dataset						Innovators Only			
	Model						Model			
	(1) Control		(2) Innovators versus Non-Innovators		(3) Degree of Innovation		(1) Control		(4) Type of Innovation	
Focus Variable: Innovation										
Innovator vs. Non-Innovator Dummy	-	-	-0.026	-0.026	-	-	-	-	-	-
			(-1.209)	(-1.202)						
Innovation Quartile Dummy										
1st Quartile	-	-	-	-	-0.030	-0.029	-	-	-	-
					(-1.348)	(-1.291)				
2nd Quartile	-	-	-	-	-0.027	-0.027	-	-	-	-
					(-1.081)	(-1.075)				
3rd Quartile	-	-	-	-	-0.007	-0.007	-	-	-	-
					(-0.234)	(-0.247)				
4th Quartile	-	-	-	-	-0.035	-0.053	-	-	-	-
					(-1.211)	(-1.217)				
Innovation Type Dummy										
Product Innovation	-	-	-	-	-	-	-	-	-0.024	-0.023
									(-1.408)	(-1.368)
Process Innovation	-	-	-	-	-	-	-	-	0.021	0.021
									(1.258)	(1.257)
Market Innovation	-	-	-	-	-	-	-	-	-0.011	-0.011
									(-0.640)	(-0.628)
Organisational Innovation	-	-	-	-	-	-	-	-	-0.023	-0.022
									(-1.410)	(-1.377)
Control Variables										
Leverage	0.316*	0.628***	0.315*	0.606***	0.315*	0.606***	0.134***	0.355*	0.130***	0.342*
	(1.797)	(3.359)	(1.797)	(3.364)	(1.797)	(3.330)	(3.098)	(1.961)	(2.971)	(1.890)
Leverage^2	-	-0.223**	-	-0.222**	-	-0.222**	-	-0.171	-	-0.165
		(-2.448)		(-2.435)		(-1.436)		(-1.164)		(-1.121)
Liquidity	0.743	0.483	0.469	0.469	0.469	0.469	0.038	0.035	0.030	0.031
	(1.165)	(1.166)	(1.162)	(1.163)	(1.161)	(1.161)	(0.699)	(0.643)	(0.543)	(0.567)
Size	0.037***	0.035***	0.038***	0.036***	0.038***	0.036***	0.024***	0.023***	0.026***	0.025***
	(4.501)	(4.141)	(4.266)	(3.940)	(4.391)	(4.056)	(4.252)	(3.883)	(4.386)	(4.004)
Proportion of Fixed Assets	-0.118	-0.114	-0.116	-0.113	-0.117	-0.113	-0.086**	-0.088**	-0.088**	-0.086**
	(-1.197)	(-1.155)	(-1.191)	(-1.149)	(-1.182)	(-1.141)	(-2.372)	(-2.373)	(-2.387)	(-2.327)
Prior Performance (Sales Growth)	0.023	0.024	0.024	0.024	0.024	0.024	0.037	0.037	0.037	0.037
	(0.852)	(0.856)	(0.846)	(0.851)	(0.847)	(0.851)	(0.714)	(0.709)	(0.703)	(0.706)
Constant	-0.916***	-0.967***	-0.928***	-0.979***	-0.931***	-0.981***	-0.481***	-0.549***	-0.517***	-0.553***
	(-3.095)	(-3.326)	(-3.057)	(-3.282)	(-3.122)	(-3.346)	(-4.321)	(-4.754)	(-4.334)	(-4.663)
Industry Dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	4722	4722	4722	4722	4722	4722	2052	2052	2052	2052
R-Square	0.023	0.023	0.023	0.023	0.023	0.023	0.113	0.116	0.116	0.117
F-value	3.340	3.493	3.298	3.455	3.191	3.352	2.185	2.127	2.072	2.082

*Note: *** p < 0.01, ** p < 0.05, * p <0.10. Robust standard errors in brackets.*

ROA Regression Output CIS2006-2008, SNF 2012

CIS 2006-2008, SNF 2012

	Dependent Variable: ROA									
	Full Dataset						Innovators Only			
	Model						Model			
	(1) Control		(2) Innovators versus Non-Innovators		(3) Degree of Innovation		(1) Control		(4) Type of Innovation	
Focus Variable: Innovation										
Innovator vs. Non-Innovator Dummy	-	-	-0.008**	-0.008**	-	-	-	-	-	-
			(-2.087)	(-2.084)						
Innovation Quartile Dummy										
1st Quartile	-	-	-	-	-0.024***	-0.024***	-	-	-	-
					(-3.020)	(-3.023)				
2nd Quartile	-	-	-	-	-0.003	-0.002	-	-	-	-
					(-0.474)	(-0.339)				
3rd Quartile	-	-	-	-	-0.012*	-0.012*	-	-	-	-
					(-1.786)	(-1.795)				
4th Quartile	-	-	-	-	-0.000	-0.008	-	-	-	-
					(-0.043)	(-0.113)				
Innovation Type Dummy										
Product Innovation	-	-	-	-	-	-	-	-	-0.009	-0.007
									(-1.493)	(-1.252)
Process Innovation	-	-	-	-	-	-	-	-	-0.005	-0.006
									(-0.760)	(-0.963)
Market Innovation	-	-	-	-	-	-	-	-	-0.017*	-0.013**
									(-1.857)	(-2.073)
Organisational Innovation	-	-	-	-	-	-	-	-	-0.009	-0.008
									(-1.488)	(-1.289)
Control Variables										
Leverage	-0.045***	0.366***	-0.045***	0.365***	-0.046***	0.364***	-0.056***	0.393***	-0.058***	0.391***
	(-3.885)	(7.107)	(-3.927)	(7.100)	(-3.993)	(7.073)	(-3.036)	(5.235)	(-3.172)	(5.220)
Leverage^2	-	-0.318***	-	-0.318***	-	-0.318***	-	-0.349***	-	-0.349***
		(-7.563)		(-7.563)		(-7.550)		(-5.692)		(-5.703)
Liquidity	0.093***	0.096***	0.093***	0.096***	0.092***	0.095***	0.100***	0.103***	0.099***	0.104***
	(7.626)	(7.911)	(7.587)	(7.872)	(7.532)	(7.811)	(4.925)	(5.125)	(4.854)	(5.197)
Size	0.006***	0.003**	0.006***	0.004***	0.007***	0.004***	0.009***	0.006***	0.010***	0.007***
	(4.608)	(2.561)	(4.805)	(2.811)	(4.959)	(2.958)	(4.533)	(3.168)	(4.876)	(3.541)
Proportion of Fixed Assets	-0.010	-0.007	-0.010	-0.007	-0.009	-0.006	-0.019	-0.020	-0.017	-0.012
	(-1.010)	(-0.713)	(-0.961)	(-0.665)	(-0.875)	(-0.585)	(-1.188)	(-1.344)	(-1.040)	(-0.760)
Prior Performance (ROA)	0.455***	0.431***	0.454***	0.430***	0.453***	0.428***	0.460***	0.431***	0.456***	0.428***
	(15.024)	(14.424)	(14.994)	(14.397)	(14.971)	(14.375)	(10.465)	(10.015)	(10.426)	(9.970)
Constant	-0.046	-0.119***	-0.053	-0.125***	-0.057	-0.129***	-0.106***	-0.177***	-0.108***	-0.177***
	(-1.230)	(-3.006)	(1.392)	(-3.151)	(-1.504)	(-3.256)	(-2.581)	(-4.077)	(-2.659)	(-4.098)
Industry Dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	4556	4556	4556	4556	4556	4556	2000	2000	2000	2000
R-Square	0.255	0.281	0.256	0.282	0.258	0.284	0.285	0.312	0.288	0.316
F-value	14.763	15.686	14.761	15.694	14.315	15.313	10.351	9.903	10.051	10.822

*Note: *** p < 0.01, ** p < 0.05, * p <0.10. Robust standard errors in brackets.*

EBITDA Margin Regression Output CIS2006-2008, SNF 2012

CIS 2006-2008, SNF 2012

	Dependent Variable: EBITDA Margin									
	Full Dataset						Innovators Only			
	Model						Model			
	(1) Control		(2) Innovators versus Non-Innovators		(3) Degree of Innovation		(1) Control		(4) Type of Innovation	
Focus Variable: Innovation										
Innovator vs. Non-Innovator Dummy	-	-	0.001	0.001	-	-	-	-	-	-
			(0.386)	(0.412)						
Innovation Quartile Dummy										
1st Quartile	-	-	-	-	-0.007	-0.006	-	-	-	-
					(-0.921)	(-0.889)				
2nd Quartile	-	-	-	-	-0.002	-0.001	-	-	-	-
					(-0.306)	(-0.247)				
3rd Quartile	-	-	-	-	0.003	0.003	-	-	-	-
					(0.435)	(0.444)				
4th Quartile	-	-	-	-	0.006	0.006	-	-	-	-
					(1.303)	(1.289)				
Innovation Type Dummy										
Product Innovation	-	-	-	-	-	-	-	-	-0.005	-0.004
									(-0.909)	(-0.770)
Process Innovation	-	-	-	-	-	-	-	-	-0.005	-0.006
									(-0.971)	(-1.067)
Market Innovation	-	-	-	-	-	-	-	-	-0.009	-0.009*
									(-1.599)	(-1.671)
Organisational Innovation	-	-	-	-	-	-	-	-	-0.002	-0.002
									(-0.375)	(-0.282)
Control Variables										
Leverage	-0.032***	0.108**	-0.032***	0.108**	-0.032***	0.107**	-0.054***	0.133*	-0.056***	0.134*
	(-2.939)	(2.180)	(-2.932)	(2.182)	(-2.949)	(2.162)	(-3.160)	(1.778)	(-3.227)	(1.781)
Leverage^2	-	-0.109***	-	-0.109***	-	-0.108***	-	-0.146***	-	-0.147***
		(-3.085)		(-3.086)		(-3.063)		(-2.665)		(-2.681)
Liquidity	0.064***	0.064***	0.064***	0.064***	0.064***	0.064***	0.059***	0.060***	0.059***	0.060***
	(5.011)	(4.999)	(5.023)	(5.012)	(5.022)	(5.010)	(2.867)	(2.878)	(2.846)	(2.891)
Size	0.001	0.000	0.001	-0.000	0.001	0.000	0.000	-0.001	0.001	-0.001
	(0.610)	(0.020)	(0.557)	(-0.024)	(0.706)	(0.128)	(0.151)	(-0.310)	(0.319)	(-0.178)
Proportion of Fixed Assets	0.045***	0.046***	0.044***	0.046***	0.045***	0.047***	0.055***	0.060***	0.056***	0.059***
	(3.572)	(3.664)	(3.563)	(3.654)	(3.620)	(3.709)	(2.833)	(3.381)	(2.884)	(2.991)
Prior Performance (EBITDA Margin)	0.669***	0.666***	0.669***	0.666***	0.668***	0.665***	0.607***	0.602***	0.604***	0.598***
	(20.333)	(20.177)	(20.323)	(20.168)	(20.251)	(20.098)	(12.678)	(12.496)	(12.581)	(12.341)
Constant	-0.013	-0.038	-0.012	-0.037	-0.017	-0.041	0.037	0.006	0.038	0.010
	(-0.095)	(-0.271)	(-0.087)	(-0.263)	(-0.119)	(-0.292)	(0.662)	(0.098)	(0.651)	(0.150)
Industry Dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	4556	4556	4556	4556	4556	4556	2000	2000	2000	2000
R-Square	0.462	0.465	0.462	0.465	0.463	0.466	0.409	0.414	0.410	0.415
F-value	26.883	27.359	26.397	27.159	25.402	26.440	13.075	13.054	12.521	12.832

*Note: *** p < 0.01, ** p < 0.05, * p <0.10. Robust standard errors in brackets.*

Sales Growth Regression Output CIS2006-2008, SNF 2012

CIS 2006-2008, SNF 2012

	Dependent Variable: Sales Growth									
	Full Dataset						Innovators Only			
	Model						Model			
	(1) Control		(2) Innovators versus Non-Innovators		(3) Degree of Innovation		(1) Control		(4) Type of Innovation	
Focus Variable: Innovation										
Innovator vs. Non-Innovator Dummy	-	-	-0.904	-0.901	-	-	-	-	-	-
			(-0.991)	(-0.991)						
Innovation Quartile Dummy										
1st Quartile	-	-	-	-	-1.345	-1.338	-	-	-	-
					(-1.024)	(-1.023)				
2nd Quartile	-	-	-	-	-1.143	-1.133	-	-	-	-
					(-1.012)	(-1.011)				
3rd Quartile	-	-	-	-	-0.571	-0.569	-	-	-	-
					(-0.860)	(-0.859)				
4th Quartile	-	-	-	-	-0.762	-0.764	-	-	-	-
					(-0.999)	(-0.999)				
Innovation Type Dummy										
Product Innovation	-	-	-	-	-	-	-	-	-0.050	-0.048
									(-1.519)	(-1.462)
Process Innovation	-	-	-	-	-	-	-	-	0.021	0.020
									(0.515)	(0.483)
Market Innovation	-	-	-	-	-	-	-	-	-0.042	-0.043
									(-1.517)	(-1.542)
Organisational Innovation	-	-	-	-	-	-	-	-	0.007	0.009
									(0.368)	(0.456)
Control Variables										
Leverage	0.686	4.503	0.647	4.411	0.651	4.372	0.108*	0.609***	0.093	0.585***
	(1.097)	(1.071)	(1.096)	(1.072)	(1.100)	(1.072)	(1.678)	(3.594)	(1.369)	(3.429)
Leverage^2	-	-2.952	-	-2.912	-	-2.878	-	-0.386***	-	-0.380***
		(-1.058)		(-1.058)		(-1.057)		(-3.755)		(-3.746)
Liquidity	0.899	0.899	0.826	0.826	0.820	0.821	0.272**	0.258**	0.282**	0.283**
	(1.116)	(1.115)	(1.120)	(1.119)	(1.120)	(1.120)	(2.376)	(2.302)	(2.420)	(2.434)
Size	0.408	0.381	0.451	0.425	0.467	0.441	0.050***	0.046***	0.050***	0.047***
	(1.099)	(1.099)	(1.088)	(1.088)	(1.089)	(1.089)	(2.920)	(2.700)	(2.996)	(2.728)
Proportion of Fixed Assets	3.673	3.709	3.731	3.767	3.776	3.811	0.112	0.079	0.126	0.133
	(0.992)	(0.993)	(0.992)	(0.993)	(0.993)	(0.994)	(0.964)	(0.761)	(0.976)	(1.027)
Prior Performance (Sales Growth)	-0.133	-0.134	-0.133	-0.135	-0.133	-0.135	-0.058	-0.059	-0.061	-0.063
	(-0.068)	(-0.068)	(-0.069)	(-0.069)	(-0.069)	(-0.069)	(-1.108)	(-1.147)	(-1.181)	(-1.226)
Constant	-9.292	-9.975	-9.999	-10.670	-10.277	-10.936	-1.075***	-1.171***	-1.003***	-1.075***
	(-1.059)	(-1.062)	(-1.055)	(-1.057)	(-1.056)	(-1.059)	(-3.178)	(-3.449)	(3.399)	(-3.698)
Industry Dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	4556	4556	4556	4556	4556	4556	2000	2000	2000	2000
R-Square	0.012	0.012	0.012	0.012	0.012	0.012	0.067	0.067	0.065	0.067
F-value	0.323	0.311	0.281	0.272	0.264	0.256	3.334	3.070	3.227	3.465

*Note: *** p < 0.01, ** p < 0.05, * p <0.10. Robust standard errors in brackets.*

ROA Regression Output CIS2008-2010, SNF 2010

CIS 2008-2010, SNF 2010

	Dependent Variable: ROA									
	Full Dataset						Innovators Only			
	Model						Model			
	(1) Control		(2) Innovators versus Non-Innovators		(3) Degree of Innovation		(1) Control		(4) Type of Innovation	
Focus Variable: Innovation										
Innovator vs. Non-Innovator Dummy	-		0.005	0.004	-		-		-	
			(1.021)	(0.829)						
Innovation Quartile Dummy	-						-		-	
1st Quartile			-		-0.001	-0.002				
	-				(-0.108)	(-0.201)	-		-	
2nd Quartile			-		0.007	0.006				
	-				(1.026)	(0.880)	-		-	
3rd Quartile	-		-		0.004	0.003	-		-	
					(0.577)	(0.523)				
4th Quartile	-		-		0.008	0.006	-		-	
					(1.270)	(1.038)				
Innovation Type Dummy										
Product Innovation	-		-		-		-		-0.004	-0.004
									(-0.606)	(-0.706)
Process Innovation	-		-		-		-		0.004	0.004
									(0.590)	(0.599)
Market Innovation	-		-		-		-		0.003	0.004
									(0.474)	(0.565)
Organisational Innovation	-		-		-		-		-0.007	-0.007
									(-1.224)	(-1.250)
Control Variables										
Leverage	-0.071***	0.337***	-0.071***	0.337***	-0.071***	0.336***	-0.058***	0.222**	-0.059***	0.222**
	(-4.600)	(3.900)	(-4.574)	(3.894)	(-4.582)	(3.889)	(-3.127)	(2.058)	(-3.184)	(2.034)
Leverage^2	-	-0.317***	-	-0.316***	-	-0.316***	-	-0.222***	-	-0.223**
		(-4.358)		(-4.349)		(-4.345)		(-2.387)		(-2.369)
Liquidity	0.074***	.0.074***	0.074***	0.075***	0.074***	0.074***	0.100***	0.103***	0.098***	0.101***
	(5.363)	(5.472)	(5.358)	(5.459)	(5.343)	(5.442)	(5.228)	(5.471)	(5.092)	(5.331)
Size	0.013***	0.011***	0.012***	0.011***	0.012***	0.011***	0.012***	0.011***	0.013***	0.012***
	(6.780)	(5.696)	(6.486)	(5.460)	(6.504)	(5.477)	(5.901)	(5.206)	(6.088)	(5.391)
Proportion of Fixed Assets	-0.033**	-0.030**	-0.033***	-0.030**	-0.033**	-0.030**	-0.036**	-0.034**	-0.037**	-0.034**
	(-2.571)	(-2.355)	(-2.577)	(-2.391)	(-2.559)	(-2.375)	(-2.203)	(-2.024)	(-2.214)	(-2.036)
Prior Performance (ROA)	0.480***	0.455***	0.480***	0.456***	0.480***	0.456***	0.485***	0.468***	0.485***	0.568***
	(14.977)	(13.808)	(14.993)	(13.821)	(14.974)	(13.807)	(11.484)	(10.654)	(11.439)	(10.606)
Constant	-0.249**	-0.338***	-0.245**	-0.335***	-0.247**	-0.336***	-0.167***	-0.224***	-0.172***	-0.230**
	(-2.074)	(-2.794)	(-2.037)	(-2.761)	(-2.053)	(-2.774)	(-4.026)	(-5.080)	(-4.217)	(-5.248)
Industry Dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	2760	2760	2760	2760	2760	2760	1385	1385	1385	1385
R-Square	0.318	0.339	0.318	0.339	0.318	0.339	0.390	0.400	0.391	0.401
F-value	13.393	13.484	13.213	13.304	12.741	12.831	8.982	8.678	8.710	8.536

*Note: *** p < 0.01, ** p < 0.05, * p <0.10. Robust standard errors in brackets.*

EBITDA Margin Regression Output CIS2008-2010, SNF 2010

CIS 2008-2010, SNF 2010

	Dependent Variable: EBITDA Margin									
	Full Dataset						Innovators Only			
	Model						Model			
	(1) Control		(2) Innovators versus Non-Innovators		(3) Degree of Innovation		(1) Control		(4) Type of Innovation	
Focus Variable: Innovation										
Innovator vs. Non-Innovator Dummy	-		0.002	0.001	-		-		-	
			(0.397)	(0.290)						
Innovation Quartile Dummy	-						-		-	
1st Quartile			-		-0.007	-0.007				
	-				(-1.050)	(-1.093)	-		-	
2nd Quartile			-		0.004	0.004				
	-				(0.531)	(0.456)	-		-	
3rd Quartile	-		-		0.002	0.002	-		-	
					(0.297)	(0.270)				
4th Quartile	-		-		0.006	0.006	-		-	
					(1.126)	(1.013)				
Innovation Type Dummy										
Product Innovation	-		-		-		-		-0.013**	-0.013**
									(-2.041)	(-2.119)
Process Innovation	-		-		-		-		0.004	0.004
									(0.587)	(0.601)
Market Innovation	-		-		-		-		-0.002	-0.002
									(-0.298)	(-0.246)
Organisational Innovation	-		-		-		-		-0.005	-0.005
									(-0.743)	(-0.750)
Control Variables										
Leverage	-0.052***	0.131**	-0.051***	0.131**	-0.052***	0.130**	-0.036*	0.165	-0.038*	0.165
	(-3.938)	(2.020)	(-3.933)	(2.015)	(-3.957)	(2.012)	(-1.664)	(1.538)	(-1.765)	(1.544)
Leverage^2	-	-0.141***	-	-0.141***	-	-0.141***	-	-0.159*	-	-0.161*
		(-2.806)		(-2.795)		(-2.799)		(-1.900)		(-1.923)
Liquidity	0.035**	0.035**	0.035**	0.035**	0.035**	0.034**	0.057**	0.058**	0.056**	0.057**
	(2.511)	(2.488)	(2.516)	(2.491)	(2.491)	(2.465)	(2.339)	(2.385)	(2.262)	(2.304)
Size	0.007***	0.006***	0.007***	0.006***	0.007***	0.006***	0.010***	0.009***	0.010***	0.010***
	(3.813)	(3.310)	(3.760)	(3.276)	(3.807)	(3.330	(4.539)	(4.093)	(4.558)	(4.155)
Proportion of Fixed Assets	0.020	0.022*	0.020	0.022*	0.021	0.023*	-0.007	-0.004	-0.007	-0.004
	(1.527)	(1.669)	(1.512)	(1.659)	(1.554)	(1.697)	(-0.360)	(-0.213)	(-0.367)	(-0.219)
Prior Performance (EBITDA Margin)	0.689***	0.685**	0.690***	0.685***	0.690***	0.685***	0.680***	0.677***	0.680***	0.677***
	(17.487)	(17.267)	(17.489)	(17.264)	(17.459)	(17.238)	(13.401)	(13.301)	(13.398)	(13.298)
Constant	-0.208**	-0.248**	-0.207**	-0.247**	-0.210**	-0.249**	-0.160***	-0.199***	-0.154***	-0.195***
	(-2.019)	(-2.388)	(-2.005)	(-2.375)	(-2.031)	(-2.398)	(-3.715)	(-4.002)	(-3.682)	(-3.995)
Industry Dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	2760	2760	2760	2760	2760	2760	1385	1385	1385	1385
R-Square	0.548	0.552	0.548	0.552	0.549	0.552	0.534	0.538	0.535	0.539
F-value	31.477	31.459	30.882	30.883	30.039	29.870	12.261	12.677	11.639	11.936

*Note: *** p < 0.01, ** p < 0.05, * p <0.10. Robust standard errors in brackets.*

Sales Growth Regression Output CIS2008-2010, SNF 2010

CIS 2008-2010, SNF 2010

Dependent Variable: Sales Growth	Full Dataset						Innovators Only			
	Model						Model			
	(1) Control		(2) Innovators versus Non-Innovators		(3) Degree of Innovation		(1) Control		(4) Type of Innovation	
Focus Variable: Innovation										
Innovator vs. Non-Innovator Dummy	-		0.022	0.023	-		-	-	-	-
			(0.556)	(0.592)						
Innovation Quartile Dummy	-						-	-	-	-
1st Quartile			-		-0.005	-0.004				
	-				(-0.167)	(-0.148)	-	-	-	-
2nd Quartile			-		0.015	0.017				
	-				(0.536)	(0.595)	-	-	-	-
3rd Quartile	-		-		0.124	0.124	-	-	-	-
					(0.806)	(0.809)				
4th Quartile	-		-		-0.025	-0.024	-	-	-	-
					(-1.111)	(-1.075)				
Innovation Type Dummy										
Product Innovation	-		-		-		-	-	0.059	0.058
									(0.704)	(0.691)
Process Innovation	-		-		-		-	-	-0.046	-0.048
									(-0.518)	(-0.538)
Market Innovation	-		-		-		-	-	-0.091	-0.088
									(-0.865)	(-0.845)
Organisational Innovation	-		-		-		-	-	0.131	0.129
									(1.777)	(1.1699
Control Variables										
Leverage	0.173*	-0.313	0.176*	-0.315	0.171*	-0.311	0.074	0.503**	0.098	0.496**
	(1.764)	(-0.354)	(1.188)	(-0.357)	(1.774)	(-0.351)	(1.022)	(2.116)	(1.052)	(2.038)
Leverage^2	-	0.376	-	0.380	-	0.373	-	-0.339**	-	-0.317*
		(0.503)		(0.509)		(0.498)		(-1.983)		(-1.833)
Liquidity	-0.096*	-0.093*	-0.091*	-0.091*	-0.098*	-0.095*	-0.086	-0.081	-0.054	-0.055
	(-1.910)	(-1.819)	(-1.894)	(-1.804)	(-1.874)	(-1.790)	(-1.178)	(-1.941)	(-0.974)	(-0.984)
Size	0.018***	0.021**	0.018***	0.020**	0.017***	0.019*	0.007	0.005	-0.002	-0.004
	(3.337)	(2.295)	(2.775)	(2.028)	(2.600)	(1.920)	(1.096)	(0.740)	(-0.195)	(-0.315)
Proportion of Fixed Assets	-0.060	-0.064	-0.062	-0.066	-0.062	-0.066	-0.061	-0.055	-0.058	-0.053
	(-1.408)	(-1.522)	(-1.477)	(-1.607)	(-1.470)	(-1.598)	(-0.202)	(-1.092)	(-1.111)	(-1.010)
Prior Performance (Sales Growth)	-0.039	-0.039	-0.039	-0.039	-0.039	-0.039	-0.170	-0.168	-0.172	-0.169
	(-0.250)	(-0.249)	(-0.248)	(-0.247)	(-0.249)	(-0.248)	(0.959)	(-0.951)	(-0.983)	(-0.965)
Constant	-0.352*	-0.249	-0.335*	-0.230	-0.320*	-0.217	-0.190	-0.253**	-0.033	-0.144
	(-1.926)	(-1.627)	(-1.753)	(-1.561)	(-1.650)	(-1.479)	(-1.561)	(-2.048)	(-0.166)	(-0.774)
Industry Dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	2760	2760	2760	2760	2760	2760	1385	1385	1385	1385
R-Square	0.020	0.021	0.020	0.021	0.022	0.022	0.019	0.019	0.023	0.023
F-value	4.004	4.024	3.990	3.995	3.840	3.855	1.197	1.923	1.679	1.738

*Note: *** p < 0.01, ** p < 0.05, * p <0.10. Robust standard errors in brackets.*

ROA Regression Output CIS2008-2010, SNF 2011

CIS 2008-2010, SNF 2011

	Dependent Variable: ROA									
	Full Dataset						Innovators Only			
	Model						Model			
	(1) Control		(2) Innovators versus Non-Innovators		(3) Degree of Innovation		(1) Control		(4) Type of Innovation	
Focus Variable: Innovation										
Innovator vs. Non-Innovator Dummy	-		0.000	0.000	-		-		-	
			(0.093)	(0.044)						
Innovation Quartile Dummy	-						-		-	
1st Quartile			-		-0.004	-0.004				
	-				(-0.552)	(-0.496)	-		-	
2nd Quartile			-		0.011*	0.011*				
	-				(1.683)	(1.680)	-		-	
3rd Quartile	-		-		0.001	0.001	-		-	
					(0.166)	(0.083)				
4th Quartile	-		-		-0.005	-0.005	-		-	
					(-0.846)	(-0.945)				
Innovation Type Dummy										
Product Innovation	-		-		-		-		0.009	0.009
									(1.284)	(1.283)
Process Innovation	-		-		-		-		-0.001	-0.001
									(-0.137)	(-0.111)
Market Innovation	-		-		-		-		-0.007	-0.006
									(-1.124)	(-0.944)
Organisational Innovation	-		-		-		-		-0.005	-0.005
									(-0.881)	(-0.819)
Control Variables										
Leverage	-0.014	0.363***	-0.014	0.363***	-0.015	0.363***	-0.025	0.283***	-0.023	0.283***
	(-0.940)	(4.816)	(-0.937)	(4.814)	(-0.941)	(4.816)	(-1.291)	(2.973)	(-1.198)	(3.014)
Leverage^2		-0.298***		-0.298***		-0.298***		-0.251***		-0.248***
		(-4.625)		(-4.625)		(-4.626)		(-3.046)		(-3.042)
Liquidity	0.126***	0.129***	0.126***	0.130***	0.126***	0.129***	0.129***	0.128***	0.128***	0.131***
	(6.928)	(7.204)	(6.928)	(7.199)	(6.918)	(7.196)	(4.820)	(4.822)	(4.780)	(4.892)
Size	0.005***	0.003*	0.005***	0.003*	0.005**	0.003*	0.006**	0.005*	0.006**	0.005*
	(2.580)	(1.750)	(2.582)	(1.750)	(2.542)	(1.713)	(2.257)	(1.696)	(2.292)	(1.799)
Proportion of Fixed Assets	-0.027**	-0.026**	-0.027**	-0.026**	-0.027**	-0.025**	-0.041**	-0.037*	-0.041**	-0.036*
	(-2.116)	(-1.998)	(-2.114)	(-1.995)	(-2.098)	(-1.981)	(-2.086)	(-1.869)	(-2.060)	(-1.826)
Prior Performance (ROA)	0.430***	0.406***	0.430***	0.406***	0.429***	0.406***	0.501***	0.485***	0.500***	0.482***
	(11.455)	(11.090)	(11.448)	(11.082)	(11.428)	(11.062)	(11.011)	(10.880)	(11.002)	(10.794)
Constant	-0.036	-0.122***	-0.035	-0.122***	-0.035	-0.122***	-0.068	-0.130**	-0.069	-0.129**
	(-0.891)	(-2.828)	(-0.885)	(-2.838)	(-0.868)	(-2.809)	(-1.334)	(-2.476)	(-1.388)	(-2.545)
Industry Dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	2695	2695	2695	2695	2695	6295	1358	1358	1358	1358
R-Square	0.303	0.323	0.303	0.323	0.304	0.324	0.381	0.391	0.383	0.395
F-value	9.808	10.322	9.683	10.175	9.561	10.017	10.754	10.446	10.037	9.731

*Note: *** p < 0.01, ** p < 0.05, * p <0.10. Robust standard errors in brackets.*

EBITDA Margin Regression Output CIS2008-2010, SNF 2011

CIS 2008-2010, SNF 2011

	Dependent Variable: EBITDA Margin										
	Full Dataset						Innovators Only				
	Model						Model				
	(1) Control		(2) Innovators versus Non-Innovators		(3) Degree of Innovation		(1) Control		(4) Type of Innovation		
Focus Variable: Innovation											
Innovator vs. Non-Innovator Dummy	-		0.001	0.001	-		-		-		
			(0.282)	(0.261)							
Innovation Quartile Dummy	-						-		-		
1st Quartile			-		-0.003	-0.003					
	-				(-0.421)	(-0.404)	-		-		
2nd Quartile			-		0.009	0.008					
	-				(1.120)	(1.109)	-		-		
3rd Quartile	-		-		0.006	0.006	-		-		
					(1.018)	(0.983)					
4th Quartile	-		-		-0.005	-0.005	-		-		
					(-0.775)	(-0.805)					
Innovation Type Dummy											
Product Innovation	-		-		-		-		0.005	0.005	
									(0.721)	(0.701)	
Process Innovation	-		-		-		-		0.004	0.003	
									(0.580)	(0.558)	
Market Innovation	-		-		-		-		-0.007	-0.006	
									(-1.085)	(-0.977)	
Organisational Innovation	-		-		-		-		-0.007	-0.007	
									(-1.148)	(-1.136)	
Control Variables											
Leverage	-0.019	0.088	-0.019	0.088	-0.019	0.088	-0.029	0.116	-0.027	0.114	
	(-1.397)	(1.466)	(-1.386)	(1.466)	(-1.378)	(1.465)	(-1.374)	(1.124)	(-1.298)	(1.113)	
Leverage^2	-	-0.084*	-	-0.084*	-	-0.084*	-	-0.119	-	-0.115	
		(-1.787)		(-1.785)		(-1.785)		(-1.370)		(-1.332)	
Liquidity	0.089***	0.089***	0.089***	0.089***	0.089***	0.089***	0.088***	0.087***	0.086***	0.087***	
	(5.950)	(5.983)	(5.925)	(5.957)	(5.927)	(5.960)	(3.587)	(3.553)	(3.509)	(3.536)	
Size	0.005**	0.004**	0.005**	0.004**	0.005**	0.004**	0.008***	0.007**	0.008***	0.008**	
	(2.330)	(2.060)	(2.295)	(2.030)	(2.244)	(1.983)	(2.619)	(2.321)	(2.685)	(2.439)	
Proportion of Fixed Assets	0.033**	0.034**	0.033**	0.034**	0.033**	0.034**	0.005	0.007	0.004	0.007	
	(2.156)	(2.212)	(2.150)	(2.207)	(2.156)	(2.212)	(0.212)	(0.322)	(0.201)	(0.329)	
Prior Performance (EBITDA Margin)	0.583***	0.580***	0.584***	0.580***	0.584***	0.580***	0.575***	0.570***	0.575***	0.570***	
	(13.851)	(13.731)	(13.856)	(13.737)	(13.840)	(13.725)	(8.746)	(8.628)	(8.775)	(8.667)	
Constant	-0.048	-0.072	-0.047	-0.071	-0.046	-0.070	-0.126**	-0.154***	-0.125**	-0.155***	
	(-1.126)	(-1.635)	(-1.101)	(-1.610)	(-1.072)	(-1.576)	(-2.152)	(-2.585)	(-2.202)	(-2.691)	
Industry Dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	
Observations	2695	2695	2695	2695	2695	2695	1358	1358	1358	1358	
R-Square	0.504	0.506	0.504	0.506	0.505	0.506	0.488	0.490	0.490	0.491	
F-value	22.075	21.676	21.722	21.324	20.911	20.574	10.745	11.675	10.207	11.166	

*Note: *** p < 0.01, ** p < 0.05, * p <0.10. Robust standard errors in brackets.*

Sales Growth Regression Output CIS2008-2010, SNF 2011

CIS 2008-2010, SNF 2011

	Dependent Variable: Sales Growth									
	Full Dataset						Innovators Only			
	Model						Model			
	(1) Control		(2) Innovators versus Non-Innovators		(3) Degree of Innovation		(1) Control		(4) Type of Innovation	
Focus Variable: Innovation										
Innovator vs. Non-Innovator Dummy	-		-0.043	-0.043	-		-		-	
			(-1.242)	(1.248)						
Innovation Quartile Dummy	-						-		-	
1st Quartile			-		0.009	0.009				
	-				(0.295)	(0.305)	-		-	
2nd Quartile			-		-0.005	-0.005				
	-				(-0.143)	(-0.146)	-		-	
3rd Quartile	-		-		-0.053	-0.053	-		-	
					(-1.592)	(-1.606)				
4th Quartile	-		-		-0.099	-0.099	-		-	
					(-1.434)	(-1.442)				
Innovation Type Dummy										
Product Innovation	-		-		-		-		0.049***	0.049***
									(2.660)	(2.694)
Process Innovation	-		-		-		-		0.006	0.006
									(0.295)	(0.276)
Market Innovation	-		-		-		-		-0.006	-0.005
									(-0.333)	(-0.279)
Organisational Innovation	-		-		-		-		-0.008	-0.007
									(-0.369)	(-0.337)
Control Variables										
Constant	-0.743***	-0.777**	-0.778**	-0.813**	-0.755**	-0.793**	-0.335**	-0.387**	-0.359**	-0.390**
	(-2.304)	(-2.574)	(-2.265)	(-2.522)	(-2.281)	(-2.542)	(-2.046)	(-2.352)	(-2.191)	(-2.414)
Leverage	0.416	0.574**	0.413	0.574**	0.419	0.590**	0.093*	0.385**	0.103**	0.388**
	(1.339)	(1.983)	(1.338)	(1.983)	(1.339)	(1.996)	(1.846)	(2.035)	(2.008)	(2.051)
Leverage^2	-	-0.124	-	-0.126	-	-0.134	-	-0.235	-	-0.229
		(-0.612)		(-0.625)		(-0.675)		(-1.490)		(-1.441)
Liquidity	0.820	0.820	0.815	0.815	0.819	0.819	-0.001	-0.000	-0.001	0.001
	(1.079)	(1.080)	(1.078)	(1.078)	(1.079)	(1.079)	(-0.009)	(-0.002)	(-0.016)	(0.013)
Size	0.031***	0.030***	0.033***	0.032***	0.032***	0.031***	0.016**	0.015*	0.016**	0.014*
	(2.942)	(2.734)	(2.875)	(2.679)	(2.901)	(2.699)	(2.056)	(1.866)	(2.049)	(1.811)
Proportion of Fixed Assets	-0.246	-0.245	-0.242	-0.241	-0.246	-0.244	-0.064	-0.059	-0.064	-0.058
	(-1.312)	(-1.300)	(-1.308)	(-1.295)	(-1.310)	(-1.298)	(-1.443)	(-1.343)	(-1.431)	(-1.311)
Prior Performance (Sales Growth)	0.028	0.028	0.028	0.028	0.028	0.028	0.047	0.047	0.046	0.046
	(0.947)	(0.950)	(0.940)	(0.943)	(0.933)	(0.936)	(0.900)	(0.896)	(0.894)	(0.892)
Industry Dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	2695	2695	2695	2695	2695	2695	1358	1358	1358	1358
R-Square	0.029	0.029	0.029	0.029	0.029	0.029	0.181	0.183	0.186	0.187
F-value	1.925	1.918	1.905	1.899	1.835	1.834	2.270	2.449	3.135	2.859

*Note: *** p < 0.01, ** p < 0.05, * p <0.10. Robust standard errors in brackets.*

ROA Regression Output CIS2008-2010, SNF 2012

CIS 2008-2010, SNF 2012

	Dependent Variable: ROA									
	Full Dataset						Innovators Only			
	Model						Model			
	(1) Control		(2) Innovators versus Non-Innovators		(3) Degree of Innovation		(1) Control		(4) Type of Innovation	
Focus Variable: Innovation										
Innovator vs. Non-Innovator Dummy	-	-	-0.003	-0.003	-	-	-	-	-	-
			(-0.564)	(-0.593)						
Innovation Quartile Dummy	-	-					-	-	-	-
1st Quartile			-	-	-0.021**	-0.019**				
	-	-			(-2.466)	(-2.405)	-	-	-	-
2nd Quartile			-	-	0.008	0.007				
	-	-			(1.187)	(1.005)	-	-	-	-
3rd Quartile	-	-	-	-	-0.006	-0.007	-	-	-	-
					(-0.821)	(-1.072)				
4th Quartile	-	-	-	-	0.004	0.005	-	-	-	-
					(0.524)	(0.645)				
Innovation Type Dummy										
Product Innovation	-	-	-	-	-	-	-	-	0.000	-0.001
									(0.059)	(-0.076)
Process Innovation	-	-	-	-	-	-	-	-	-0.008	-0.007
									(-1.095)	(-1.016)
Market Innovation	-	-	-	-	-	-	-	-	-0.003	-0.002
									(-0.379)	(-0.322)
Organisational Innovation	-	-	-	-	-	-	-	-	-0.016**	-0.014**
									(-2.394)	(-2.177)
Control Variables										
Leverage	-0.047***	0.454***	-0.047***	0.454***	-0.049***	0.451***	-0.041*	0.468***	-0.043*	0.463***
	(-2.892)	(5.917)	(-2.900)	(5.910)	(-2.993)	(5.910)	(-1.871)	(5.587)	(-1.955)	(5.663)
Leverage^2	-	-0.394***		-0.394***		-0.393***	-	-0.408***	-	-0.404***
		(-6.234)		(-6.229)		(-6.249)		(-5.575)		(-5.652)
Liquidity	0.093***	0.093***	0.092***	0.093***	0.092***	0.092***	0.089***	0.096***	0.089***	0.096***
	(5.404)	(5.453)	(5.403)	(5.449)	(5.361)	(5.405)	(3.295)	(3.591)	(2.277)	(3.571)
Size	0.005***	0.003*	0.005***	0.003*	0.006***	0.003*	0.009***	0.007***	0.010***	0.008***
	(3.008)	(1.713)	(3.034)	(1.760)	(3.201)	(1.944)	(3.498)	(2.939)	(3.930)	(3.290)
Proportion of Fixed Assets	0.001	0.002	0.001	0.003	0.002	0.004	-0.011	-0.003	-0.008	-0.000
	(0.059)	(0.188)	(0.083)	(0.212)	(0.174)	(0.296)	(-0.622)	(-0.162)	(-0.439)	(-0.008)
Prior Performance (ROA)	0.471***	0.444***	0.471***	0.444***	0.469***	0.442***	0.507***	0.475***	0.504***	0.470***
	(10.681)	(10.305)	(10.694)	(10.319)	(10.657)	(10.281)	(7.164)	(8.774)	(9.100)	(8.687)
Constant	-0.048	-0.157***	-0.051	-0.159***	-0.057	-0.165***	-0.108**	-0.225***	-0.113**	-0.213***
	(-1.295)	(-3.871)	(-1.339)	(-3.908)	(-1.492)	(-4.021)	(-2.065)	(-4.256)	(-2.226)	(-4.233)
Industry Dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	2615	2615	2615	2615	2615	2615	1319	1319	1319	1319
R-Square	0.268	0.302	0.268	0.302	0.271	0.305	0.319	0.350	0.321	0.354
F-value	9.393	9.905	9.311	9.971	9.094	9.764	7.631	8.360	7.341	8.260

*Note: *** p < 0.01, ** p < 0.05, * p <0.10. Robust standard errors in brackets.*

EBITDA Margin Regression Output CIS2008-2010, SNF 2012

CIS 2008-2010, SNF 2012

	Dependent Variable: ROA									
	Full Dataset						Innovators Only			
	Model						Model			
	(1) Control		(2) Innovators versus Non-Innovators		(3) Degree of Innovation		(1) Control		(4) Type of Innovation	
Focus Variable: Innovation										
Innovator vs. Non-Innovator Dummy	-	-	-0.005	-0.005	-	-	-	-	-	-
			(-1.044)	(-1.054)						
Innovation Quartile Dummy	-	-					-	-	-	-
1st Quartile			-	-	-0.005	-0.005				
	-	-			(-0.763)	(-0.704)	-	-	-	-
2nd Quartile			-	-	-0.007	-0.008				
	-	-			(-1.045)	(-1.122)	-	-	-	-
3rd Quartile	-	-	-	-	-0.004	-0.005	-	-	-	-
					(-0.595)	(-0.667)				
4th Quartile	-	-	-	-	-0.003	-0.003	-	-	-	-
					(-0.452)	(-0.418)				
Innovation Type Dummy										
Product Innovation	-	-	-	-	-	-	-	-	0.003	0.003
									(0.523)	(0.432)
Process Innovation	-	-	-	-	-	-	-	-	-0.010	-0.010
									(-1.507)	(-1.457)
Market Innovation	-	-	-	-	-	-	-	-	0.011	0.011*
									(1.635)	(1.692)
Organisational Innovation	-	-	-	-	-	-	-	-	-0.004	-0.003
									(-0.629)	(-0.466)
Control Variables										
Leverage	-0.030**	0.118	-0.030**	0.117	-0.030**	0.118	-0.039**	0.225***	-0.039**	0.222***
	(-2.020)	(1.561)	(-2.037)	(1.560)	(-2.034)	(1.564)	(-2.217)	(3.032)	(-2.180)	(3.016)
Leverage^2	-	-0.116**	-	-0.116**	-	-0.116**	-	-0.209***	-	-0.208***
		(-2.095)		(-2.100)		(-2.104)		(-3.563)		(-3.567)
Liquidity	0.067***	0.066***	0.066***	0.066***	0.066***	0.066***	0.083***	0.084***	0.085***	0.087***
	(3.617)	(3.564)	(3.599)	(3.546)	(3.598)	(3.544)	(3.231)	(2.280)	(3.328)	(3.383)
Size	0.002	0.001	0.002	0.001	0.002	0.001	0.007**	0.006**	0.007**	0.006**
	(0.709)	(0.362)	(0.807)	(0.458)	(0.813)	(0.465)	(2.417)	(2.004)	(2.460)	(2.084)
Proportion of Fixed Assets	0.056***	0.057***	0.056***	0.057***	0.056***	0.057***	0.045**	0.051**	0.048**	0.053**
	(3.254)	(3.287)	(3.274)	(3.308)	(3.263)	(3.297)	(2.100)	(2.323)	(2.227)	(2.438)
Prior Performance (EBITDA Margin)	0.694***	0.691***	0.694***	0.691***	0.694***	0.691***	0.619***	0.608***	0.619***	0.609***
	(15.189)	(15.074)	(15.178)	(15.063)	(15.141)	(15.031)	(9.153)	(8.950)	(9.134)	(8.941)
Constant	-0.018	-0.050	-0.022	-0.045	-0.022	-0.054	-0.111*	-0.152***	-0.111**	-0.162***
	(-0.361)	(-0.914)	(-0.443)	(-0.996)	(-0.451)	(-1.002)	(-1.946)	(-2.623)	(-2.003)	(-2.812)
Industry Dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	2615	2615	2615	2615	2615	2615	1319	1319	1319	1319
R-Square	0.475	0.478	0.475	0.478	0.476	0.478	0.455	0.465	0.459	0.467
F-value	20.512	20.197	20.139	(19.840)	19.246	18.984	11.242	11.865	10.828	11.320

*Note: *** p < 0.01, ** p < 0.05, * p <0.10. Robust standard errors in brackets.*

Sales Growth Regression Output CIS2008-2010, SNF 2012

CIS 2008-2010, SNF 2012

Dependent Variable: Sales Growth

	Full Dataset						Innovators Only			
	Model						Model			
	(1) Control		(2) Innovators versus Non-Innovators		(3) Degree of Innovation		(1) Control		(4) Type of Innovation	
Focus Variable: Innovation										
Innovator vs. Non-Innovator Dummy	-	-	0.009	0.009	-	-	-	-	-	-
			(0.416)	(0.412)						
Innovation Quartile Dummy										
1st Quartile	-	-	-	-	-0.015	-0.014	-	-	-	-
					(-0.822)	(-0.756)				
2nd Quartile	-	-	-	-	-0.006	-0.008	-	-	-	-
					(-0.289)	(-0.351)				
3rd Quartile	-	-	-	-	-0.033	-0.035	-	-	-	-
					(-1.037)	(-1.079)				
4th Quartile	-	-	-	-	0.065	0.066	-	-	-	-
					(0.955)	(0.965)				
Innovation Type Dummy										
Product Innovation	-	-	-	-	-	-	-	-	0.001	0.001
									(0.053)	(0.029)
Process Innovation	-	-	-	-	-	-	-	-	-0.033	-0.033
									(-0.853)	(-0.844)
Market Innovation	-	-	-	-	-	-	-	-	-0.004	-0.003
									(-0.191)	(-0.172)
Organisational Innovation	-	-	-	-	-	-	-	-	-0.023	-0.022
									(-1.288)	(-1.235
Control Variables										
Leverage	0.068	0.463***	0.069	0.463***	0.065	0.470***	0.022	0.270	0.018	0.254
	(1.298)	(4.001)	(1.334)	(4.020)	(1.200)	(4.158)	(0.320)	(1.551)	(0.258)	(1.439)
Leverage^2	-	-0.309***	-	-0.309***	-	-0.318***	-	-0.196	-	-0.187
		(-3.950)		(-3.955)		(-4.037)		(-1.635)		(-1.541)
Liquidity	0.128	0.126	0.129	0.126	0.126	0.123	0.180	0.180	0.184	0.184
	(1.330)	(1.305)	(1.328)	(1.302)	(1.323)	(1.297)	(0.997)	(0.996)	(0.977)	(0.978)
Size	0.037***	0.035**	0.036***	0.034***	0.037***	0.035**	0.036	0.035	0.037	0.036
	(2.705)	(2.545)	(2.797)	(2.630)	(2.717)	(2.564)	(1.483)	(1.426)	(1.532)	(1.476)
Proportion of Fixed Assets	-0.008	-0.006	-0.009	-0.007	-0.008	-0.006	0.063	0.068	0.070	0.074
	(-0.160)	(-0.117)	(-0.184)	(-0.139)	(-0.150)	(-0.107)	(0.598)	(0.641)	(0.630)	(0.668)
Prior Performance (Sales Growth)	-0.004	-0.004	-0.004	-0.004	-0.004	-0.004	-0.061	-0.062	-0.061	-0.062
	(-0.060)	(-0.059)	(-0.060)	(-0.059)	(-0.059)	(-0.058)	(-1.522)	(-1.540)	(-1.525)	(-1.543)
Constant	-0.975***	-1.059***	-0.967***	-1.052***	-0.986***	-1.073***	-0.770	-0.807*	-0.774	-0.818*
	(-2.596)	(-1.820)	(-2.629)	(-2.858)	(-2.617)	(-2.834)	(-1.598)	(-1.697)	(-1.634)	(-1.733)
Industry Dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	2615	2615	2615	2615	2615	2615	1319	1319	1319	1319
R-Square	0.049	0.050	0.049	0.050	0.051	0.053	0.090	0.090	0.091	0.091
F-value	4.344	4.576	4.290	4.510	4.072	4.275	1.737	1.842	1.753	1.816

*Note: *** p < 0.01, ** p < 0.05, * p <0.10. Robust standard errors in brackets.*

7.2 Appendix 2: Pearson's Correlation Analyses

Here, we run Pearson's Correlation analyses. The output is provided below. We did not find any correlation above the recommended minimum for variables included in the same models from these analyses.

Correlation Matrix CIS2006-2008, SNF 2008

		ROA	EBITDAm	LEVER	LEVER2	CASHra	SIZEsal	PROPfias	TOT_INNOV	QUARTILE4	QUARTILE3	QUARTILE2	QUARTILE1	PROD_INNOV	PROC_INNOV	MKT_INNOV	ORG_INNOV
ROA	Pearson Correlation	1															
	Sig. (2-tailed)																
EBITDAm	Pearson Correlation	.581**	1														
	Sig. (2-tailed)	0,000															
LEVER	Pearson Correlation	-.177**	-.155**	1													
	Sig. (2-tailed)	,000	,000														
LEVER2	Pearson Correlation	-.227**	-.183**	.970**	1												
	Sig. (2-tailed)	,000	,000	0,000													
CASHra	Pearson Correlation	.301**	.154**	-.163**	-.154**	1											
	Sig. (2-tailed)	,000	,000	,000	,000												
SIZEsal	Pearson Correlation	,017	.116**	,006	-,024	-.252**	1										
	Sig. (2-tailed)	,220	,000	,650	,076	,000											
PROPfias	Pearson Correlation	-.197**	.088**	-.077**	-.055**	-.404**	.161**	1									
	Sig. (2-tailed)	,000	,000	,000	,000	,000	,000										
TOT_INNOV	Pearson Correlation	-.074**	-.045**	-.034*	-.034*	-.064**	.145**	.046**	1								
	Sig. (2-tailed)	,000	,001	,014	,013	,000	,000	,001									
QUARTILE4	Pearson Correlation	-,019	,010	,005	,001	-,015	,013	-,016	.474**	1							
	Sig. (2-tailed)	,170	,466	,712	,921	,279	,348	,234	,000								
QUARTILE3	Pearson Correlation	-,020	-,009	-,016	-,016	-,020	,012	.032*	.385**	-.141**	1						
	Sig. (2-tailed)	,146	,522	,241	,230	,147	,365	,020	,000	,000							
QUARTILE2	Pearson Correlation	-,026	-.028*	-,004	-,003	-,026	.098**	,012	.355**	-.130**	-.106**	1					
	Sig. (2-tailed)	,058	,043	,771	,815	,061	,000	,367	,000	,000	,000						
QUARTILE1	Pearson Correlation	-.056**	-.052**	-.042**	-.039**	-.045**	.120**	.052**	.371**	-.136**	-.110**	-.102**	1				
	Sig. (2-tailed)	,000	,000	,002	,004	,001	,000	,000	,000	,000	,000	,000					
PROD_INNOV	Pearson Correlation	-.060**	-.043**	-.059**	-.055**	-,024	.060**	,025	.668**	.155**	.244**	.232**	.462**	1			
	Sig. (2-tailed)	,000	,002	,000	,000	,080	,000	,066	0,000	,000	,000	,000	,000				
PROC_INNOV	Pearson Correlation	-.033*	-,022	-,024	-,022	-,012	.057**	.060**	.583**	,011	.275**	.237**	.456**	.470**	1		
	Sig. (2-tailed)	,015	,102	,080	,111	,376	,000	,000	0,000	,408	,000	,000	,000	,000			
MKT_INNOV	Pearson Correlation	-.053**	-.057**	-.052**	-.049**	-.067**	.150**	.035*	.541**	,010	.084**	.302**	.521**	.374**	.277**	1	
	Sig. (2-tailed)	,000	,000	,000	,000	,000	,000	,011	0,000	,473	,000	,000	0,000	,000	,000		
ORG_INNOV	Pearson Correlation	-.052**	-.037**	-,007	-,009	-.091**	.203**	.064**	.554**	-,026	.158**	.248**	.561**	.227**	.311**	.385**	1
	Sig. (2-tailed)	,000	,006	,626	,526	,000	,000	,000	0,000	,057	,000	,000	0,000	,000	,000	,000	

Correlation Matrix CIS2006-2008, SNF 2009

		ROA	EBITDAm	SALEgr	LEVER	LEVER2	CASHra	SIZEsal	PROPfias	PRIroa	PRIebma	ORG_INNOV	MKT_INNOV	PROD_INNOV	PROC_INNOV	TOT_INNOV	QUARTILE4	QUARTILE3	QUARTILE2	QUARTILE1
ROA	Pearson Correlation	1																		
	Sig. (2-tailed)																			
EBITDAm	Pearson Correlation	.612**	1																	
	Sig. (2-tailed)	0,000																		
SALEgr	Pearson Correlation	.061**	.058**	1																
	Sig. (2-tailed)	,000	,000																	
LEVER	Pearson Correlation	-.187**	-.144**	.068**	1															
	Sig. (2-tailed)	,000	,000	,000																
LEVER2	Pearson Correlation	-.248**	-.171**	.071**	.967**	1														
	Sig. (2-tailed)	,000	,000	,000	0,000															
CASHra	Pearson Correlation	.256**	.128**	-,022	-.185**	-.174**	1													
	Sig. (2-tailed)	,000	,000	,125	,000	,000														
SIZEsal	Pearson Correlation	.079**	.153**	.045**	,011	-.032*	-.248**	1												
	Sig. (2-tailed)	,000	,000	,001	,414	,021	,000													
PROPfias	Pearson Correlation	-.126**	.139**	,024	-.040**	-,025	-.411**	.183**	1											
	Sig. (2-tailed)	,000	,000	,093	,005	,075	,000	,000												
PRIroa	Pearson Correlation	.410**	.306**	-.056**	-.158**	-.191**	.260**	-,016	-.166**	1										
	Sig. (2-tailed)	,000	,000	,000	,000	,000	,000	,242	,000											
PRIebma	Pearson Correlation	.325**	.632**	-,004	-.153**	-.168**	.134**	.090**	.116**	.571**	1									
	Sig. (2-tailed)	,000	0,000	,759	,000	,000	,000	,000	,000	0,000										
ORG_INNOV	Pearson Correlation	-,043**	-,018	,009	,004	,002	-.085**	.211**	.062**	-.049**	-.038**	1								
	Sig. (2-tailed)	,002	,208	,509	,795	,914	,000	,000	,000	,001	,007									
MKT_INNOV	Pearson Correlation	-,014	-,024	,014	-.050**	-.054**	-.075**	.156**	.031*	-.054**	-.053**	.382**	1							
	Sig. (2-tailed)	,316	,093	,329	,000	,000	,000	,000	,026	,000	,000	,000								
PROD_INNOV	Pearson Correlation	-,019	-,025	,025	-.063**	-.064**	-.030*	.069**	,026	-.058**	-.041**	.231**	.374**	1						
	Sig. (2-tailed)	,171	,073	,079	,000	,000	,033	,000	,061	,000	,004	,000	,000							
PROC_INNOV	Pearson Correlation	-,013	-,008	,018	-,026	-.029*	-,016	.058**	.062**	-.041**	-,027	.312**	.276**	.470**	1					
	Sig. (2-tailed)	,342	,558	,194	,069	,037	,263	,000	,000	,003	,050	,000	,000	,000						
TOT_INNOV	Pearson Correlation	-.040**	-.031*	,015	-,024	-.030*	-.063**	.153**	.041**	-.073**	-.049**	.550**	.541**	.671**	.587**	1				
	Sig. (2-tailed)	,004	,029	,282	,090	,032	,000	,000	,003	,000	,001	0,000	0,000	0,000	0,000					
QUARTILE4	Pearson Correlation	-,011	-,001	-,005	,017	,011	-,007	,014	-,022	-,017	,005	-.029*	,013	.154**	,014	.475**	1			
	Sig. (2-tailed)	,417	,923	,712	,232	,428	,602	,311	,117	,234	,746	,038	,355	,000	,301	,000				
QUARTILE3	Pearson Correlation	-.032*	-,023	,004	-,014	-,016	-,019	,012	,026	-,023	-,019	.153**	.090**	.249**	.274**	.387**	-.142**	1		
	Sig. (2-tailed)	,021	,101	,761	,307	,248	,176	,378	,062	,098	,180	,000	,000	,000	,000	,000	,000			
QUARTILE2	Pearson Correlation	,002	-,008	,002	-,007	-,011	-,025	.105**	,022	-,024	-,026	.247**	.298**	.240**	.242**	.355**	-.130**	-.106**	1	
	Sig. (2-tailed)	,910	,578	,897	,632	,449	,076	,000	,123	,085	,061	,000	,000	,000	,000	,000	,000	,000		
QUARTILE1	Pearson Correlation	-,022	-,019	,026	-.039**	-.037**	-.054**	.127**	.048**	-.055**	-.043**	.566**	.516**	.457**	.456**	.370**	-.135**	-.110**	-.101**	1
	Sig. (2-tailed)	,113	,185	,068	,005	,008	,000	,000	,001	,000	,002	0,000	0,000	,000	,000	,000	,000	,000	,000	

Correlation Matrix CIS2006-2008, SNF 2010

		ROA	EBITDAm	SALEgr	LEVER	LEVER2	CASHra	SIZEsal	PROPfias	PRIroa	PRIebma	PRIsagr	ORG_INNOV	MKT_INNOV	PROD_INNOV	PROC_INNOV	TOT_INNOV	QUARTILE4	QUARTILE3	QUARTILE2	QUARTILE1
ROA	Pearson Correlation	1																			
	Sig. (2-tailed)																				
EBITDAm	Pearson Correlation	.616**	1																		
	Sig. (2-tailed)	0,000																			
SALEgr	Pearson Correlation	.079**	.067**	1																	
	Sig. (2-tailed)	,000	,000																		
LEVER	Pearson Correlation	-.188**	-.177**	.038**	1																
	Sig. (2-tailed)	,000	,000	,009																	
LEVER2	Pearson Correlation	-.234**	-.193**	.038**	.969**	1															
	Sig. (2-tailed)	,000	,000	,008	0,000																
CASHra	Pearson Correlation	.241**	.119**	-,007	-.202**	-.192**	1														
	Sig. (2-tailed)	,000	,000	,628	,000	,000															
SIZEsal	Pearson Correlation	.098**	.139**	.065**	,015	-,025	-.255**	1													
	Sig. (2-tailed)	,000	,000	,000	,289	,076	,000														
PROPfias	Pearson Correlation	-.124**	.144**	,006	-,028	-,017	-.404**	.169**	1												
	Sig. (2-tailed)	,000	,000	,660	,054	,232	,000	,000													
PRIroa	Pearson Correlation	.431**	.308**	,002	-.149**	-.187**	.214**	.041**	-.125**	1											
	Sig. (2-tailed)	,000	,000	,913	,000	,000	,000	,004	,000												
PRIebma	Pearson Correlation	.341**	.641**	-,006	-.144**	-.156**	.113**	.127**	.136**	.611**	1										
	Sig. (2-tailed)	,000	0,000	,683	,000	,000	,000	,000	,000	0,000											
PRIsagr	Pearson Correlation	,008	,005	-.033*	.055**	.063**	-,019	.030*	.033*	.058**	.053**	1									
	Sig. (2-tailed)	,563	,735	,023	,000	,000	,194	,035	,021	,000	,000										
ORG_INNOV	Pearson Correlation	-,019	-,009	,025	-,001	-,006	-.091**	.214**	.064**	-.042**	-,015	,015	1								
	Sig. (2-tailed)	,176	,522	,081	,958	,667	,000	,000	,000	,003	,287	,311									
MKT_INNOV	Pearson Correlation	,004	-,012	,017	-.049**	-.053**	-.057**	.154**	,022	-,015	-,024	,014	.380**	1							
	Sig. (2-tailed)	,784	,412	,229	,001	,000	,000	,000	,123	,279	,094	,337	,000								
PROD_INNOV	Pearson Correlation	,008	-,020	.032*	-.059**	-.056**	-,024	.078**	,014	-,013	-,020	,019	.233**	.370**	1						
	Sig. (2-tailed)	,562	,154	,027	,000	,000	,099	,000	,314	,357	,170	,175	,000	,000							
PROC_INNOV	Pearson Correlation	-,003	-,010	.048**	-,019	-,022	-,019	.066**	.067**	-,015	-,006	,015	.313**	.267**	.469**	1					
	Sig. (2-tailed)	,852	,477	,001	,182	,123	,194	,000	,000	,307	,675	,294	,000	,000	,000						
TOT_INNOV	Pearson Correlation	-,001	-,006	,026	-,024	-.028*	-.063**	.157**	.044**	-.038**	-,028	,009	.548**	.540**	.671**	.587**	1				
	Sig. (2-tailed)	,969	,672	,070	,088	,048	,000	,000	,002	,008	,050	,514	0,000	0,000	0,000	0,000					
QUARTILE4	Pearson Correlation	,026	.031*	,004	,005	,000	-,011	,017	-,013	-,004	,000	-,011	-.029*	,018	.150**	,016	.476**	1			
	Sig. (2-tailed)	,071	,030	,764	,716	,993	,443	,247	,351	,774	,973	,449	,040	,204	,000	,262	,000				
QUARTILE3	Pearson Correlation	-,017	-,010	-,008	-,010	-,008	-,019	,008	,028	-.032*	-,018	-,005	.146**	.089**	.254**	.275**	.384**	-.141**	1		
	Sig. (2-tailed)	,238	,497	,576	,492	,564	,184	,590	,053	,026	,203	,751	,000	,000	,000	,000	,000	,000			
QUARTILE2	Pearson Correlation	,000	-,020	,007	,008	,007	-,023	.108**	,022	-,008	-,013	,004	.254**	.297**	.243**	.243**	.359**	-.131**	-.106**	1	
	Sig. (2-tailed)	,976	,173	,645	,555	,644	,107	,000	,131	,561	,382	,804	,000	,000	,000	,000	,000	,000	,000		
QUARTILE1	Pearson Correlation	-,014	-,019	.041**	-.046**	-.046**	-.051**	.132**	.041**	-,018	-,017	.030*	.565**	.511**	.455**	.453**	.368**	-.135**	-.109**	-.102**	1
	Sig. (2-tailed)	,312	,188	,005	,001	,001	,000	,000	,005	,199	,236	,035	0,000	0,000	,000	,000	,000	,000	,000	,000	

Correlation Matrix CIS2006-2008, SNF 2011

		ROA	EBITDAm	SALEgr	LEVER	LEVER2	CASHra	SIZEsal	PROPfias	PRIroa	PRIebma	TOT_INNOV	QUARTILE4	QUARTILE3	QUARTILE2	QUARTILE1	PROD_INNOV	PROC_INNOV	MKT_INNOV	ORG_INNOV
ROA	Pearson Correlation	1																		
	Sig. (2-tailed)																			
EBITDAm	Pearson Correlation	.581**	1																	
	Sig. (2-tailed)	0,000																		
SALEgr	Pearson Correlation	.041**	,020	1																
	Sig. (2-tailed)	,005	,178																	
LEVER	Pearson Correlation	-.127**	-.137**	.036*	1															
	Sig. (2-tailed)	,000	,000	,013																
LEVER2	Pearson Correlation	-.176**	-.152**	.031*	.968**	1														
	Sig. (2-tailed)	,000	,000	,031	0,000															
CASHra	Pearson Correlation	.257**	.115**	.043**	-.193**	-.178**	1													
	Sig. (2-tailed)	,000	,000	,003	,000	,000														
SIZEsal	Pearson Correlation	.042**	.082**	,026	.036*	-,014	-.254**	1												
	Sig. (2-tailed)	,004	,000	,075	,014	,321	,000													
PROPfias	Pearson Correlation	-.149**	.161**	-,025	-.041**	-.033*	-.396**	.159**	1											
	Sig. (2-tailed)	,000	,000	,090	,005	,025	,000	,000												
PRIroa	Pearson Correlation	.476**	.334**	-,019	-.158**	-.189**	.197**	.084**	-.091**	1										
	Sig. (2-tailed)	,000	,000	,198	,000	,000	,000	,000	,000											
PRIebma	Pearson Correlation	.338**	.641**	,011	-.161**	-.179**	.079**	.118**	.170**	.601**	1									
	Sig. (2-tailed)	,000	0,000	,443	,000	,000	,000	,000	,000	0,000										
TOT_INNOV	Pearson Correlation	-,005	-,011	-,012	-.036*	-.039**	-.066**	.153**	.050**	-,003	-,009	1								
	Sig. (2-tailed)	,732	,460	,400	,013	,008	,000	,000	,001	,829	,522									
QUARTILE4	Pearson Correlation	,015	,011	-,009	-,001	-,002	-,018	,014	-,018	,021	,023	.477**	1							
	Sig. (2-tailed)	,290	,449	,549	,953	,866	,218	,353	,213	,152	,115	,000								
QUARTILE3	Pearson Correlation	,019	,022	-,002	-,026	-,028	-,004	,001	,014	-,015	-,003	.383**	-.140**	1						
	Sig. (2-tailed)	,200	,136	,886	,072	,058	,768	,965	,338	,315	,843	,000	,000							
QUARTILE2	Pearson Correlation	,006	-,007	-,002	-,006	-,010	-,024	.117**	.037*	,018	-,006	.357**	-.131**	-.105**	1					
	Sig. (2-tailed)	,658	,615	,878	,697	,502	,100	,000	,011	,210	,660	,000	,000	,000						
QUARTILE1	Pearson Correlation	-.053**	-.047**	-,006	-,027	-,024	-.062**	.127**	.056**	-.033*	-.034*	.370**	-.136**	-.109**	-.101**	1				
	Sig. (2-tailed)	,000	,001	,689	,060	,092	,000	,000	,000	,022	,018	,000	,000	,000	,000					
PROD_INNOV	Pearson Correlation	-,001	-,011	-,011	-.060**	-.055**	-,025	.073**	,025	-,001	-,022	.676**	.149**	.256**	.250**	.456**	1			
	Sig. (2-tailed)	,971	,462	,461	,000	,000	,087	,000	,084	,939	,137	0,000	,000	,000	,000	,000				
PROC_INNOV	Pearson Correlation	,006	,000	-,004	-,014	-,014	-,018	.064**	.066**	-,005	-,003	.590**	,014	.286**	.242**	.451**	.467**	1		
	Sig. (2-tailed)	,703	,998	,777	,347	,338	,223	,000	,000	,750	,836	0,000	,349	,000	,000	,000	,000			
MKT_INNOV	Pearson Correlation	-.036*	-.051**	-,010	-.038**	-.041**	-.063**	.152**	.033*	-,012	-.029*	.540**	,023	.084**	.296**	.511**	.373**	.267**	1	
	Sig. (2-tailed)	,014	,000	,481	,008	,005	,000	,000	,022	,404	,046	0,000	,112	,000	,000	0,000	,000	,000		
ORG_INNOV	Pearson Correlation	-.031*	-,020	-,006	-,006	-,011	-.094**	.211**	.082**	-,019	-,017	.545**	-.033*	.141**	.250**	.573**	.242**	.321**	.379**	1
	Sig. (2-tailed)	,033	,166	,657	,687	,446	,000	,000	,000	,189	,253	0,000	,022	,000	,000	0,000	,000	,000	,000	

Correlation Matrix CIS2006-2008, SNF 2012

		ROA	EBITDAm	SALEgr	LEVER	LEVER2	CASHra	SIZEsal	PROPfias	PRIroa	PRIebma	PRIsagr	ORG_INNOV	MKT_INNOV	PROD_INNOV	PROC_INNOV	TOT_INNOV	QUARTILE4	QUARTILE3	QUARTILE2	QUARTILE1
ROA	Pearson Correlation	1																			
	Sig. (2-tailed)																				
EBITDAm	Pearson Correlation	.558**	1																		
	Sig. (2-tailed)	0,000																			
SALEgr	Pearson Correlation	,002	,016	1																	
	Sig. (2-tailed)	,910	,276																		
LEVER	Pearson Correlation	-.146**	-.161**	,004	1																
	Sig. (2-tailed)	,000	,000	,789																	
LEVER2	Pearson Correlation	-.198**	-.176**	,001	.968**	1															
	Sig. (2-tailed)	,000	,000	,936	0,000																
CASHra	Pearson Correlation	.227**	.110**	-,012	-.189**	-.175**	1														
	Sig. (2-tailed)	,000	,000	,426	,000	,000															
SIZEsal	Pearson Correlation	,026	.037*	,023	.080**	,027	-.270**	1													
	Sig. (2-tailed)	,077	,012	,126	,000	,065	,000														
PROPfias	Pearson Correlation	-.139**	.158**	,030*	-,025	-,017	-.391**	.126**	1												
	Sig. (2-tailed)	,000	,000	,042	,098	,238	,000	,000													
PRIroa	Pearson Correlation	.462**	.308**	-,003	-.132**	-.162**	.212**	,009	-.141**	1											
	Sig. (2-tailed)	,000	,000	,839	,000	,000	,000	,552	,000												
PRIebma	Pearson Correlation	.297**	.662**	,010	-.151**	-.156**	.078**	.060**	.180**	.575**	1										
	Sig. (2-tailed)	,000	0,000	,509	,000	,000	,000	,000	,000	0,000											
PRIsagr	Pearson Correlation	,006	-,011	-,010	,027	,023	.052**	,010	-,024	,025	,005	1									
	Sig. (2-tailed)	,700	,458	,515	,067	,116	,000	,504	,100	,096	,730										
ORG_INNOV	Pearson Correlation	-.046**	-,014	-,006	,007	,001	-.085**	.211**	.072**	-.036*	-,015	-,004	1								
	Sig. (2-tailed)	,002	,354	,670	,643	,940	,000	,000	,000	,015	,314	,765									
MKT_INNOV	Pearson Correlation	-.045**	-.039**	-,007	-.042**	-.045**	-.062**	.147**	,029	-.034*	-.042**	-,012	.375**	1							
	Sig. (2-tailed)	,002	,009	,616	,005	,003	,000	,000	,054	,021	,005	,405	,000								
PROD_INNOV	Pearson Correlation	-,026	,004	-,009	-.051**	-.043**	-,028	.065**	,016	-,002	-,006	-,010	.235**	.367**	1						
	Sig. (2-tailed)	,077	,794	,537	,001	,003	,057	,000	,271	,893	,678	,517	,000	,000							
PROC_INNOV	Pearson Correlation	-,028	,002	-,007	-,004	-,005	-,011	.057**	.060**	-,002	,000	-,002	.315**	.265**	.457**	1					
	Sig. (2-tailed)	,055	,896	,615	,809	,754	,467	,000	,000	,902	,983	,885	,000	,000	,000						
TOT_INNOV	Pearson Correlation	-.032*	,004	-,013	-,028	-,028	-.054**	.140**	.040**	-,016	-,011	-,009	.542**	.537**	.673**	.588**	1				
	Sig. (2-tailed)	,031	,796	,386	,055	,055	,000	,000	,007	,283	,461	,523	0,000	0,000	0,000	0,000					
QUARTILE4	Pearson Correlation	,015	,022	-,007	-,008	-,009	-,006	,001	-,016	,007	,008	-,005	-.038**	,018	.153**	,016	.479**	1			
	Sig. (2-tailed)	,311	,146	,661	,569	,555	,688	,933	,270	,623	,593	,733	,010	,226	,000	,285	,000				
QUARTILE3	Pearson Correlation	-,010	,026	-,004	-,029	-,028	-,006	,003	,007	,016	,021	-,005	.143**	.086**	.250**	.286**	.380**	-.142**	1		
	Sig. (2-tailed)	,496	,076	,789	,052	,062	,669	,860	,630	,294	,161	,738	,000	,000	,000	,000	,000	,000			
QUARTILE2	Pearson Correlation	,004	-,013	-,005	,013	,012	-,011	.113**	,028	-,007	-,018	-,004	.258**	.301**	.245**	.241**	.357**	-.134**	-.106**	1	
	Sig. (2-tailed)	,792	,370	,753	,389	,416	,445	,000	,062	,620	,216	,776	,000	,000	,000	,000	,000	,000	,000		
QUARTILE1	Pearson Correlation	-.066**	-.034*	-,005	-,021	-,021	-.066**	.122**	.053**	-.045**	-.032*	-,001	.565**	.504**	.455**	.446**	.365**	-.137**	-.109**	-.102**	1
	Sig. (2-tailed)	,000	,022	,730	,162	,159	,000	,000	,000	,003	,032	,967	0,000	,000	,000	,000	,000	,000	,000	,000	

Correlation Matrix CIS2008-2010, SNF 2010

		ROA	EBITDAm	SALEgr	LEVER	LEVER2	CASHra	SIZEsal	PROPfias	PRIroa	PRIebma	PRIsagr	ORG_INNOV	MKT_INNOV	PROD_INNOV	PROC_INNOV	TOT_INNOV	QUARTILE4	QUARTILE3	QUARTILE2	QUARTILE1
ROA	Pearson Correlation	1																			
	Sig. (2-tailed)																				
EBITDAm	Pearson Correlation	.576**	1																		
	Sig. (2-tailed)	,000																			
SALEgr	Pearson Correlation	.063**	.052**	1																	
	Sig. (2-tailed)	,001	,006																		
LEVER	Pearson Correlation	-.184**	-.181**	.040*	1																
	Sig. (2-tailed)	,000	,000	,035																	
LEVER2	Pearson Correlation	-.234**	-.200**	.044*	.973**	1															
	Sig. (2-tailed)	,000	,000	,021	0,000																
CASHra	Pearson Correlation	.208**	.071**	-,030	-.148**	-.143**	1														
	Sig. (2-tailed)	,000	,000	,116	,000	,000															
SIZEsal	Pearson Correlation	.116**	.182**	,037	,023	-,015	-.250**	1													
	Sig. (2-tailed)	,000	,000	,055	,223	,445	,000														
PROPfias	Pearson Correlation	-.112**	.179**	,019	-.045*	-,036	-.401**	.185**													
	Sig. (2-tailed)	,000	,000	,325	,017	,059	,000	,000													
PRIroa	Pearson Correlation	.494**	.333**	.041*	-.129**	-.163**	.220**	,028	-.137**	1											
	Sig. (2-tailed)	,000	,000	,031	,000	,000	,000	,143	,000												
PRIebma	Pearson Correlation	.366**	.708**	,014	-.147**	-.157**	.103**	.129**	.168**	.557**	1										
	Sig. (2-tailed)	,000	0,000	,467	,000	,000	,000	,000	,000	,000											
PRIsagr	Pearson Correlation	,015	-,009	-,028	.040*	.044*	-,012	,011	.047*	.054**	,037	1									
	Sig. (2-tailed)	,442	,629	,138	,037	,020	,535	,576	,014	,004	,053										
ORG_INNOV	Pearson Correlation	,000	,015	,034	-.038*	-.043*	-.070**	.169**	.052**	-,012	,013	,013	1								
	Sig. (2-tailed)	,981	,416	,070	,048	,024	,000	,000	,006	,523	,496	,481									
MKT_INNOV	Pearson Correlation	,036	-,016	-,007	-,030	-,029	-,025	,004	,006	,002	-,031	-,001	.298**	1							
	Sig. (2-tailed)	,056	,398	,720	,117	,134	,188	,845	,760	,911	,108	,955	,000								
PROD_INNOV	Pearson Correlation	.038*	-,024	,018	-.101**	-.099**	-,012	,026	,000	,028	-,018	-,010	.283**	.436**	1						
	Sig. (2-tailed)	,046	,215	,357	,000	,000	,526	,173	,999	,140	,357	,584	,000	,000							
PROC_INNOV	Pearson Correlation	,025	,019	,001	-.052**	-.052**	-,007	.049**	.052**	-,004	,005	,009	.302**	.297**	.451**	1					
	Sig. (2-tailed)	,194	,329	,951	,006	,006	,717	,009	,006	,818	,784	,626	,000	,000	,000						
TOT_INNOV	Pearson Correlation	,034	,012	,015	-.072**	-.073**	-.039*	.093**	,031	-,003	-,009	,000	.578**	.570**	.660**	.516**	1				
	Sig. (2-tailed)	,070	,541	,435	,000	,000	,040	,000	,100	,864	,643	,999	,000	,000	0,000	,000					
QUARTILE4	Pearson Correlation	,019	,027	-,016	-,028	-,030	-,003	-,001	-,005	,001	,019	-,010	-.043*	-,003	.068**	-.044*	.422**	1			
	Sig. (2-tailed)	,325	,150	,413	,144	,112	,891	,959	,793	,973	,331	,613	,024	,880	,000	,022	,000				
QUARTILE3	Pearson Correlation	,004	,000	.042*	-,002	-,001	-,011	,032	,009	-,003	-,008	,002	.178**	.122**	.157**	.114**	.352**	-.149**	1		
	Sig. (2-tailed)	,843	,988	,029	,914	,967	,561	,088	,652	,857	,664	,905	,000	,000	,000	,000	,000	,000			
QUARTILE2	Pearson Correlation	,027	,008	,003	-,035	-.037*	-,016	,035	,010	,009	-,014	,001	.232**	.278**	.286**	.248**	.358**	-.152**	-.127**	1	
	Sig. (2-tailed)	,159	,679	,871	,062	,050	,397	,063	,599	,642	,450	,957	,000	,000	,000	,000	,000	,000	,000		
QUARTILE1	Pearson Correlation	,002	-,020	-,003	-.042*	-.041*	-,030	.077**	,035	-,011	-,012	,007	.529**	.482**	.500**	.481**	.376**	-.160**	-.133**	-.136**	1
	Sig. (2-tailed)	,900	,293	,872	,027	,030	,113	,000	,066	,566	,537	,702	,000	,000	,000	,000	,000	,000	,000	,000	

Correlation Matrix CIS2008-2010, SNF 2011

		ROA	EBITDAm	SALEgr	LEVER	LEVER2	CASHra	SIZEsal	PROPfias	PRIroa	PRIebma	PRIsagr	ORG_INNOV	MKT_INNOV	PROD_INNOV	PROC_INNOV	TOT_INNOV	QUARTILE4	QUARTILE3	QUARTILE2	QUARTILE1
ROA	Pearson Correlation	1																			
	Sig. (2-tailed)																				
EBITDAm	Pearson Correlation	.589**	1																		
	Sig. (2-tailed)	,000																			
SALEgr	Pearson Correlation	,032	,011	1																	
	Sig. (2-tailed)	,101	,576																		
LEVER	Pearson Correlation	-.120**	-.148**	,036	1																
	Sig. (2-tailed)	,000	,000	,061																	
LEVER2	Pearson Correlation	-.167**	-.166**	,035	.972**	1															
	Sig. (2-tailed)	,000	,000	,070	0,000																
CASHra	Pearson Correlation	.259**	.107**	.065**	-.138**	-.124**	1														
	Sig. (2-tailed)	,000	,000	,001	,000	,000															
SIZEsal	Pearson Correlation	.057**	.157**	,006	.042*	,001	-.248**	1													
	Sig. (2-tailed)	,003	,000	,754	,031	,954	,000														
PROPfias	Pearson Correlation	-.152**	.173**	-,034	-.056**	-.053**	-.391**	.183**	1												
	Sig. (2-tailed)	,000	,000	,078	,003	,006	,000	,000													
PRIroa	Pearson Correlation	.496**	.364**	-,018	-.163**	-.198**	.167**	.104**	-.090**	1											
	Sig. (2-tailed)	,000	,000	,341	,000	,000	,000	,000	,000												
PRIebma	Pearson Correlation	.337**	.679**	,020	-.168**	-.185**	.049*	.155**	.188**	.583**	1										
	Sig. (2-tailed)	,000	0,000	,301	,000	,000	,010	,000	,000	,000											
PRIsagr	Pearson Correlation	,022	.053**	,031	,028	,029	-,007	.042*	.048*	,002	-.079**	1									
	Sig. (2-tailed)	,250	,006	,109	,148	,133	,735	,029	,013	,908	,000										
ORG_INNOV	Pearson Correlation	-,027	,002	-,013	-,035	-,038	-.080**	.164**	.067**	-,007	,018	,001	1								
	Sig. (2-tailed)	,168	,910	,488	,073	,051	,000	,000	,000	,732	,362	,966									
MKT_INNOV	Pearson Correlation	,004	-,030	-,016	-,020	-,016	-,023	,001	,011	,031	-,018	-,015	.291**	1							
	Sig. (2-tailed)	,840	,123	,395	,288	,408	,223	,971	,580	,109	,348	,433	,000								
PROD_INNOV	Pearson Correlation	,035	-,012	-,008	-.098**	-.097**	-,016	,030	-,009	,032	-,026	,013	.286**	.438**	1						
	Sig. (2-tailed)	,068	,532	,678	,000	,000	,407	,124	,650	,095	,175	,490	,000	,000							
PROC_INNOV	Pearson Correlation	,022	,025	-,009	-.073**	-.072**	,009	.051**	.052**	,028	,016	,013	.295**	.297**	.450**	1					
	Sig. (2-tailed)	,250	,195	,657	,000	,000	,652	,009	,007	,141	,416	,516	,000	,000	,000						
TOT_INNOV	Pearson Correlation	,013	,006	-,022	-.060**	-.062**	-.047*	.095**	,037	,027	,006	,005	.575**	.567**	.661**	.516**	1				
	Sig. (2-tailed)	,504	,775	,263	,002	,001	,015	,000	,053	,166	,736	,809	,000	,000	0,000	,000					
QUARTILE4	Pearson Correlation	-,013	-,003	-,014	,008	,006	-,010	,002	,000	,009	,016	-,014	-.043*	-,004	.066**	-.042*	.425**	1			
	Sig. (2-tailed)	,516	,864	,460	,697	,763	,587	,915	,986	,640	,399	,461	,027	,821	,001	,028	,000				
QUARTILE3	Pearson Correlation	,002	,007	-,010	-,024	-,027	-,019	,028	,012	,008	,002	,007	.171**	.110**	.160**	.116**	.347**	-.150**	1		
	Sig. (2-tailed)	,915	,717	,613	,204	,159	,328	,141	,522	,676	,918	,701	,000	,000	,000	,000	,000	,000			
QUARTILE2	Pearson Correlation	.049*	,031	-,002	-,027	-,029	-,010	.040*	,005	,027	,012	,027	.236**	.286**	.284**	.248**	.358**	-.154**	-.126**	1	
	Sig. (2-tailed)	,011	,111	,928	,163	,138	,586	,038	,777	,167	,517	,158	,000	,000	,000	,000	,000	,000	,000		
QUARTILE1	Pearson Correlation	-,016	-,024	-,006	-.050**	-.047*	-,031	.076**	.040*	-,003	-,022	-,011	.526**	.482**	.502**	.478**	.375**	-.162**	-.132**	-.136**	1
	Sig. (2-tailed)	,402	,207	,749	,009	,014	,106	,000	,039	,885	,256	,581	,000	,000	,000	,000	,000	,000	,000	,000	

Correlation Matrix CIS2008-2010, SNF 2012

		ROA	EBITDAm	SALEgr	LEVER	LEVER2	CASHra	SIZEsal	PROPfias	PRIroa	PRIebma	PRIsagr	ORG_INNOV	MKT_INNOV	PROD_INNOV	PROC_INNOV	TOT_INNOV	QUARTILE4	QUARTILE3	QUARTILE2	QUARTILE1
ROA	Pearson Correlation	1																			
	Sig. (2-tailed)																				
EBITDAm	Pearson Correlation	.567**	1																		
	Sig. (2-tailed)	,000																			
SALEgr	Pearson Correlation	.088**	.042*	1																	
	Sig. (2-tailed)	,000	,032																		
LEVER	Pearson Correlation	-.150**	-.167**	,036	1																
	Sig. (2-tailed)	,000	,000	,062																	
LEVER2	Pearson Correlation	-.205**	-.182**	,023	.970**	1															
	Sig. (2-tailed)	,000	,000	,250	0,000																
CASHra	Pearson Correlation	.214**	.112**	,016	-.123**	-.115**	1														
	Sig. (2-tailed)	,000	,000	,414	,000	,000															
SIZEsal	Pearson Correlation	,038	.082**	.088**	.082**	.041*	-.264**	1													
	Sig. (2-tailed)	,051	,000	,000	,000	,035	,000														
PROPfias	Pearson Correlation	-.111**	.172**	-,036	-.050*	-.045*	-.377**	.154**	1												
	Sig. (2-tailed)	,000	,000	,065	,011	,021	,000	,000													
PRIroa	Pearson Correlation	.478**	.298**	-.066**	-.144**	-.170**	.216**	,029	-.144**	1											
	Sig. (2-tailed)	,000	,000	,001	,000	,000	,000	,145	,000												
PRIebma	Pearson Correlation	.324**	.670**	-.200**	-.168**	-.173**	.086**	.121**	.182**	.576**	1										
	Sig. (2-tailed)	,000	0,000	,000	,000	,000	,000	,000	,000	,000											
PRIsagr	Pearson Correlation	-,001	-,014	-,011	,030	,029	.075**	-,009	-,033	,022	,003	1									
	Sig. (2-tailed)	,975	,472	,572	,129	,136	,000	,645	,087	,252	,880										
ORG_INNOV	Pearson Correlation	-,038	,004	,023	-,033	-,033	-.060**	.156**	.058**	-,018	,008	-,016	1								
	Sig. (2-tailed)	,052	,857	,234	,089	,088	,002	,000	,003	,350	,669	,413									
MKT_INNOV	Pearson Correlation	,002	,007	-,016	-,015	-,012	-,008	-,006	-,003	,001	-,023	-,012	.298**	1							
	Sig. (2-tailed)	,909	,715	,410	,439	,547	,666	,752	,885	,958	,240	,543	,000								
PROD_INNOV	Pearson Correlation	,028	,003	-,005	-.080**	-.079**	-,004	,033	-,017	,035	-,010	-,005	.293**	.437**	1						
	Sig. (2-tailed)	,157	,882	,794	,000	,000	,847	,096	,392	,074	,609	,795	,000	,000							
PROC_INNOV	Pearson Correlation	-,001	,008	-,010	-.047*	-.045*	,006	.052**	.055**	,027	,027	-,008	.299**	.306**	.449**	1					
	Sig. (2-tailed)	,969	,680	,604	,016	,022	,754	,008	,005	,175	,168	,691	,000	,000	,000						
TOT_INNOV	Pearson Correlation	,011	,004	,017	-.050*	-.050*	-.041*	.089**	,031	,021	,005	-,021	.571**	.569**	.668**	.515**	1				
	Sig. (2-tailed)	,558	,820	,396	,010	,011	,036	,000	,118	,291	,787	,290	,000	,000	0,000	,000					
QUARTILE4	Pearson Correlation	,019	-,003	.041*	,002	,007	-,009	,002	,000	-,006	-,007	-,016	-.047*	-,006	.071**	-.047*	.427**	1			
	Sig. (2-tailed)	,320	,889	,035	,901	,721	,636	,916	,991	,778	,732	,411	,017	,746	,000	,017	,000				
QUARTILE3	Pearson Correlation	-,010	-,002	-,008	-,022	-,027	-.042*	,022	,012	,007	,000	-,012	.168**	.115**	.166**	.112**	.344**	-.150**	1		
	Sig. (2-tailed)	,609	,917	,673	,259	,173	,033	,265	,553	,734	,986	,548	,000	,000	,000	,000	,000	,000			
QUARTILE2	Pearson Correlation	.054**	,013	-,004	-,024	-,030	,002	,032	-,004	.045*	,027	,005	.233**	.288**	.290**	.253**	.359**	-.156**	-.126**	1	
	Sig. (2-tailed)	,006	,500	,841	,216	,126	,921	,106	,835	,020	,175	,780	,000	,000	,000	,000	,000	,000	,000		
QUARTILE1	Pearson Correlation	-.047*	-,001	-,009	-,035	-,029	-,015	.081**	.039*	-,013	-,010	-,008	.533**	.482**	.497**	.481**	.373**	-.162**	-.131**	-.136**	1
	Sig. (2-tailed)	,016	,954	,659	,076	,132	,449	,000	,045	,509	,609	,686	,000	,000	,000	,000	,000	,000	,000	,000	

7.3 Appendix 3: SPSS Macros

Breusch-Koenker Test for Heteroskedasticity

This syntax was run on each of the CIS-SNF combined dataset for regression model (2), Innovators versus Non-Innovators. Each was found to exhibit heteroskedasticity at a 1% significance level, leading us to conclude that a heteroskedasticity-consistent regression model was needed.

```
* BREUSCH-PAGAN & KOENKER TEST MACRO *
* See 'Heteroscedasticity: Testing and correcting in SPSS'
* by Gwilym Pryce, for technical details.
* Code by Marta Garcia-Granero 2002/10/28.
* The MACRO needs 3 arguments:
* the dependent, the number of predictors and the list of predictors
* (if they are consecutive, the keyword TO can be used) .
* (1) MACRO definition (select an run just ONCE).

DEFINE bpktest(!POSITIONAL !TOKENS(1) /!POSITIONAL !TOKENS(1) /!POSITION
AL !CMDEND).
* Regression to get the residuals and residual plots.
REGRESSION
/STATISTICS R ANOVA
/DEPENDENT !1
/METHOD=ENTER !3
/SCATTERPLOT=(*ZRESID,*ZPRED)
/RESIDUALS HIST(ZRESID) NORM(ZRESID)
/SAVE RESID(residual) .
do if $casenum=1.
print /"Examine the scatter plot of the residuals to detect"
/"model misspecification and/or heteroscedasticity"
/""
/"Also, check the histogram and np plot of residuals "
/"to detect non normality of residuals "
/"Skewness and kurtosis more than twice their SE indicate non-normality ".
end if.
* Checking normality of residuals.
DESCRIPTIVES
VARIABLES=residual
/STATISTICS=KURTOSIS SKEWNESS .
* New dependent variable (g) creation.
COMPUTE sq_res=residual**2.
compute constant=1.
AGGREGATE
/OUTFILE='M:\Master\Outputs\Heteroskedasticity Analysis\Tempdata\tempdata.sav'
/BREAK=constant
/rss = SUM(sq_res)
```

```
/N=N.
MATCH FILES /FILE=*
/FILE='M:\Master\Outputs\Heteroskedasticity Analysis\Tempdata\tempdata.sav'.
EXECUTE.
if missing(rss) rss=lag(rss,1).
if missing(n) n=lag(n,1).
compute g=sq_res/(rss/n).
execute.
* BP&K tests.
* Regression of g on the predictors.
REGRESSION
/STATISTICS R ANOVA
/DEPENDENT g
/METHOD=ENTER !3
/SAVE RESID(resid) .
*Final report.
do if $casenum=1.
print /" BP&K TESTS"
/" ==========".
end if.
* Routine adapted from Gwilym Pryce.
matrix.
compute p=!2.
get g /variables=g.
get resid /variables=resid.
compute sq_res2=resid&**2.
compute n=nrow(g).
compute rss=msum(sq_res2).
compute ii_1=make(n,n,1).
compute i=ident(n).
compute m0=i-((1/n)*ii_1).
compute tss=transpos(g)*m0*g.
compute regss=tss-rss.
print regss
/format="f8.4"
/title="Regression SS".
print rss
/format="f8.4"
/title="Residual SS".
print tss
/format="f8.4"
/title="Total SS".
compute r_sq=1-(rss/tss).
print r_sq
/format="f8.4"
/title="R-squared".
print n
/format="f4.0"
/title="Sample size (N)".
print p
```

```
/format="f4.0"
/title="Number of predictors (P)".
compute bp_test=0.5*regss.
print bp_test
/format="f8.3"
/title="Breusch-Pagan test for Heteroscedasticity"
+ " (CHI-SQUARE df=P)".
compute sig=1-chicdf(bp_test,p).
print sig
```

Heteroskedasticity-Robust Regression Model SPSS Macro

This syntax macro was applied to run the heteroskedasticity-consistent regressions, yielding the outputs in Appendix 1.

```
DEFINE hcreg (dv =!charend ('/')/iv =!charend ('/')
        /test = !charend('/') !default (0)
        /const = !charend('/') !default(1)
        /method = !charend ('/') !default (3)
        /covmat = !charend('/') !default(0)).
PRESERVE.
set length = none.
SET MXLOOP = 100000000.
MATRIX.
GET x/file = */variables = !dv !iv/names = dv/missing = omit.
compute y=x(:,1).
compute x=x(:,2:ncol(x)).
compute iv5 = x.
compute pr = ncol(x).
compute n = nrow(x).
compute L = ident(pr).
compute tss=cssq(y)-(((csum(y)&**2)/n)*(!const <> 0)).
do if (!const = 0).
compute iv = t(dv(1,2:ncol(dv))).
compute df2 = n-pr.
else.
compute iv = t({"Constant", dv(1,2:ncol(dv))}).
compute con = make(n,1,1).
compute x={con,x}.
compute df2 = n-pr-1.
compute L1 = make(1,pr,0).
compute L = {L1;L}.
end if.
compute dv=dv(1,1).
compute b = inv(t(x)*x)*t(x)*y.
compute k = nrow(b).
compute invXtX = inv(t(x)*x).
compute h = x(:,1).
```

```
loop i=1 to n.
compute h(i,1)= x(i,:)*invXtX*t(x(i,:)).
end loop.
compute resid = (y-(x*b)).
compute mse = csum(resid&**2)/(n-ncol(x)).
compute pred = x*b.
compute ess= cssq(resid).
 do if (!method = 2 or !method = 3).
loop i=1 to k.
compute x(:,i) = (resid&/(1-h)&**(1/(4-!method)))&*x(:,i).
end loop.
 end if.
 do if (!method = 0 or !method = 1).
loop i=1 to k.
compute x(:,i) = resid&*x(:,i).
end loop.
 end if.
 do if (!method = 5).
loop i=1 to k.
compute x(:,i) = sqrt(mse)&*x(:,i).
end loop.
 end if.
do if (!method = 4).
 compute mn = make(n,2,4).
 compute pr3 = n-df2.
 compute mn(:,2) = (n*h)/pr3.
 compute ex=rmin(mn).
loop i=1 to k.
compute x(:,i) = (resid&/(1-h)&**(ex/2))&*x(:,i).
end loop.
 end if.
compute hc = invXtX*t(x)*x*invXtX.
do if (!method = 1).
compute hc = (n/(n-k))&*hc.
end if.
compute F = (t(t(L)*b)*inv(t(L)*hc*L)*((t(L)*b)))/pr.
compute pf = 1-fcdf(f,pr,df2).
compute r2 = (tss-ess)/tss.
compute pf = {r2,f,pr,df2,pf}.
do if (!method <> 5).
print !method/title = "HC Method"/format F1.0.
end if.
print dv/title = "Criterion Variable"/format A8.
print pf/title = "Model Fit:"/clabels = "R-sq" "F" "df1" "df2" "p"
/format F10.4.
compute sebhc = sqrt(diag(hc)).
compute te = b&/sebhc.
compute p = 2*(1-tcdf(abs(te), n-nrow(b))).
compute oput = {b,sebhc, te, p}.
do if (!method <> 5).
```

```
print oput/title = 'Heteroscedasticity-Consistent Regression Results'/clabels
      = "Coeff" "SE(HC)" "t" "P>|t|"/rnames = iv/format f10.4.
else if (!method = 5).
print oput/title = 'OLS Regression Results Assuming Homoscedasticity'/clabels
      = "Coeff" "SE" "t" "P>|t|"/rnames = iv/format f10.4.
end if.
compute iv2 = t(iv).
do if (!covmat = 1).
print hc/title = 'Covariance Matrix of Parameter Estimates'/cnames =
     iv/rnames = iv2/format f10.4.
end if.
do if (!test > 0 and !test < pr).
 compute L2 = make(pr-!test+!const,!test,0).
 compute L = {L2;L((pr+1-!test+!const):(pr+!const),(pr-!test+1):(pr))}.
 compute F = (t(t(L)*b)*inv(t(L)*hc*L)*((t(L)*b)))/!test.
 compute pf = 1-fcdf(f,!test,df2).
```

7.4 Appendix 4: Inflation Adjustment Factors

Inflation Adjustments:	**2008**	**2009**	**2010**	**2011**	**2012**
Inflation (%)	2,1	2	2,8	0,2	1,4
Index	100	102	104,856	105,065712	106,536632
Adjustment Factor	1,000	0,980	0,954	0,952	0,939

Source: SSB

These adjustment factors were applied to the original SNF data in order to ensure comparability across regressions.