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The Mediating Effect of Innovation on the Relationship Between Gender Diversity and Financial Performance

Empirical evidence from listed Nordic companies in 2000-2022

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Acknowledgments

This thesis constitutes 30 ECTS points of our master’s degree in Business Analysis and Performance Management at the Norwegian School of Economics. After lengthy and vibrant discussions of our interests, skills, and trends in the business environment related to our major, we agreed on gender diversity as a topic worthy of putting our research efforts into.

Writing this thesis has been an extensive learning process. We are grateful to have had Astrid Kunze as our supervisor. Her extensive knowledge in gender diversity studies meant our discussions always ended with valuable new angles to investigate to improve our work. We would like to thank SNF and Norwegian School of Economics for the smooth process of granting us access to the datasets we required. Finally, we are grateful for all the support from our families, friends and running friends from Stafkom, providing us encouragement when the work felt overwhelming.

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Abstract

This paper explores the intricate relationship between boardroom gender diversity and firm performance. Aiming to establish a causal pattern of how female board members could affect firm performance, we propose innovation as a possible mediator.

We define gender diversity as the female share on boards and cover financial performance from both accounting (ROA & ROE) and market (market-to-book ratio, Tobin's Q) perspectives. Using R&D expenditures and patent applications as proxies for innovation, alongside other control variables, we conduct step-by-step mediation analysis on an unbalanced panel of 867 listed companies in Sweden, Norway, Finland, or Denmark from 2000 to 2022. We also use difference-in-differences (DiD) regressions, focusing on the 2008 board gender quota in Norway as an alternative approach when relevant.

The mediation analysis using pooled OLS and panel regressions discovers no effect of diversity on market performance and no positive effect on accounting returns, which disappear when firm-fixed effects are added. The effect of diversity on innovation varies from negative to positive, depending on the model specifications. Innovation is associated with improved market performance and negative or no effect on accounting returns, depending on the fixed effects used. Innovation (R&D spending) is recognized to mediate the relationship between gender diversity and performance (ROA or ROE) in a few specific setups, but generally, evidence for innovation as a mediator is weak.

Alternatively, the DiD regressions show some evidence of linking the quota and, thus, gender diversity to negative effects on ROA and market to book ratio and positive on R&D spending.

Contents

1. Introduction

This chapter will outline the background of our research, our goal, relevance of the study, and the structure of our paper.

1.1 Background

Recent years have witnessed significant changes in the composition of corporate leadership. Companies are now more welcoming of diverse workforces, with women making notable progress in entering roles traditionally dominated by men. In places like Norway, women now make up almost half of the workforce (World Bank, n.d.-a). They are pursuing higher education[1], securing full-time careers, and venturing into international roles as companies expand globally.

Diversity has moved to the forefront of corporate agendas. Leading organizations like ABB and PwC actively promote diversity on their websites and incorporate it into their long-term strategies. Notably, the role of Chief Diversity Officers (CDOs) has emerged, with over 50% of Fortune 500 companies appointing individuals to drive diversity and inclusion efforts (McKinsey, 2022).

However, significant challenges persist. A gender disparity in top leadership positions continues globally. According to the Center for Research on Gender Equality (CORE), in 2021 14% of CEOs in Norway's largest companies are women. Within the European Union in 2021, a mere 20.2% of executives and only 7.8% of CEOs in the largest publicly listed companies are women (Catalyst, 2022).

To address these disparities, some countries have enacted policies promoting gender diversity. Norway led the way in 2003 with a law requiring at least 40% female board members in public-limited companies, increasing female board representation significantly[2]. Denmark, Sweden and Finland, adopted 'soft law' approaches, setting gender-specific targets and

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[1] Norway's educational statistics from 2017 to 2022 illustrate a shift towards gender parity in higher education, with female participation rising from 37.4% to 41.9%, and male participation decreasing from 62.6% to 58.1% (Statistics Norway, 2023).

[2] The law went into effect on January 1, 2006, following a two-year transition period. Businesses that did not comply by January 2008 risked being dissolved. By April 2008 all businesses complied (Ahern & Dittmar, 2011).

recommendations rather than mandatory quotas, which led to substantial increases in female board representation. Other countries like Spain, Iceland, France, Belgium, the Netherlands, Italy, and Germany followed Norway's example by implementing similar quotas, contributing to a global trend towards greater gender diversity in corporate governance.

"Diversity is not only a matter of fairness. It also drives growth and innovation. The business case for having more women in leadership is clear" says the President of the European Commission, Ursula von der Leyen (European Commission, 2022). In this study, we delve into understanding the possible causal relationship between gender diversity and firm performance through the perspective of innovation, recognized as a vital factor for firm competitiveness (Clark & Guy, 1998). Specifically, we investigate whether the potential improvements in financial performance in companies with female directors materialize through their unique approach to innovation, rather than solely looking at the presence of women on corporate board and performance, which is a relationship of a correlational and endogenous nature. Therefore, the study tests the link between diversity and financial performance, the impact of innovation on business success, and whether females' approach to innovation explain the changes in the financial performance of companies.

1.2 Goal

Our master's thesis explores the relationship between gender diversity, innovation, and financial performance of firms. We study the Nordic listed companies in the period from 2000 to 2022. We aim to answer the following research questions:

1. *Does boardroom gender diversity lead to improved firm performance?*
2. *Does innovation mediate the relationship between boardroom gender diversity and firm performance?*

We define gender diversity as the female share on board. Financial performance is measured from both accounting (ROA & ROE) and market (market-to-book ratio, Tobin's Q) perspectives. Innovation is assessed through R&D spending and patent application count. The differences among firms are reduced by using control variables, which enables a better separation of the effect of diversity.

We utilize the mediation framework defined by Baron and Kenny (1986), where in a relationship between two variables, a third variable, referred to as a mediator, is introduced and operates as the intermediary or mechanism through which the causal effect unfolds. Following this approach, we must sequentially establish a correlation between (1) diversity and performance, (2) diversity and innovation, (3) innovation and performance, controlling for diversity. We do that using pooled ordinary least squares and panel regressions.

However, our choice of the time (around gender quota in Norway) and geography (Norway and comparable control group of Swedish, Finnish and Danish firms) offers us an opportunity to cross-check our findings on the diversity and performance (1) and diversity and innovation (2) links using the difference-in-differences (DiD) method. The DiD methodology, comparing performance and innovation changes over time between groups affected by the quota and those not affected is closer to the arguably more robust, alleviating some of the endogeneity concerns plaguing the panel regressions, leading us to more rigorous conclusions.

For our study, we chose the years 2000 to 2022. We are bound by the data on board diversity, and BoardEx, our source of the data on the executive, began its coverage of the Nordics in 2000. This period includes multiple years before and after Norway's 2008 gender quota law, giving us enough time to see its effects. We excluded Iceland because, like Norway, it has a gender quota, making it ineligible for the control group in DiD models.

1.3 Relevance

The study contributes to the previous research by examining innovation as a mediating factor in the Nordic context. Little attention has been paid to the impact of female leaders on innovation and its consequences. Moreover, the thesis makes a methodological contribution by employing both the difference-in-difference approach and multiple regression analyses, providing a deeper understanding of the relationship between gender diversity and firm’s performance, as well as the mediating effect of innovation. We aim to deliver valuable insights to companies, policymakers, and stakeholders. Furthermore, it is in accordance with Sustainable Development Goal 5, which specifically targets gender equality and the empowerment of women.

Gender diversity is particularly relevant in Nordic countries, as the region is known for being leaders in gender equality. The 2023 Global Gender Gap Report by the World Economic

Forum places Norway, Finland, and Sweden among the top five countries for gender equality (World Economic Forum, 2023). While Denmark is not in the top five, it still ranks highly (as 23rd), demonstrating a strong commitment to gender parity in various societal aspects. Moreover, these countries rank high in terms of both shareholder protection, which Post and Byron (2015) recognize as an amplifier of the positive effect of gender diversity on accounting returns, and gender parity, which they identify as a precondition for a positive effect of diversity on market performance[3]. Lastly, according to the Global Innovation Index 2023 by the World Intellectual Property Organization (WIPO), Sweden, Finland, and Denmark are among the world's most innovative economies, with Sweden ranked 2nd, Finland 6th, and Denmark 9th. Norway also places highly at 19th (WIPO, 2023).

The Nordic region, therefore, provides an interesting setting for our thesis, offering a unique blend of high gender equality, strong investor protection, and a supportive environment for innovation, making it a perfect laboratory to investigate our proposed research questions.

1.4 Structure

The subsequent sections of the thesis are organized in the following manner: Chapter two provides a comprehensive review of the literature that examines the relationship between gender diversity within companies, their overall performance, and the mediating role of innovation. In chapter three, we introduce a data set and sample used. Chapter four provides a detailed explanation of the empirical methodology, including the regression models. Chapter five includes the empirical analysis, which showcases the outcomes derived from the regressions conducted on the relationship between diversity and performance. In chapter six, we examine the findings are examined and elaborate on limitations and recommendations for future research. The last chapter concludes our findings.

[3] Norway is 2nd worldwide in terms of gender parity, Finland is 3rd, Sweden 5th, and Denmark 23rd (World Economic Forum, 2023). Moreover, the "Protecting Minority Investors" ranking ranks Norway as 21st globally, Sweden and Denmark - 28th, and Finland 61st (World Bank, n.d.-b).

2. Literature review

This section covers a review and summary of past empirical studies on examine the effects of Norway's gender quota on corporate board composition, gender diversity, and its subsequent impact on corporate performance, with a particular emphasis on the mediating role of innovation. Subsequently, we present the hypotheses that will be examined in our empirical analysis. Lastly, we propose a model showcasing the hypothesis outlined.

2.1 Impact of Norway's Gender Quota on Corporate Boards

Several papers examine the effects of Norway's gender quota on corporate boards, providing varied viewpoints on its consequences. The study by Wang and Kelan (2013) finds that the quota positively affected the appointment of women to top leadership roles. The gender gap in qualifications and age among directors diminishes at the leadership level, with female and male board chairs having similar profiles. However, the quota had no significant impact on the overall gender gaps between female and male directors post-implementation[4].

Kunze and Scharfenkamp (2022) explore the wider organizational effects of the quota. By employing a difference-in-differences approach and a triple difference model, the researchers uncover significant discoveries when examining Norwegian[5] and German[6] companies. They find a positive impact of employee representation on gender diversity before the gender quota reform. The quota not only raised the probability of women obtaining director positions but also diminished the role of employee representation in promoting gender diversity post-implementation. The authors set the introduction of the quota as year 2008 and distinguish between the "in-phase" period (2004-2007) and the as "post-reform" period (2008-2009).

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[4] While the introduction of the gender quota in Norway led to an increase in the number of women in top leadership roles (such as board chairs and CEOs), it did not significantly change the existing disparities in certain aspects (like age, qualifications, or experience) between female and male directors on corporate boards (Wang & Kelan, 2013)

[5] All registered public limited corporations (ASAs) in Norway, which are required to file yearly financial reports and register the names and roles of board directors during the 1999–2009 period.

[6] The authors created a dataset of boards and directors from companies with at least 2,000 employees and parity employee representation, meaning equal representation of employees and shareholders on the board, with the board chair elected from the shareholders.

Finally, Eckbo et al. (2022) offer a meticulous reassessment of the valuation impacts of the quota. They highlight the difficulty in pinpointing quota-related news[7] and stress the importance of adjusting for contemporaneous cross-correlation of stock returns. Their study concludes that the quota has had no significant effect on stock returns, whether in the short or long term. This discovery is especially remarkable because it contradicts previous claims of adverse economic effects associated with the quota. However, according to their analysis, the outcomes were not directly caused by the quota law. They argue that this is because there were already qualified female director candidates available when the law was put into effect.

Yang et al. (2019) focus on the intersection of diversity and firm performance, particularly the impact of women directors on firm risk. The paper employs a meta-analysis and difference-in-differences methodology, analyzing data from Norwegian firms, with Swedish, Danish, and Finnish firms as control groups, spanning from 2002 to 2008. The study concludes that mandated female representation has a negative effect on firm performance and firm risk. The authors explain that the imposition of gender-balancing quotas reduces firm risk, and the quota policy significantly increases the number of women directors on the boards of treated firms.

Studies on Norway's gender quota for corporate boards yield mixed results: some indicate positive effects on women's leadership roles and firm performance, while others find no significant impact on gender gaps or economic outcomes like stock returns. This variety in findings suggests a need for further investigation to fully understand the quota's effectiveness.

2.2 Gender Diversity and Firm Performance

Research on the impact of gender diversity in corporate boardrooms on their financial performance has produced mixed results. Many studies point towards a positive relationship[8].

[7] Due to the potential political controversy surrounding quotas, engaging in public discussions about them can hinder the accurate identification of news events that have a substantial impact on the market's initial likelihood of a quota law (Eckbo et al., 2022)

[8] See, for instance, Conyon and He (2017), Campbell and Minguez-Vera (2007), Eckbo et al. (2022), Gordini & Rancati, (2017), Vafaei et al. (2015)

For instance, Conyon and He (2017) using quantile regression methods, found gender diversity to significantly boost firm performance, particularly in high-performing companies.

Kim and Starks (2016) noted the diverse expertise of female directors, enhancing board capabilities. García-Meca et al. (2015) observed that gender-diverse boards correlate with lower stock price volatility, attracting investors seeking stability and consistent growth. Collectively, these findings emphasize the benefits of gender diversity in improving corporate governance and financial stability. The reason for that could be grounded in the Resource Dependence Theory, which, as described by Pfeffer and Salancik (2003), supports the idea that directors with diverse backgrounds bring considerable advantages to a firm, such as providing knowledge, connecting to external information sources, accessing resources, and enhancing credibility.

Adams and Ferreira (2009) studied the board dynamics in 2000 U.S. companies from 1996 to 2003, finding that gender-diverse boards are more diligent, especially in monitoring[9] responsibilities, with higher female representation correlating to better attendance. However, they noted that in companies with already strong governance, gender quotas might lead to excessive supervision and negatively impact performance. The study also explored the potential endogeneity in using female directors as a diversity metric. Initially, female directors seem to boost performance, but this changes when considering firm-specific factors, suggesting a misinterpretation of diversity's impact due to endogeneity. The authors mention reverse causality, where firm performance might affect female director appointments, and use a two-stage least squares (2SLS) to address this, employing the proportion of male directors with board connections to female directors as variables.

Marinova et al. (2016) examined the relationship between the diversity of genders on company boards and the performance of firms. They analyzed 186 publicly listed companies in the Netherlands and Denmark in the year 2007. The study employed a two-stage least squares estimation method, using Tobin's Q as the performance metric, to investigate the influence of female representation on corporate boards. Although approximately 40% of the companies

[9] The term "monitoring" in the Adams and Ferreira (2009) study refers to the active involvement of directors in supervising the operations of the firm as part of corporate governance. Key factors include the presence of directors at board meetings, their remuneration frameworks, and the frequency of these meetings. These factors collectively guarantee that directors are well-informed and make decisions that prioritize the shareholders' best interests.

have at least one female member on their board, the results indicate that there is no substantial relationship between gender diversity and the performance of the firm. The study, however, focuses solely on a single year, which could affect the results. Notably, the researchers focused solely on a single year, which could affect the results.

The term "firm performance" is broad and includes different types of metrics. Return on assets (ROA), return on equity (ROE), return on sales (ROS), and return on investment (ROI) are examples of accounting-based performance measures that were used in past studies (see for example Post & Byron, 2015 or Miller and Del Carmen Triana, 2009). One problem with these measures is that they only look at the firm's past performance. Accounting-based metrics are determined by the company's historical performance as well as its short-term performance (Gentry & Shen, 2010). Tobin's Q is the most widely used market-based indicator of long-term firm performance. The advantage of Tobin's q is that it does not require risk adjustment or normalization to compare across firms, which is beneficial over comparisons using stock return or accounting performance measures (Stulz, 1994). Because different aspects of firm performance are measured by different performance measures, results from previous studies are not always consistent with the measures used.

While the topic of gender diversity has been extensively explored, the role of innovation as a mediating factor has received relatively little attention. An additional drawback is that many studies look at the link between gender diversity and performance in the U.S. This focus may yield less representative results due to distinct cultural differences. For instance, Norway is renowned for its significant gender equality, contrasting with the USA, which is particularly characterized by a high degree of individualism (Hagen, 2011)

The following hypothesis is grounded in the Resource Dependence Theory, suggesting that diverse perspectives and experiences brought by women can enhance decision-making and governance within organizations (Reddy & Jadhav, 2019).

Hypothesis 1 (H1): Gender diversity has a positive effect on financial performance of firms.

2.3 Gender Diversity and Innovation

Innovation is distinct from creativity, and it is defined as a process beginning with the generation and planning of ideas and culminating in the creation of functionalities (Tohidi & Jabbari, 2012). The scope of innovation extends beyond the mere development of new products and services (Damanpour & Evan, 1984); it encapsulates the ongoing enhancement of processes, strategies, and approaches, positioning businesses to thrive in a dynamic and competitive environment (Tohidi & Jabbari, 2012). Innovation emerges as a fundamental necessity and a pivotal driver of competitiveness. It also is the engine that propels growth and empowers companies to navigate the ever-changing market dynamics adeptly (Barney, 1991).

Østergaard et al. (2011) provided valuable insights into how gender and educational diversity contribute to promoting innovation in companies. The authors assessed innovation by examining whether a company introduced a new service or product between 2003 and 2005. This definition of innovation centers on the introduction of new offerings while excluding incremental enhancements to pre-existing products and services. The study revealed a robust positive correlation between gender diversity and the probability of a company implementing innovation, indicating that having a diverse gender composition in the workforce greatly enhances the ability to innovate. It suggests that companies with a more equitable distribution of genders are in a more advantageous position to foster innovation. Likewise, the presence of a variety of educational backgrounds among employees was found to have a positive correlation with innovation. They discovered that diversity in terms of gender and educational background improves decision-making and problem-solving skills by enhancing the use of information and professional identity. While these studies explore the link between gender diversity and innovation, they do not address how this innovation translates into financial performance, which your thesis aims to investigate.

Research by Miller and Del Carmen Triana (2009) also delved into the impact of gender diversity in boardrooms on innovation. Their findings show that companies with gender-diverse boards report greater progress in innovation. This is attributed to the inclusion of women in decision-making processes, introducing a range of perspectives and experiences, thereby enriching the pool of ideas and solutions essential for innovative advancements. The research investigated American companies, and our research can contribute by examining how this relationship specifically plays out in Nordic countries.

Vafaei et al. (2021) seek to examine the influence of female representation on the boards of Australian companies on the level of innovation. The researchers examined data derived from the 500 largest corporations listed on the Australian Securities Exchange (ASX) during the period spanning from 2004 to 2015. The measurement of innovation was conducted by considering inputs such as research and development expenditure and intangible assets, as well as outputs such as registered patents. The findings demonstrated a clear and positive effect of the involvement of female directors on the level of innovation within a company.

Many papers use R&D and a number of patents as the measure of innovation (see for example: Apesteguia et al., 2010; Cheng et al., 2010; Loof and Heshmati, 2001). According to Coombs and Bierly (2006), R&D investment is often closely linked to technological innovation. It enables researchers to discover how much a company contributes to technological progress in its field by looking at its R&D. Patents are a good way to determine if a technology has been commercialized, and they have been used frequently as a way to track technology and knowledge trends, look at patterns of innovation, and come up with knowledge strategies (Kim & Lee, 2015).

The below hypothesis is grounded in the observation that diverse teams, especially those that include varied gender perspectives, offer a wealth of experiences and viewpoints. This range of thoughts and experiences is pivotal for creative problem-solving and innovative thinking, which are essential for fostering innovation. In alignment with the resource-based view (RBV) as outlined by Barney (1991), integrating these diverse perspectives enables organizations to identify and respond to emerging market opportunities, craft unique solutions, and maintain a competitive edge in fast-paced industries more effectively. Therefore, the hypothesis is formulated as follows:

Hypothesis 2 (H2): Gender diversity has a positive effect on innovation.

2.4 Firm’s innovation and performance

The relationship between innovation and firm’s performance has been extensively explored in various studies, highlighting its crucial role in driving success across different sectors and economic conditions.

Damanpour and Evan (1984) set out to investigate the adoption rates of technical and administrative innovations in organizations with diverse performance levels. They discovered that high-performing organizations were more inclined to adopt these innovations. These findings, focusing primarily on innovation as a driver of success, overlook the role of gender diversity within this relationship.

Lome et al. (2016) examined the effect of R&D intensity on the performance of Norwegian manufacturing SMEs during financial crises. They measured R&D intensity as the ratio of R&D expenditure to total revenue and assessed firm performance through relative revenue growth. Their findings indicated that firms with substantial R&D investments outperformed others during the late 2000s financial crisis, with a notable lag effect of two to three years between R&D investment and its positive revenue impact.

Nilsen et al. (2020) analyzed the effects of public R&D support[10] on firm performance in Norway from 2002 to 2013, focusing on firms with and without prior R&D activity ("R&D-experienced" and "R&D-starters"). The findings indicated that R&D support positively influenced the performance of R&D-starters, but had an insignificant effect on R&D-experienced firms. Additionally, the study suggested that while major instruments for direct R&D support were less effective in terms of output and employment compared to tax credits, overall, R&D support should favor R&D-starters to maximize its impact on firm performance.

Cheng et al. (2010) investigated the relationship between innovation and corporate performance in the healthcare industry. The authors used intellectual capital as a measure of innovation. They claim that it helps bridge the gap between firm's market value and its book value, providing a more accurate representation of the company's true value, especially in the context of modern markets where intangible assets play a significant role. Their study emphasized the importance of creating an innovative environment within organizations to utilize its benefits effectively.

[10] In the study by Nilsen et al. (2020), R&D support was measured using a concept termed "support dose". This measure represents the intensity of R&D support received by a firm. Specifically, the support dose was calculated as the sum of support from various R&D instruments over the entire treatment period, divided by the duration of the treatment (D). This approach allowed for a quantitative assessment of the amount of R&D support each firm received relative to the length of time they were receiving it.

The study conducted by Lööf and Heshmati (2002) utilizes knowledge capital as the measure of innovativeness, which is measured as the proportion of innovation sales to total sales. The authors investigated its impact on the variation in performance among manufacturing firms in Sweden. They discovered that knowledge capital plays a significant role in explaining variations in firm performance. This effect remained significant even after controlling for variables such as human capital and firm size. The study found that knowledge capital is positively influenced by innovation input and collaboration with universities.

Studies consistently show that innovation, whether through R&D, knowledge capital, or new patents, leads to improved outcomes like higher profits, market share, and resilience in tough times. However, they often do not consider the impact of gender diversity in these processes. We suggest the following hypothesis:

Hypothesis 3 (H3): Innovation has a positive effect on firm performance.

2.5 The mediating effect of innovation on gender diversity and firm performance

The nexus between gender diversity in corporate governance and firm innovation has been an important point in recent research, underscoring the pivotal role of boardroom diversity in driving organizational success and innovation.

Chen et al. (2015) explored the effect of female board representation on corporate innovation and firm performance. Their study revealed a positive correlation between the proportion of female directors and increased innovation investment, leading to more patents and citations. Notably, a 10% increase in female directors correlated with a 6% rise in patents and a 7% increase in citations. While these findings are pivotal, other innovation metrics, such as R&D spending, could have been employed.

Miller and Del Carmen Triana (2009), using a sample of Fortune 500 companies, investigated the mediating effect of innovation on the relationship of gender boardroom diversity and financial performance. They used R&D spending as a proxy for innovation, and accounting-based performance measures namely ROI and ROS. The authors found a positive link between gender diversity and innovation, claiming that diverse boards contribute to innovation in the form of increased R&D spending. In terms of the mediating effect of innovation, the results were mixed.

Building on these insights, the study by Agyapong et al. (2017) investigated the interplay between social capital[11], innovation[12], and the performance of MSBs in Ghana. The research, through a survey of 500 MSBs, found that innovation serves as both a precursor and mediator in this relationship. The study's stepwise regression analysis showed that social capital positively impacts performance and innovation, with innovation partially mediating the relationship between social capital and performance.

In conclusion, these studies collectively suggest that innovation plays a crucial mediating role in realizing the benefits of gender diversity on boards, translating into improved firm performance. There is an opportunity to further explore the topic within the Nordic context, to provide additional insights into the dynamics between board diversity, innovation, and firm success. This leads to the hypothesis that innovation is a key mediator in the relationship between gender diversity and a firm's performance, underscoring the strategic significance of fostering innovation within gender-diverse corporate environments.

Hypothesis 4 (H4): Innovation positively mediates the relationship between gender diversity and firm's performance.

Figure 1 shows a conceptual model illustrating the hypothesized positive relationships between gender diversity, innovation, and performance within a firm. Gender diversity has a direct positive impacts on both performance (H1) and innovation (H2). Additionally, we hypothesize that innovation positively influences performance (H3), and it positively mediates the relationship between gender diversity and performance (H4).

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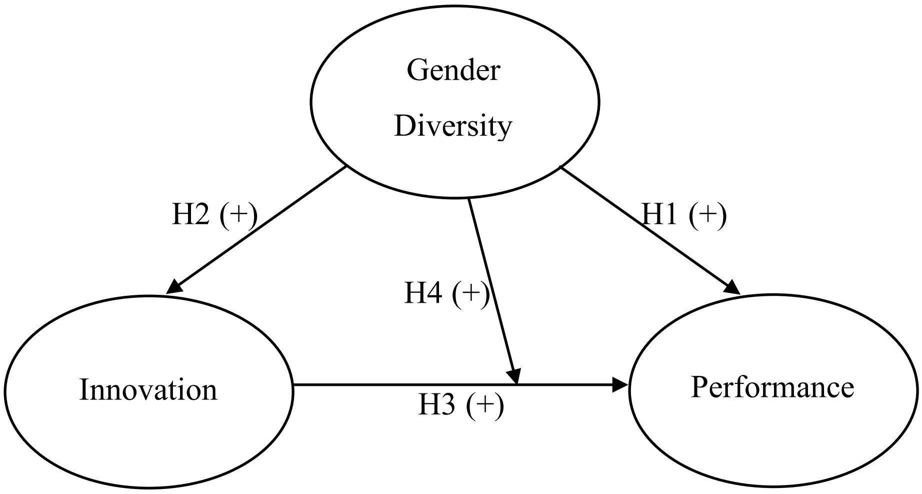
[11] A seven-point Likert scale is used to measure social capital. The higher the number, the more social capital a company has compared to its competitors. This way of measuring social capital looks at aspects such as how open and honest communication is within the staff, how much trust there is between officers, and whether everyone on the staff has the same goals and vision for the company (Agyapong et al., 2017).

[12] Innovation was measured across process, solution, and product/service dimensions. The authors use three levels of innovation: innovation in the process, innovation in the solution, and innovation in the product or service. A seven-point Likert scale is used to measure these aspects of innovation. Respondents are asked to rate how innovative their companies are compared to their competitors (Agyapong et al., 2017)

Figure 1.1 - Conceptual Model of the Mediating Role of Innovation in the Relationship Between Gender Diversity and Firm Performance



3. Data

In this chapter, split into four parts, we introduce the data used in our empirical analysis. Firstly, we present the sources. Secondly, we describe the sample selection. Thirdly, we describe the variables used in our research. Fourthly, we present the descriptive statistics.

3.1 Data Sources

The final merged data set we use in our empirical analysis is assembled from three different sources. The board-level data is acquired from the BoardEx, covering various characteristics of the board composition. Next, the firm-level financial data, including both the accounting and market performance measures, is collected from the Refinitiv Eikon database. Finally, the firm-level patent data is added from Orbis Intellectual Property.

Merging of the data sets is done primarily through International Securities Identification Number (ISIN) codes (International Monetary Fund, 2002). Since some of the companies we cover have experienced ISIN number alteration due to a name change or other corporate events, we use tickers as an alternative for data merging. In the rare instances of neither of these working, we rely on manual matching.

The final dataset is an unbalanced panel covering 867 companies that have been listed for at least two years from 2000 to 2022 in Sweden, Norway, Finland, or Denmark.

3.1.1 BoardEx – board diversity and controls

The data describing the board composition of the listed companies we used in our analysis comes from the BoardEx database. BoardEx holds information on more than 1.6 million executives, their demographic and professional profiles; around 400 analysts are involved in maintaining and updating the data (Altrata, n.d.).

When considering the data required for our research, we recognized the board data to be the limiting factor. That is, while the accounting and market-based data for the Nordic firms could be accessible through multiple sources, BoardEx, to our knowledge, is the only database that contains the board characteristics for all the countries in this region. Therefore, if BoardEx had no board data of the company, it would have to be assembled manually, significantly limiting the viability of the study. Hence, we based our merged dataset on the BoardEx data as a foundation, subsequently adding the performance and patent data.

3.1.2 Refinitiv Eikon – firm performance, innovation and controls

The accounting and market performance data was acquired from Refinitiv EIKON (Eikon). Eikon is a powerful platform, integrating thousands of data sources to offer real-time coverage of countless equities from more than 180 countries (London Stock Exchange Group, n.d.).

While Regnskapsdatabasen could be the most trustworthy source of data for Norwegian companies, the inclusion of non-Norwegian companies creates the need for an alternative. Given our utilization of Bureau van Dijk's Orbis for patent data gathering, intuitively, it would be the most convenient to collect the accounting and market data from it, too. Yet, in practice, Orbis lacks the market data of many companies before 2007, so we would have to use another data source to fill this gap. Hence, for better uniformity of data, we decided to use Eikon for the whole timespan, as it covers all countries and years we are interested in.

3.1.3 Orbis Intellectual Property – patents

Finally, we gather patent data of the companies in our dataset from Orbis Intellectual Property (hereby Orbis IP). Combining multiple sources, Orbis IP connects 156 million patents to 2.4 million firms (Bureau van Dijk, n.d.).

The addition of patent data was the most time-consuming step in the data set creation process as we did not find a way to automatically extract company-by-year patent applications for all companies at once. We had to manually download and extract the patent data for each company separately. Thus, this was left as the final step, covering only the companies we knew we had both the board and the financial data on.

3.2 Sample selection

BoardEx, our seminal data source, offers two ways to determine the nationality of a company. The first is to filter by the *Country* variable, which states the land of the company's head office location. The other is to filter by the ISIN, where the first two letters refer to the country of domicile, so we would require the ISIN code to start with "NO", "SE", "DK" or "FI".

Filtering by head office country failed to include companies with headquarters outside of the Nordics, but domiciled in the Nordics (10 firms, 72 firm-year observations), while also adding firms headquartered in the Nordics, but domiciled elsewhere (22 firms, 143 firm-year observations). The inverse is true when filtering by ISIN. Hence, we download the data using both approaches and then merge it. We consider either a satisfactory headquarters location or ISIN code to be sufficient inclusion criteria for our study. Since the headquarters' country variable is later used as a country indicator in the analysis, the 10 companies with "foreign" headquarters get their country assigned based on the ISIN code.

Table 3.1 – Sample selection process

	Removed obs.	***Remaining obs.***
All BoardEx firm-year observations in our countries of interest from 2000 to 2022		10,464
1) Removing financial companies	1,508	8,956
2) Removing non-listed companies	1,724	7,232
3) Removing observations with missing board values	11	7,221
4) Removing observations with missing accounting data	4	7,217
Final sample		**7,217**

Table 3.1 summarizes the steps taken in the sample selection process. Extracting companies with either headquarters in Norway, Sweden, Denmark or Finland, ISIN code beginning with "NO", "SE", "DK", "FI" or both, we get 10,464 firm-year observations. The year 2000 is chosen as the first since that is when BoardEx coverage of Nordic companies begins.

Researchers covering diversity and performance have often excluded financial companies as they operate with different capital structures, business models, risk profiles and are subject to additional regulations (Yang et al., 2019). Thus, in data filtering, we remove financial setor companies: firms that BoardEx labeled as "Banks", "Blank Check / Shell Companies", "Insurance", "Investment Companies", "Private Equity" and "Specialty & Other Finance".

The next step is to remove the private companies. BoardEx coverage includes notable private and governmental companies, such as LEGO Group A/S or Norges Bank Investment Management. We take multiple steps to ensure there are only listed companies in our sample. Firstly, we use company names and ISIN codes to cross-check the listing status on Eikon and Orbis, showing whether the company is among the ones publicly quoted or formerly publicly quoted. Secondly, private companies would have missing values for market to book ratio and Tobin's Q as market capitalization is needed for the calculation of these variables.

In the third step we remove observations with missing data on the board level controls. In the fourth step we remove the few observations with missing data for the accounting variables.

After the sample selection steps, our final dataset has 7,217 firm-year observations, covering 867 listed companies. As can be seen in table 3.2, the number of companies covered increases steadily until it peaks in 2021. Sweden is the country with the highest number of observations, followed by Norway, Finland and Denmark.

Table 3.2 – Firm-year Observations by Country by Year

Year	Denmark	Finland	Norway	Sweden	Total
2000	10	6	45	74	135
2001	11	7	62	86	166
2002	12	7	75	97	191
2003	13	8	76	108	205
2004	13	9	81	109	212
2005	17	19	82	107	225
2006	19	23	75	104	221
2007	20	27	74	103	224
2008	21	31	68	101	221
2009	21	30	59	96	206
2010	26	39	66	101	232
2011	28	48	69	104	249
2012	30	49	65	106	250
2013	30	51	60	105	246
2014	34	55	67	111	267
2015	36	56	68	121	281
2016	40	53	68	130	291
2017	52	80	88	216	436
2018	67	97	92	238	494
2019	73	108	93	260	534
2020	76	107	161	272	616
2021	85	115	188	301	689
2022	83	113	157	273	626
Total	**817**	**1 138**	**1 939**	**3 323**	**7 217**

3.3 Variable description

In this section we describe the variables that are used in the empirical analysis. The variables are split into four groups and are covered in the following order: dependent, independent, control and mediator. We offer arguments for the choice of the variables based on the past research. The summary of variables can be found in tables A1-A4 in Appendix A.

3.3.1 Dependent variables – financial performance

The focal relationship of our research is the effect of board gender diversity on financial performance of a company. Following the setup in the meta-analysis of female representation on boards and financial performance by Post and Byron (2015), we split the performance into two separate categories: accounting returns and market performance. Based on studies covering "multi-dimensionality of organizational performance", the authors argue for the use of accounting outcomes in tandem with market-based measures to cover both short-term firm profitability and outsiders' forward-looking anticipations (Post & Byron, 2015, p. 1547). Specifically, the authors indicate that return on assets (ROA) and return on equity (ROE) are among the most frequently utilized accounting measures in the diversity and performance studies, while market-to-book ratio (M/B) and Tobin's Q are recurrent market-based performance measures. Thus, we choose these four as our performance indicators, too.

While convenient for comparing similar characteristics or tracking a company's progress over time, both ROA and ROE have some peculiarities that require attention. ROA, which demonstrates how efficiently a company uses its assets to generate profits, varies across industries, depending on the capital intensity. The asset-heavy sectors like telecommunications or utilities will gravitate towards low ROA, while asset-light software & computer services can generate high ROA due to low asset base. Sector or individual fixed effects should account for these disparities.

Similar cross-sector consideration is valid for ROE, which shows how good a company is at generating profits on its shareholders' equity. Additionally, ROE will be much more sensitive to firm's financial leverage than ROA, since ROE ignores the debt in its calculation. Thus, highly indebted companies can appear extraordinarily profitable due to their low equity. Again, sector and firm fixed effects aim to address this concern.

We calculate ROA and ROE using the respective year's net income and assets or equity. Following methodology by Yang et al. (2019), who study the effect of board gender quota in Norway with Finland, Sweden and Finland as a control group, we winsorize both accounting variables at 1st and 99th percentile to limit the effect of the outliers.

Comparing our two market-based measures, the key difference is in the scope. Calculated as market capitalization divided by equity, the M/B ratio is centered in shareholder's perspective. M/B ratio is an indicator of the anticipated profit for equity investors, arising from the company's strategic decisions over time, relative to the original equity investment's time-adjusted value. Meanwhile, Tobin's Q, measured as market capitalization divided by total assets, offers a broader perspective. As an indicator that considers total assets, it limits the need for risk, leverage, or size adjustments. Again, following Yang's et al. (2019) approach, who also use both Tobin's Q and M/B ratio, we winsorize these variables at 1^{st} and 99^{th} percentile.

3.3.2 Independent variables – board gender diversity

Following the research question, our independent variable is the fraction of females on a corporate board. BoardEx provides a variable called "GenderRatio", which reflects the share of male board directors at a company in a specific year. For better interpretability, we make a transformation: 1 – GenderRatio = *FemaleShare*, to create a new variable that reflects the fraction of females on board.

Additionally, in the difference-in-differences regression, the independent variable is the interaction term between variables *treat* and *Post2007*, comparing the change in the performance measures in Norway pre-quota to Norway post-quota versus controls pre-quota to controls post-quota.

3.3.3 Control variables – board & firm measures

The analysis features multiple control variables, grouped into types: board and firm level. At the company level, we control for firm characteristics often adopted in the academic literature, namely, firm age, and sector. Given the specificality of Norway, we also retain dummy variables for country. At the board level, in adherence with the past research, we include multiple board demographic and composition control variables.

Board-level variables

Firstly, considering board composition measures, Adams and Ferreira (2009) rationalize the need for board size and independence controls through mathematical perspective. That is, using Norway as an example, if regulators require a firm to appoint an additional female on board, she could be employed as an independent director, raising both the independence share and board size. It underscores the need to control for these factors to isolate the effect attributed to gender diversity.

Formally, larger boards can bring performance improvements through broader collective knowledge base (Pearce & Zahra, 1992). Yet Pearce and Zahra (1992) also acknowledge that part of the benefits of a larger board is attributable to having more independent directors, whose impartiality makes them better monitors, they possess broader non-company specific knowledge and a larger external network, further emphasizing the interlink between size and independence. On the contrary, larger boards could experience difficulties in coordinating and communicating effectively, which may hinder their ability to reach agreement (Ellwood & Garcia-Lacalle, 2015). To account for these intertwined links and separate the female role, we control for board size and board independence (share of independent board members).

A considerable degree of disparity is found in the empirical research on board members' age effect on the performance, where, for example, older executives are linked to more resistance to strategic change and decreased bankruptcy risk (Fernández-Temprano & Tejerina-Gaite, 2020). Strategic flexibility, however, might be required to reap the full benefits of innovation efforts. Kim and Lim (2010) contrast the experience benefits and risk-aversion disadvantage of older executives, then drawing attention to the collaborative advantages that arise from the combination of younger board members' innovative contributions and the seasoned insights provided by older members, showing a positive impact of board age diversity on financial performance. With the age disparity as a potentially influential factor, we control for it following Fernández-Temprano and Tejerina-Gaite (2020) approach, including a variable for the standard deviation of board members' ages.

Another consideration is the board members' tenure. Logic suggests that the longer an executive has been on the board, the more extensive their knowledge of the firm, enhancing their reasoning. Yet, longer tenure comes at a risk of getting too attached to existing approaches; longer tenures have been linked to higher inflexibility, and avoidance of novel ideas and changes (Golden & Zajac, 2001). To counteract the rigidity and increase the board's efficiency, Ahmadi et al. (2018) propose raising the fraction of directors with shorter tenures as they diversify viewpoints and beliefs on specific cases. Combining both ends, Tuggle et al. (2010) show that a higher variance of board members' tenures lead to more frequent discussions of entrepreneurial subjects. Thus, we include standard deviation of board members' years on the board as a control variable.

Additionally, we use the standard deviation of board members' years in the company as a control, too. Despite a strong correlation with years on board, distinguishing between the two offers unique insights. Years on board relates to the governance experience and familiarity with board dynamics, while years in the company reflects in-depth, firm-specific knowledge. Thus, short board tenure executives with a lengthy experience in the company could offer opinions grounded in practical observations from the firm, while board members without employee experience in the firm can bring a governance perspective without internal bias. This nuance would be lost if we looked only at the standard deviation of years on board.

Firm-level variables

Related to the company age, the life-cycle effects of a firm are a potential concern. Firms are often found to follow a U-shape performance pattern, where the first years are characterized by inexperience drawbacks, which gradually improve with acquisition of resources and experience, followed by a decline rooted in flexibility loss and bureaucracy (Coad et al., 2018). Therefore, we add a control variable for firm's age, measured as a natural logarithm of company's years since incorporation.

Depending on the regression configuration, we add controls for the firm's sector. Sectors vary in terms of risk profiles, regulatory environments, capital intensity, and competition levels, all of which significantly influence firm performance (Barth et al., 2013). Innovation intensity will also differ across industries, so more accurate isolation of the effect of female board representation requires sectoral differences control. Sectors are gathered from BoardEx database, which follows the FTSE International classification guidelines; 36 different sectors are represented in our data.

We try to account for cross-country differences since Norway is subject to specific quota. In the linear regression setup, this leads to the inclusion of country dummies. In the difference-in-differences, this means split between Norwegian companies and the rest.

3.3.4 Mediator variables - innovation

The remaining two variables vital to our research, R&D expenses and patent applications filed by company, fit into the unusual category of mediator variables. Due to particularities of mediator analysis, these two innovation-related variables will be either dependent, independent, or control variables, depending on the specific regressions. Therefore, they require a separate subsection.

The incorporation of two proxies for innovation is based on the work of Bouchmel et al. (2022), who recognized a mediating effect of corporate innovation on the relationship between the board gender diversity and firm performance among listed French companies in the timeframe from 2013 to 2017. Allocating funds to R&D is the initial stage of pursuing innovations, expressing the depth of commitment (Chen et al., 2018). Yet, R&D expenditures do not necessarily reflect the actual outcomes or effectiveness of the innovation process (Atanassov, 2013). Consequently, scholars have suggested the use of patent count in conjunction with R&D expenditures for a more holistic evaluation of the company's proficiency and productive use of the resources for innovation (Bouchmel et al., 2022). In our research, in alignment with Bouchmel et al. (2022), we use the natural logarithm of (1 + R&D expenses) and natural logarithm of (1 + patents). The addition of 1 in the transformation helps us to avoid elimination of firm-year observations with 0 R&D expenses and/or 0 patents. Following Chen et al. (2018), we change all missing R&D expenditure values to zero.

3.4 Descriptive statistics

In the following section we cover relevant descriptive statistics based on the data sample. Firstly, we present an overview of all variables, comparing Norwegian and non-Norwegian firm-year samples. Next, we present key insights regarding dependent, independent, control and mediator variables respectively.

3.4.1 Sample characteristics

The table B1 in Appendix B presents the mean and standard deviations of the numerical variables in our dataset. Since we will utilize difference-in-differences regression, too, a comparison between Norwegian companies and control group (firm-year observations from Swedish, Danish and Finnish companies) is also offered in table 3.3.

Unsurprisingly, Norwegian firms tend to have more females on boards (table 3.3). Compared to the control group’s boards, Norwegian boards are less independent and slightly less diverse when considering dispersion of how long the board members have been on the board and in the company. In the whole sample, the average ROA is 0.05% and average ROE is 2.41%, yet both profitability metrics on average for Norwegian firms are negative and more volatile. Non-Norwegian firms achieve better outcomes in the market metrics. So, looking purely at the averages, the data indicates a better performance of non-Norwegian firms. Finally, on average, there is substantially lower average innovation activity in the Norwegian firms, with multiple times lower R&D expenditures and patent application counts.

To illustrate the skewness of the data, we have added a median of the full sample. Median ROA (3.9%) and ROE (9.47%) are more in line with the usual profitability expectations, indicating a negatively skewed distribution. The median company age is also lower than the mean, so a few old companies are raising the average. The mean of assets is almost six times higher than median, an example of how in the Nordic stock markets a few massive companies can influence the average figures. Finally, as shown by the median of zero in both our innovation metrics, there are many companies not reporting any research activity.

Table 3.3 – Firm-year Observation Count by Country by Year

	All firm sample (n = 7217)			**Norwegian firm sample (n = 1939)**		**Non-Norwegian firm sample (n = 5278)**	
	Median	***Mean***	***St. Dev.***	***Mean***	***St. Dev.***	***Mean***	***St. Dev.***
Female Share	0.29	0.27	0.16	0.32	0.16	0.25	0.15
Board Size	7.00	7.70	2.71	6.87	2.27	8.01	2.80
Independent Share	0.58	0.55	0.31	0.44	0.35	0.59	0.28
SD Time on board	3.00	3.48	2.81	2.95	2.80	3.67	2.78
SD Time in company	3.50	4.41	3.62	3.88	3.59	4.61	3.62
SD Age	7.40	7.50	2.56	7.50	2.92	7.50	2.42
ROA	3.90	0.05	18.51	-2.76	20.04	1.08	17.80
ROE	9.47	2.41	39.25	-2.63	45.65	4.26	36.46
Market to Book ratio	3.86	3.37	3.98	3.00	3.85	3.51	4.02
Tobin's Q	1.90	1.71	2.21	1.43	1.89	1.81	2.31
Debt to Equity	1.87	1.55	2.00	1.81	2.64	1.45	1.70
Age	25.00	45.09	4.67	36.65	53.79	48.19	47.70
Assets (billion EUR)	0.45	2.62	7.48	2.49	9.78	2.67	6.44
R&D (million EUR)	0.00	49.35	329.23	7.94	32.9	64.57	383.35
Patents	0.00	59.71	430.10	10.08	34.72	77.95	501.17

Table B1 in Appendix B gives further split by sectors, stating the observation counts, returns, valuations, innovation, and size. Software & computer services are the most recurrent industry, with 815 firm-years, 11.3% of the total sample, followed by diversified industrials (9.4% of observations) and pharmacy and biotechnology (7%).

3.4.2 Dependent variables – financial performance

Table B1 in Appendix B is valuable for a more nuanced split of the dependent variables. It reveals significant sectoral variations and possible discrepancies between performance from accounting and market perspective.

Pharmaceuticals and biotechnology is a sector that stands out from the rest. It is characterized by the worst returns, yet the highest average Tobin's Q and one of the highest M/B ratios. Part of the complexity comes from grouping together well-established pharmaceutical companies and risky, new biotech companies. In this sector, Novo Nordisk, from 2000 to 2022, has been operating with an average ROE of 46% and ROA of 24%, while many smaller biotech and pharma companies have operated with returns deeply into double-digit negatives. However, the market puts high optimism in their future growth and innovation potential, so they trade at high multiples. This emphasizes the value in separating market and accounting performance.

Intriguing dynamics are shown by the most frequent sector – software & computer services. Unexpectedly, it shows negative average returns. However, a closer look reveals a possible explanation. There are 30 software firms in our sample in 2000, growing to 43 by 2005, and declining to 21 in 2010. A few years later, the count starts to grow again. Meanwhile, the returns were deeply negative in the early 2000s, turned positive just before the financial crisis, took a strong hit during the crisis and then began slowly inching upwards again. The average assets also showed a rapid increase during the financial crisis. Thus, a sizable amount of variation comes from smaller software companies that were in their growth phase before the Great Financial Crisis and went bankrupt or delisted when it hit.

As correlation matrix in table B2 in Appendix B shows, both accounting performance metrics have a high correlation (0.91), the market performance measures move similarly closely together (0.84). Yet, the correlation pairs of accounting and market performance exhibit much weaker correlations (from 0.21 to 0.27). So, top returns do not imply valuation leadership.

Figure 3.1 – Median ROA by Groups

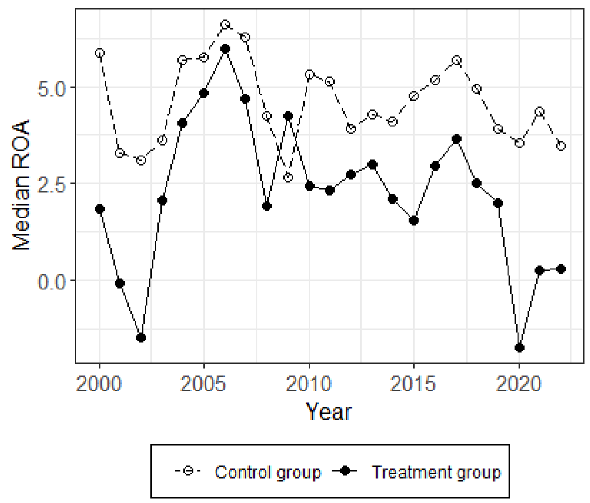
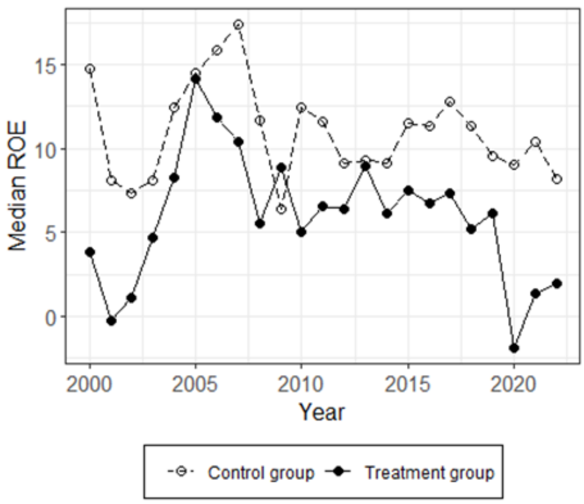


Figure 3.2 – Median ROE by Groups



Figures 3.1-3.2 show the fluctuations in median accounting profitability measures split by the control and treatment groups. Based on ROA, Norwegian firms are underperforming compared to the controls up until 2003, then begin to rapidly close the gap from 2004 to the peak of the pre-financial crisis in 2006. The profitability drops in 2007 to 2008 are more pronounced in Norwegian companies, while in 2009 there is a reversal that is not observed in the control group. This is likely attributable to the oil & gas sector's returns; the high oil prices in 2009 lead to outperformance of other industries still dealing with consequences of the economic downturn. In our data in 2009, 22% of Norwegian observations are from oil & gas sector, compared to less than 1% in the control group.

After 2009, though, a gap develops again, and Norwegian listed companies yield lower median returns than the others. The disparity noticeably widens after 2020. While it could imply that Norwegian firms were hit by COVID-19 downturn more than the controls and are struggling to recover, we suspect a presence of structural changes in the data. In 2019, BoardEx covered 93 Norwegian companies, but this number surged to 161 in 2020 and 188 in 2021. In the same period, the average Norwegian firm's size (by assets) in our data noticeably decreased. Correlation matrix in Table B2 in Appendix B shows larger companies are associated with better accounting performance and worse market metrics, which could explain the shifts seen in Figures 3.1-3.4, where after 2019, Norwegian firms catch up in market performance and fall behind on accounting returns. To address this issue, we do the analysis excluding observations after 2020 in the robustness tests. ROE follows similar trends to ROA, except that in Norway, the pre-crisis decline started already in 2006.

Figure 3.3 – Median M/B ratio by Groups

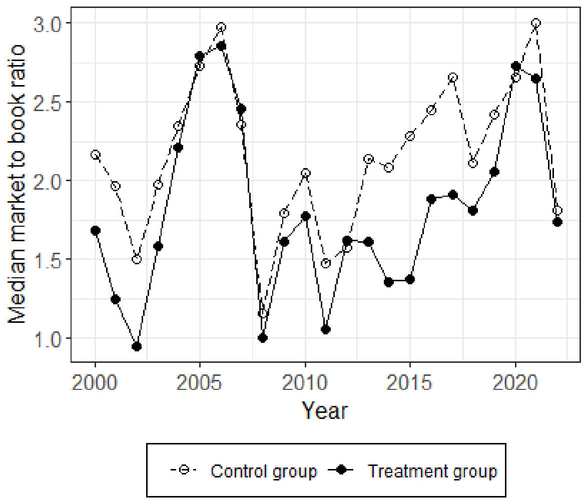
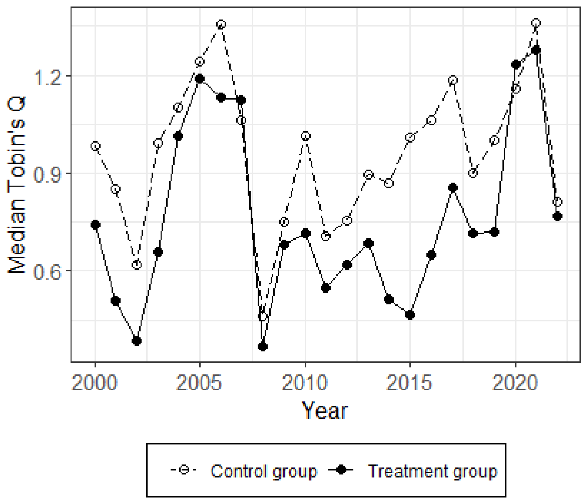


Figure 3.4 – Median Tobin's Q by Groups

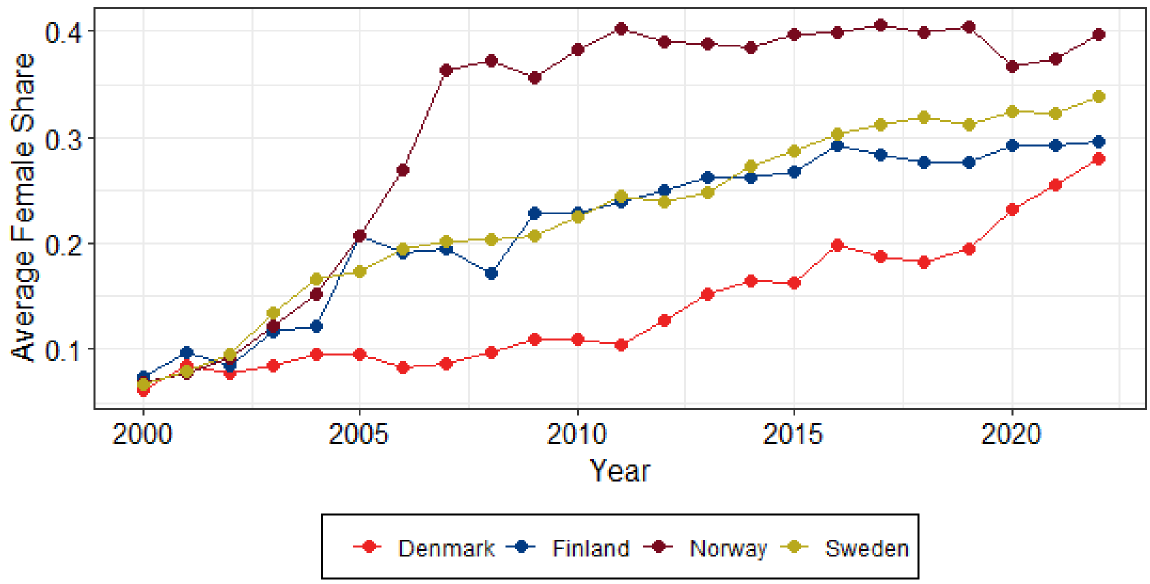


In the median value developments in the market performance metrics illustrated in figures 3.3 and 3.4, control and treatment groups follow one another very closely, with Norwegian companies slightly lagging. However, one might notice a more pronounced divergence in 2014 to 2016. These three years were defined by a sizable oil price plunge, halving from US$100 per barrel, going as low as US$30 per barrel (Grigoli et al., 2019). Undoubtedly, as Norway's biggest sector, this left an effect on the valuations of the companies. Considering the possibly significant volatility caused by the oil sector, we run difference-in-difference analysis with oil and gas sector excluded in the robustness tests.

3.4.3 Independent variable – board gender diversity

In this section, we will look at the independent variable, female share, from multiple angles.

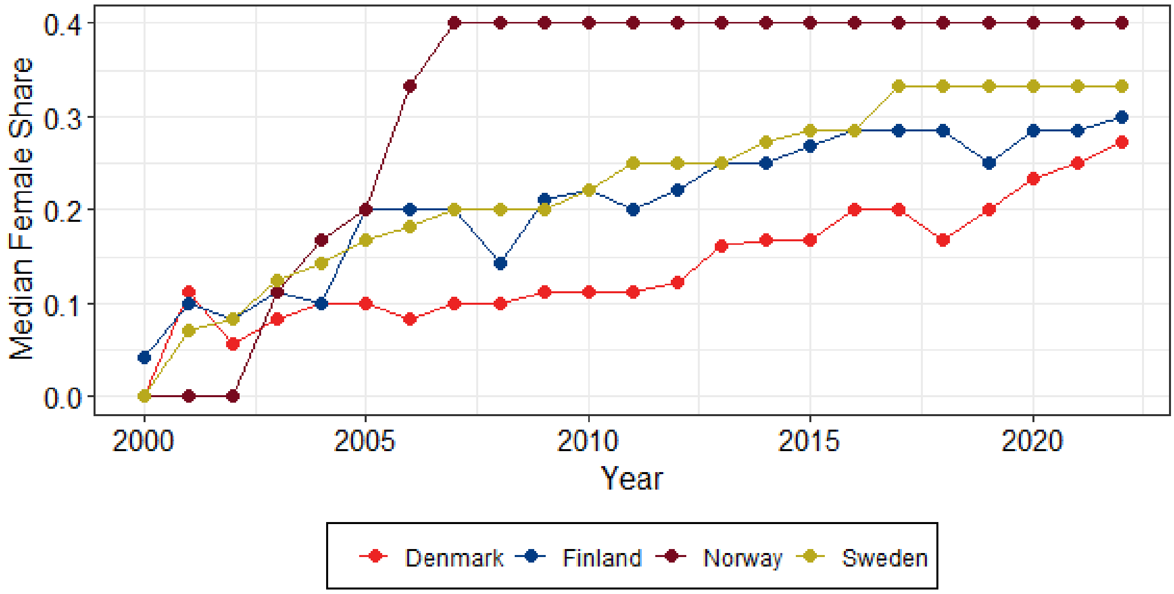
Figure 3.5 – Average Female Share on Boards by Country



Firstly, we look at the average fraction of females split by countries (figure 3.5). In our sample, all four countries show very similar patterns in 2000 to 2002, with female share staying below 10%. A steep increase begins in 2003 and by 2005, the female fraction has approximately doubled in all countries except for Denmark, where the share stays flat. Year 2006 is the separation point, where listed Norwegian companies continue to make substantial improvements preparing for the quota, Denmark stagnates, while Finnish and Swedish companies set themselves on a gradual growth path in the middle between both extremes.

Importantly, due to the specifics of the quota and inclusion of listed companies not subject to the quota, the Norwegian averages can still be under 40%. However, the trends show a clear pattern: after convergence with the quota recruitment, no further progress in board gender diversity has been made in Norway. Meanwhile, on average, Sweden has continued the steady progress, Finnish companies have stopped the growth after reaching almost 30% in 2016, while Danish firms have made good progress starting from 2012 and have almost caught up with the rest. Thus, after the big gaps in the middle, the Nordic countries have evened out most of the inconsistencies.

Figure 3.6 – Median Female Share on Boards by Country



The use of medians (figure 3.6) reveals multiple distinct thresholds of female fraction: 20%, 25%, 33% and 40%. Another noticeable point is ~28.6%, corresponding to 2 out of 7 board members being female (or 4/14 in a few cases). This again shows how progress has stopped in Norway after rapidly reaching the quota demands. Additionally, besides the 40% point, the pronounced thresholds suggest strategic targeting by the companies.

The correlation matrix in Table B2 in Appendix B shows of the female share's relationships with the other variables. Female share has a small (0.04), but statistically significant positive correlation with both ROE and ROA. The relationship with the market performance variables is smaller and not significant. From firm metrics, female share has a significant positive relationship with assets, in line with the expectations that larger companies are more likely to diversify their boards.

The same correlation matrix in Table B2 in Appendix B reveals peculiar dynamics of female share's correlation with innovation measures. Unexpectedly, there is a negative association between females and research & development expenditures. Simultaneously, the correlation of female share and patents is positive, albeit not statistically significant. Viewed in isolation, it might suggest more effective innovation activities in firms with higher female fraction as more patent applications are filed despite a decrease in spending on research.

Intriguing interactions of female share with the board-level control variables can be observed in the correlation matrix in Table B2. Female share has a strong positive relationship with board independence. On the one hand, it could mean that boards with a higher fraction of independent directors are more progressive and more likely to adopt inclusive governance practices – have more females on board. On the other, it could be the inverse, where women already on boards play a significant role in advocating for the appointment of more independent directors. Or could be a mix of both, where females are brought on board as independent directors. Moreover, with female fraction going up, other board diversity metrics decrease, so there is less variability of tenure on the board, tenure in the company, and age among board members. It might indicate that the recent efforts to enhance gender diversity on boards has led to clustering of appointments of female directors. If multiple female directors are appointed within a short timeframe and belong to similar age cohorts, it can lower the standard deviations of time on board and age of board members.

An overview of gender diversity by sectors can be seen in Table B1 in Appendix B. On average, consumer services (47%) and education (42%) are the only sectors exceeding 40% female share, followed by electricity (38%) and food & drug retailers (37%). However, those are sectors with few observations. From sectors with at least 100 observations, the most diverse are the firms from the chemical (34%), household products (33%) and oil & gas (32%). Mining (15%), information technology hardware (21%) and forestry & paper (22%) stand out as the least diverse.

3.4.4 Control variables – board & firm measures

The summary table of statistics in Table 3.3 gives an overview of the key numbers for the control variables. The average board has 7.7 seats, where 4.24 are held by independent directors. The average Norwegian board, compared to non-Norwegian, is by 1.14 seats smaller and has 15 percentage points lesser independent director share. Non-Norwegian boards are also more diverse in terms boards members' variation in tenure and time in company. The average standard deviation of board members' age stands at 7.50 in both groups.

In our data sample, Norwegian firms are smaller, with the average assets of 2.49 billion EUR, compared to the 2.67 billion EUR in the controls, although the Norwegian sample is more volatile. Among all observations, the mean assets are 2.62 billion EUR, but median is much smaller, just 0.45 billion EUR, indicating skewness caused by some of the massive public companies. On average, Norwegian firms are almost 12 years younger and almost 25% more levered than the rest.

Table B1 in Appendix B shows an unsurprising dynamic that on average, electricity sector firms are the largest by assets (17.3b EUR), telecommunication services come next (10.3b), followed closely by forestry & paper (9.2b).

3.4.5 Mediator variables – innovation

Table 3.4 – Sample Characteristics of Zero and Non-zero R&D Expense Firms

	Zero R&D sample (n = 3983)			**Non-zero R&D sample (n = 3234)**		
	Median	***Mean***	***St. Dev.***	***Median***	***Mean***	***St. Dev.***
Female Share	0.29	0.28	0.16	0.25	0.26	0.15
Board Size	7.00	7.20	2.27	8.00	8.33	2.84
Independent Share	0.50	0.50	0.32	0.64	0.61	0.28
SD Time on board	2.70	3.40	3.07	3.20	3.57	2.44
SD Time in company	3.10	4.18	3.79	3.90	4.70	3.39
SD Age	7.60	7.69	2.75	7.10	7.26	2.29
ROA	3.65	0.78	16.26	4.25	-0.85	20.91
ROE	9.39	3.74	37.46	9.53	0.78	41.30
Market to Book ratio	1.84	2.92	3.54	2.44	3.92	4.41
Tobin's Q	0.78	1.37	1.84	1.17	2.13	2.54
Debt to Equity	1.31	1.72	2.17	1.06	1.33	1.75
Age	22.00	38.11	44.10	29.00	53.68	54.57
Assets (bn EUR)	0.37	1.55	4.45	0.66	3.95	9.87
R&D (m EUR)	0	0	0	15.00	110.14	485.01
Patents	0	2.55	13.65	9.00	130.11	635.21
Treatment	0	0.36	0.48	0	0.16	0.37

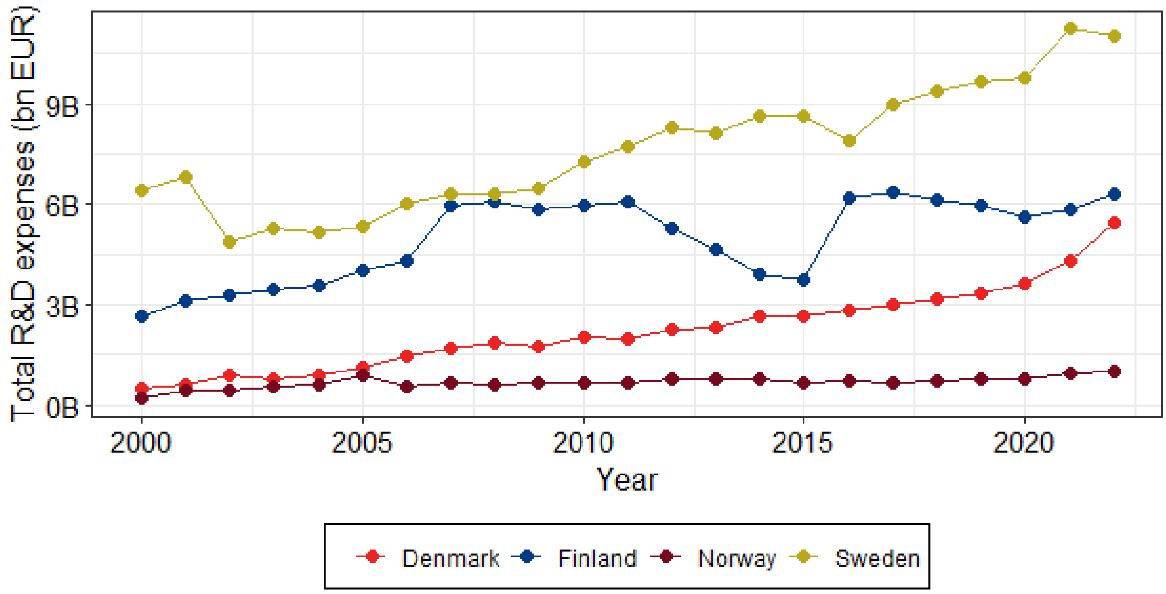
Many companies in our dataset do not report any research and development expenses: 55.2% of the firm-year observations have a zero R&D spending. When split into 0 and non-0 R&D expense sample, table 3.4 reveals a couple of noteworthy differences between the two groups. On average, the firms that report R&D costs are older, much larger, and less levered. Also, they perform worse than the non-reporting firms by the accounting returns but have better valuations on the market metrics. However, apart from the leverage, all the firm-level variables are more spread out in the "innovative" group as indicated by the higher standard deviation.

Moreover, median ROA and ROE, contrary to the means, are higher in the non-zero R&D group. These two facts point toward the presence of different kinds of innovative companies. For instance, one group is the young and small biotechnology firms with highly negative accounting returns, responsible for mean ROA turning negative. Another group consists of the old, large and stable companies that can afford to invest in research, generating strong financial performance as shown by the median accounting returns, yet operating with lower market to book ratio and Tobin's Q.

Boards in 0 R&D spending sample are by about 1 seat smaller, have less diversity of time in company and on board and have a lower share of independent directors. Yet, they have a slightly better age and female diversity metrics. Despite not reporting R&D expenses, these firms on average, still generate a few patents, albeit just a fraction of what firms with reported R&D spending create.

Finally, a firm-year observation from Norway is much more likely to be found in the zero R&D sample. As indicated by the Treatment group dummy variable, 36% of the zero R&D observations are from Norway, compared to just 16% in the other group.

Figure 3.7 – Total R&D Spending by Country

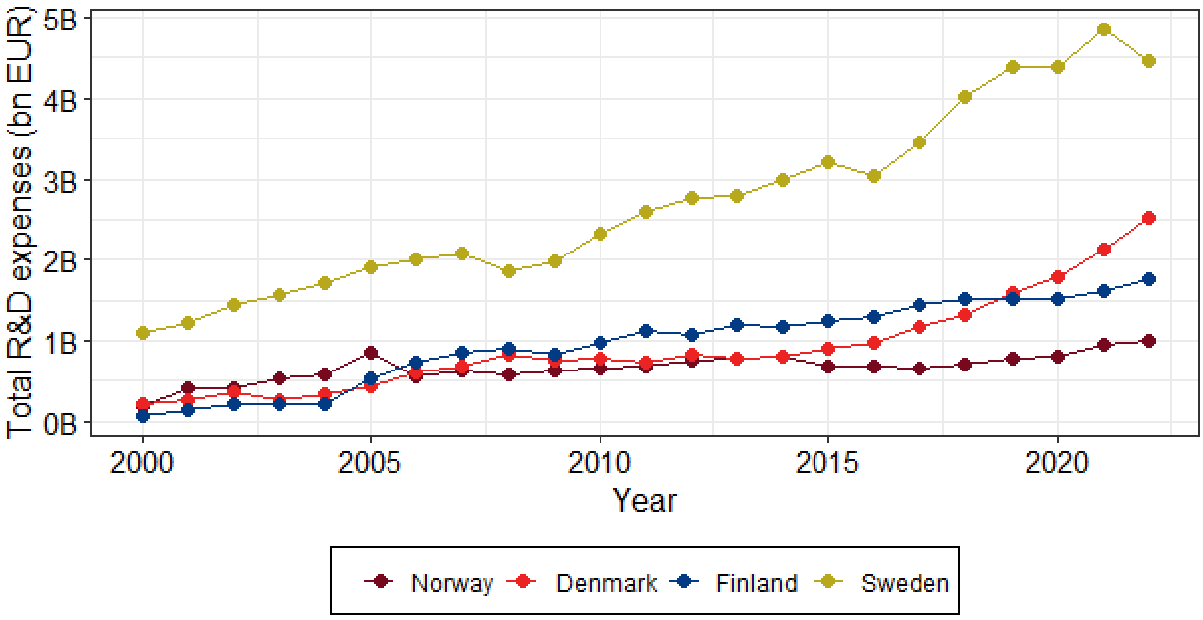


Graph in the Figure 3.7 illustrates the total R&D spending of all firms in our data sample split by years. It appears that R&D spending is not sensitive to the effects of economic downturns. Sweden is a consistent leader, followed by Finland, Denmark and Norway. This order would be in line with firm-year observations in our data, where there are 3,323 firm-years from

Sweden, 1,138 from Finland and 817 from Denmark. However, Norway clearly stands out since it has 1,939 firm-year observations in our data but convincingly lowest R&D spending.

Looking at our data, we believe that the likeliest explanation of Norway's divergence is its lack of research and development "powerhouses" among the listed companies. A few companies can leave a massive impact on the aggregate numbers. In 2022, Sweden had Ericsson and Volvo AB that reported 4.3 and 1.8 billion EUR of research and development expenses respectively, Finland was led by Nokia with 4.6 billion EUR, while Denmark had Novo-Nordisk spending 2.9 billion EUR. Meanwhile, the highest reported R&D expenditure among Norwegian companies was Equinor's 0.29 billion EUR.

Figure 3.8 – Total R&D Spending by Country After Exclusion of 4 Biggest R&D firms



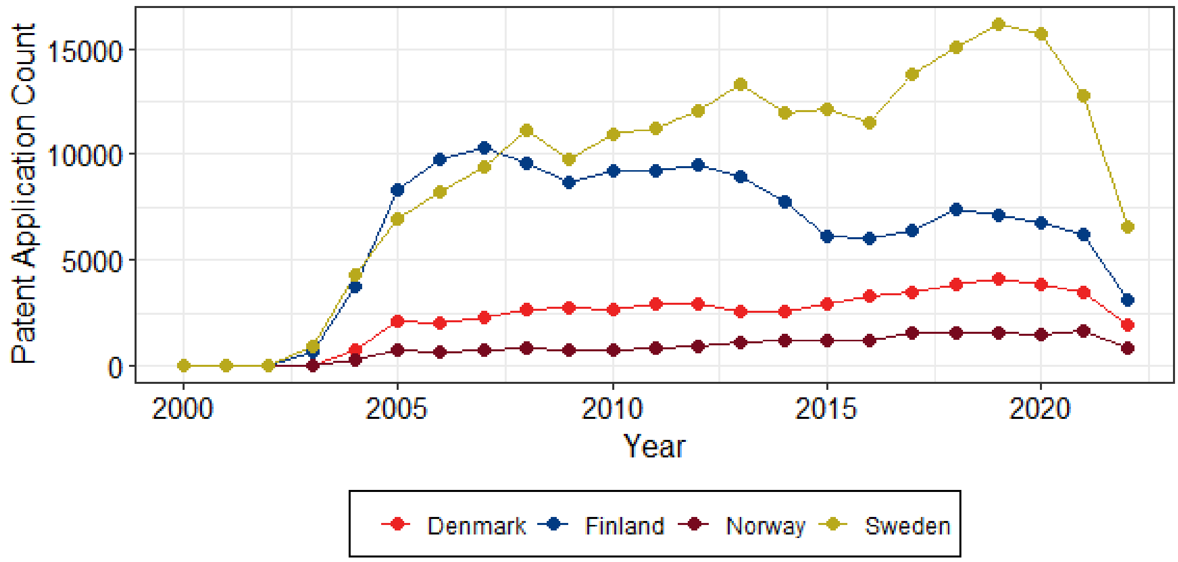
To illustrate how sizable impact these few companies have, we recreated the R&D spending graph in figure 3.7, excluding just four firms: Nokia (Finland), Novo-Nordisk (Denmark), Ericsson (Sweden) and Volvo (Sweden). The outcome is seen in figure 3.8. Sweden remains as the clear leader. Meanwhile, Norway no longer appears to be a significant outlier, at least up until 2017, when other countries began the rise in other countries' R&D spending was not matched by Norwegian listed firms.

We did not find an external source that would present aggregated figures of R&D spending by listed companies by country for an easy comparison. Combining stats presented by multiple sources, however, the figure 3.8 with "outliers" excluded seems to be accurate. Firstly, the OECD data on R&D spending by countries as a percentage of GDP indicates that Norway is persistently the relatively lowest innovator (OECD, 2023). From 2000 to 2021, Norway's R&D/GDP ratio has generally fluctuated in 1.5% to 2% range, while Sweden has steadily remained above 3% since 2003, Denmark has been at about 3% mark since the Great Financial Crisis and Finland being the most volatile, ranging from 3.7% in 2009 to 2.7% in 2016.

Secondly, an adviser from Ministry of Education in Norway and an adviser from Statistics Norway published an article analyzing R&D data gathered from the National Statistics websites of all Nordic countries (Berg & Wendt, 2023). Besides confirming OECD's figures, they calculate and show total PPP$-adjusted R&D expenditures in all the Nordic countries from 2011 to 2021. Clearly Sweden, with the highest GDP and the highest R&D/GDP ratio, is distinctly ahead of the other countries, with the other three countries being closer together, but Norway remaining the lowest total R&D spender each year from 2011 to 2021.

Moreover, Berg and Wendt (2023) present the split of R&D spending by sectors. While business enterprises account for the largest proportion in all countries, Norway sees the lowest share. Whereas in 2021, businesses made up 72% of R&D spending in Sweden, 69% in Finland and 61% in Denmark, in Norway, this percentage reached only 54%. In simple words, this means that in Norway, business enterprises have a smaller share of the smallest innovation "pie" compared to the other three countries we cover. This is in line with what we observe in our data.

Figure 3.9 – Total Patent Application Count by Country



The graph of total patent applications by the firms split by country in Figure 3.9 reveals similar dynamics to the R&D expenditures. Norway is the last, closely following the trends of patent applications in Danish companies. The 2012-2015 slowdown of R&D spending growth in Sweden and decrease in Finland is mirrored in the patenting activity. Compared to general uptrend in the other countries, Finland stands out as country where patenting activity has been decaying. This effect is deeply influenced by Nokia seeing its performance peak in the past.

Apparent in the graph is the decline in patent applications in 2022 and to some extent in 2021, too. We attribute it to a possible time lag between when a patent application is filed and when it appears in Orbis Intellectual Property database. There is also no patent activity coverage from 2000 to 2003. Despite this, we include these initial years in our analysis as they are highly valuable in extending the coverage of the pre-quota period for difference-in-differences regression. It can distort the mediator analysis with patents as the mediator, but the mediating effect of R&D spending should not be affected. We recognize this issue in our limitations and in the robustness checks, limit the timeframe to exclude 2000 to 2003, the years of missing patent coverage.

Table B1 in Appendix B reveals the average R&D spending and patent applications filed split by sectors. Telecommunication services, including Nokia, is in the front in terms of both the highest average R&D spending (474m EUR) and patent applications (551). Software & computer services, including Ericsson, are in the second with 110m EUR average spending and 131 patents. Third in R&D expenditures is pharmaceuticals and biotechnology sector (92m EUR), while the third highest patenting activity is among diversified industrials (96).

If scaled by innovation intensity, dividing average observation's R&D costs by assets, pharmaceuticals and biotechnology is the most innovative, spending 11% of the assets on R&D, followed closely by software & computer services with 9%. Information technology hardware is third with 6%.

4. Methodology

In this section of the thesis, the methodology used to explore the connections between board gender diversity, innovation, and performance is outlined. The first part discusses the theoretical foundation of the methodology, while the second part describes the specific regression models used for analysis.

4.1 Innovation as a mediator

At the core of our research is the question of whether board gender diversity leads to improved financial performance. However, a mere appearance of a female on a board is not the reason why financial performance should change. There are underlying mechanisms of changes, improvements and actions brought by female board members that should shift the firm performance. In our thesis, we decided to offer innovation as one of these intermediary activities that females could influence. In other words, we predict that innovation will act as a "mediator" between gender and performance.

Mediation is a process that explains how and why a causal relationship between two variables occurs (Baron & Kenny, 1986). A mediator variable is a third variable that represents the mechanism or the pathway through which the causal effect operates. Essentially, we are investigating whether an increase in female representation on boards predicts changes in innovation practices and strategies, which subsequently impact the financial outcomes of the company. This approach allows us to understand not just the direct effects of gender diversity, but also the indirect pathways through which it can influence corporate performance.

To test for the mediation effect of innovation in the link between boardroom gender diversity and financial performance, we employ the framework proposed by Baron and Kenny (1986). Almost forty years ago, Baron and Kenny (1986) distinguished mediation and moderation in social psychology, where mediation was defined as the identification of a third variable that explains the process or mechanism through which an independent variable influences a dependent variable, while moderation identifies external factors that influence the strength or direction of the existing direct relationship. Their approach gained traction beyond psychology literature and has remained the standard in mediation and moderation research for decades.

Regarding specific steps, Baron and Kenny's (1986) framework of testing for mediation comprises a sequential three-step procedure. The first step involves establishing a significant relationship between the independent variable and the dependent variable. In our context, this means checking whether firms with more women on boards tend to have a profitability or market valuation that differs from firms with fewer or no women on boards.

The second step requires demonstrating a significant association between gender diversity and the mediating variable, innovation. We must observe that higher female fraction on boards is associated with substantial differences in R&D investments or patent applications.

The third step entails regressing firm performance on both gender diversity and innovation to verify that the mediator influences the dependent variable holding the independent variable constant. That is, testing if one company changes their innovation activities and other does not, is the increased innovation expected to alter the financial performance, keeping female share on both boards constant.

If all three steps detect significant relationships and the initially strong link between the independent and dependent variables (found in step one) is diminished when controlling for the mediator (in step three), a mediating effect is confirmed. That is, in the first step, we established a coefficient for the total effect of gender diversity on firm performance. Then, if this coefficient changes significantly compared to the first step, it suggests that a significant portion of the total effect was through the mediator.

While their framework provides guidelines on how to conduct mediation analysis, Barron and Kenny (1986) do not mandate the use of a specific type of regression models to carry it out. When testing for innovation and company's reputation as potential mediators between board diversity and financial performance of a firm following Baron and Kenny's framework, Miller and Del Carmen Triana (2009) used multiple regression. We have decided to do the same. A deeper look into implications of this choice follow in the next subsection.

4.1.1 Multiple regression

Multiple regression is a fundamental technique used in the social sciences to measure the impact of different independent variables on a dependent variable (Johnson et al., 2018). This approach, commonly employed using ordinary least squares (OLS), distinguishes itself from simple regression by incorporating multiple explanatory variables (Wooldridge, 2018, p.96). It provides an enhanced understanding of intricate phenomena, such as the correlation between gender and performance, while also considering other factors affecting firm performance.

Unbiased estimates assumptions

The Ordinary Least Squares (OLS) method that underlies the multiples regression, operates under five key assumptions. Initially, it models the dependent variable as a linear combination of several independent variables, coupled with an error term. A critical aspect of this method is the nature of the error term: it must be exogenous, having an expected value of zero and no correlation with the regression analysis's independent variables.

Homoskedasticity is another essential requirement, where the error terms should have equal variances. Additionally, to prevent autocorrelation, the error terms must not correlate with the independent variables. The method also assumes that observations of the independent variables are consistent and deterministic across different samples, free of measurement errors.

The absence of multicollinearity is the final assumption, ensuring no exact linear relationship among the independent variables. When these conditions are satisfied, OLS estimators can provide unbiased estimations of the population parameters, symbolized as βi, regardless of their specific values.

Pooled OLS regression

The pooled OLS regression model combines all observations in a dataset to create a regression model (Wooldridge, 2016, pp. 402-426). This approach fails to consider the panel structure of the data, treating each observation as independent. The model assumes a fixed intercept and slope coefficients, disregarding the temporal dynamics and groupings. For example, it considers observations of a company in one year as unrelated to those in another year. Assuming that there are no individual time or cross-sectional effects (u_i = 0), pooled OLS estimation can give us estimates that are both efficient and consistent. Nevertheless, if there are individual effects that remain consistent over time, the model is susceptible to serial correlation, which can result in distorted estimates. This complexity requires us to examine panel data methods in the following sections. Panel methods allows correlations between the error term and explanatory variables, thereby offering a more precise approach to analyzing data in such scenarios.

Fixed effects regression

Panel data methods are valuable for dealing with variations among cross-sectional entities, such as firms in our example. These methods require a crucial decision between two models: fixed effects and random effects. The fixed effects model assumes that the entity-specific effect, represented as α_i, is correlated with the explanatory variables. In contrast, the random effects model posits that α_i is uncorrelated with these variables.

Both models uphold their respective assumptions regarding the correlation of α_i with explanatory variables throughout all time periods (t). Fixed effects models are favored for their ability to handle the unrestricted correlation between α_i and the explanatory variables. This feature makes them superior to pooled OLS for our analysis, as they provide a more nuanced understanding of the data. By accounting for entity-specific characteristics, the fixed effects approach allows us to estimate the impact of time-varying variables more accurately on firm performance, controlling for unobserved, invariant attributes of each firm.

The use of panel data is primarily driven by the necessity to consider unobserved firm-specific effects, indicated as α_i, and their potential correlation with explanatory variables, as emphasized by (Wooldridge, 2012, p. 493) Within the framework of the fixed effects approach, these hidden effects are regarded as parameters that need to be estimated for each individual firm, avoiding the need to assume independence of observations across time.

For instance, factors like a firm's inherent culture, which may consistently influence its performance and remain constant over time, are integral to our analysis. The fixed effect transformation method, known as the within transformation, helps to exclude these time-invariant characteristics, assuming the explanatory variables are strictly exogenous. This method involves demeaning the variables to eliminate the unobserved effect (a_i), thus refining the pooled OLS estimator (Wooldridge, 2018, p. 463).

Our model applies this transformation, operating under the premise that the idiosyncratic error term (u_{it}) is uncorrelated with the explanatory variables across different time periods, ensuring unbiased OLS estimates. However, a limitation of the fixed effects model is its inability to analyze time-invariant observable variables directly, such as industry factors. To address this, we incorporate interactions with time-varying variables, like year dummies, enabling the examination of how company performance indicators evolve over time.

In summary, the fixed effects model is a robust choice for our study, offering a more accurate analysis of the impact of time-varying variables on firm performance, while accounting for unobserved, consistent firm-specific characteristics. It provides a detailed insight into performance changes over time, albeit with the caveat of not facilitating direct year-to-year performance comparisons.

4.2 Quota effect: difference-in-differences method

In the mediator analysis, we test whether gender diversity influences financial performance and innovation, referring to our first two hypotheses[13]. Despite the improvements in multiple regression models brought by the fixed effects, they still inherently encounter endogeneity problems, including reverse causality (if best performing firms recruit more females on board), omitted variable and selection biases, limiting any claims of causality (Yang et al., 2019).

However, the board gender quota imposed on Norwegian companies creates a quasi-experimental setting, with Norwegian firms as the treatment group and firms from the other three countries forming a control group. Leveraging this external shock, we can test the "gender to performance" and "gender to innovation" links in a DiD setup. The common trend assumption implies that before and after quota, the performance difference between control and treatment groups should have remained the same if quota had not made distortions. The only distortion quota brings is the change in female share on boards. Thus, if the performance gap widens (negative effect of quota), it implies that the negative effect is attributed to the higher share of females on board. This quasi-experimental design allows us to better isolate the effects of gender diversity on firm performance and innovation for causal inferences.

We continue with a further elaboration on the sources of endogeneity, how difference-in-differences design alleviates them, elaborate on our choice of the point of "treatment", as well as briefly touch upon why we do not combine difference-in-differences with mediation.

4.2.1 Sources of Endogeneity

Besides the intuitive reverse causality, the endogeneity issues in our research can be grouped by omitted variable bias and sample selection bias.

Omitted variable bias

A significant factor contributing to endogeneity in the relationship between gender diversity and firm performance is attributed to omitted variable bias. This bias arises from the exclusion of certain variables that may have a substantial impact on the clarity and integrity of the observed effects between gender diversity on corporate boards and firm performance. For

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[13] Where Hypothesis 1 predicts a positive effect of gender diversity on financial performance, while Hypothesis 2 expects a positive effect of gender diversity on innovation.

example, failure to account for board members' abilities (Yang et al., 2019). Since there are fewer females on boards, they might be, on average, more qualified or skilled compared to the average board member. If the regressions do not control for all the qualifications, the positive effects attributed to female representation might be overstated as it is not just the presence of women per se that is driving better firm performance, but potentially the higher ability or qualifications that these women bring to the board.

If the research does not use panel data with fixed effects, it gives rise to distortions caused by omitted time-consistent firm-specific features (Adams & Ferreira, 2009). Intuitive example is the company culture. If the firm simultaneously has a culture of innovation, risk-taking and creative problem-solving (yielding great returns) and is also more open to gender diversity on the board, the regression without fixed effects might falsely attribute the firm's strong performance to its gender-diverse board (Hewlett, 2013). However, even with firm fixed effects and year dummies included some effects like strategic alliances, customer perception or cultural trends will remain unaccounted for and could distort the results.

Selection bias

A different, but also relevant source of endogeneity common in our research field is the selection bias (Yang et al., 2019). One direction of selection bias occurs when percentage of female directors differs in relation to the distinct qualities of various firms. For example, new companies might be more flexible and proactive in promoting diversity and, thus, have a higher share of females on board. However, they could also have a worse accounting performance given they are still in a phase where expansion is the priority. The strong positive correlation between firm age and ROA and ROE seen in correlation matrix in Table B2 in Appendix B suggests younger companies will perform worse. So, without controlling for firm age, we might unintentionally capture differences between older and younger firms, rather than accurately reflecting the real impact of female directorships on firm performance. While we account for firm age, adding it as a control variable, there could be other relevant firm characteristics affecting the relationship that we do not control for.

Another direction of selection bias considers the idea that females who reach the positions on board possess score higher on characteristics that are atypical for general population of females and display behaviors usually perceived as "masculine" (Adams & Funk, 2012). For instance, in a comprehensive survey involving numerous board members, Adams and Funk (2012), in contrast to findings in population, found women board members to be less risk-averse and more open to challenging the established practices than the male board members. If these characteristics correlate with firm outcomes like innovation and financial performance and are not adequately accounted for, research might incorrectly attribute the effects on performance to gender diversity alone. Moreover, it affects the generalizability to overall female population.

4.2.2 Difference-in-differences addressing endogeneity

The endogeneity problem in board gender diversity and financial performance research is prevalent. In their thorough meta-analysis, Post and Byron (2015) estimate a positive correlation between women board members and financial performance, yet identify their inability to claim causality as most of studies they covered overlooked possible endogeneity.

In a perfect world, we would carry out an experiment of a randomized treatment, introducing females with various capabilities to all kinds of firms. In this experimental study, also allocating firms to treatment and control groups by chance, we would effectively addresses endogeneity by limiting biases related to selection and ability (Antonakis et al., 2010). Yet such a study is virtually impossible due to firms' unwillingness to randomly assign leadership roles. The alternative approach of eliminating endogeneity by including all confounding variables that are not affected by the treatment, but impact either board gender diversity, financial performance, or both, is also considered unworkable (Yang et al., 2019).

Thus, an attainable compromise, which we use in our study, is a combination of quasi-experiment and difference-in-differences arrangement (Antonakis et al., 2010). Contrasting the differences before and after reform in both the treatment and control groups of firms regarding female directorship and firm performance, this technique adjusts for variations across sections and temporal trends. In our research context, the gender quota acts as an external "treatment" that affected only Norwegian firms (the treatment group), but not comparable Swedish, Finnish, and Danish firms (the control group). Then, in difference-in-differences setup, we look at the financial performance gap between Norwegian companies and the control group before the quota and then examine whether this gap has changed after the quota implementation. The common trend assumption implies that in the absence of the gender quota, the performance gap between Norwegian and control groups would have remained the same as it has been, so all the changes in it are attributable to the effect of the quota – the increase in gender diversity on corporate boards.

Difference-in-difference analysis in the quota context offers multiple remedies to the endogeneity. For example, omitted variable bias of board members' abilities is addressed by extending the variety of females on boards (as many females appointed to boards rapidly), lowering the chances of "overqualification" compared to the male directors, while firm or sector specific bias is lessened by including firm or sector fixed effects. Selection bias of specific firms having higher female share is countered as firms no longer not self-select into having more gender-diverse boards, but are mandated by policy, while the selection bias of female personality characteristics is reduced by policy-induced variation as the pool of female directors broadens.

4.2.3 The choice of treatment time

An integral decision for difference-in-differences analysis is the choice of "treatment" point to determine which years belong to pre-treatment, and which to post-treatment group. As a brief reminder, in December 2003, Norway passed the Companies Act reform mandating a minimum 40% gender representation on public limited company boards (Garcia-Blandon et al., 2023). Initially introduced on a voluntary basis, the law transitioned to mandatory in 2006 after companies failed to meet the threshold by July 2005. Following transition period of two years, the full implementation was completed in January 2008.

Researchers are not unanimous in their choice of the treatment year. Yang et al. (2019) considers post-2003 years as post-quota, grounded in the announcement of the voluntary female board quota. Matsa and Miller (2013) choose post-2006 instead, based on the new regulations in 2006 that defined the mandatory quota. However, the firms affected by the quota were given about 2 years to comply (by 1st of January 2008), making 2008 the first year when incompliance was punishable by law. Thus, we follow Kunze and Scharfenkamp (2022) in the choice of 2008 as the first year in the post-reform period.

4.2.4 Difference-in-differences and innovation as a mediator

Ideally, we would have liked to utilize the difference-in-differences setup for the study of the mediating effect of innovation, too. Thus far, however, there have been very few attempts at establishing theory framework for establishing mediation in difference-in-differences design and none of it has gained traction (Hsia et al., 2021). Thus, we abstain from using this design for the full mediation analysis and use it for testing just the first two hypotheses.

4.3 Regression models in mediation analysis

As stated before, we employ Baron and Kenny's (1986) methodology to examine if innovation serves as a mediator in the relationship between gender diversity and firm performance.

The base regression model employed for empirical analysis in the mediation part utilizes pooled ordinary least squares and can be expressed as follows:

$$\text{(I)} \qquad Firm\ performance_{i,j,k,t} = \beta_0 + \beta_1 FS_{i,j,k,t} + \sum_{m=1}^{6} \beta_m X_{m_{i,j,k,t}} + \epsilon_{i,j,k,t}$$

$$\epsilon_{i,j,k,t} = \alpha_i + \gamma_j + \theta_k + \delta_t + \upsilon_{i,j,k,t}$$

Firm performance$_{i,j,k,t}$ encompasses all our performance metrics - ROA, ROE, market to book ratio, and Tobin's Q, identified for firm i in sector j, located in country k at time t. Our primary variable of interest, $FS_{i,j,k,t}$ measures the female share on firm's board. Female share is a decimal that can range from 0 to 1, so one unit increase in it would correspond to a change from no females on board (0) to fully female board (1). $X_{m_{i,j,k,t}}$ is a vector of control variables, where m = 1 to 6 represent board size, board independence, standard deviation of board members' time on board, standard deviation of board members' time in company, standard deviation of board members' age and firm's age.

The error term $\epsilon_{i,j,k,t}$ contains α_i that captures firm-specific unobserved characteristics that might affect its performance, γ_j that covers sector-specific effects, θ_k corresponding to effects specific to each country and the time-specific effects δ_t that vary over time but are consistent across firms, sectors, and countries. Finally, $\upsilon_{i,j,k,t}$ is the idiosyncratic error or the residual term. It captures the random variation in firm performance that is not explained by firm-specific, sector-specific, country-specific, or time-specific factors. Some of the effects are mutually exclusive, so none of the model specifications uses all of them at once.

Given its stepwise construction, the initial procedure is to explore the direct impact of gender diversity on firm performance, the second stage is to evaluate the effect diversity has on innovation, while the final step requires to regress firm performance against both innovation and gender diversity. Thus, in the following section, we sequentially describe the specific regression models used in each of the steps.

4.3.1 Models for estimating the effect of gender diversity on financial performance

To determine whether a significant relationship exists between gender diversity and financial performance, we use five different regression models. We begin by using the simple linear regression and progress gradually, first by adding the board and firm controls, then introducing country dummies and year fixed effects, while in the final two regressions, we increase the granularity of the data by including sector or individual fixed effects.

Regression model 1: pooled OLS

$$(1)\ Firm\ performance_{i,t} = \beta_0 + \beta_1 FS_{i,t} + u_{i,t}$$

The initial regression model employs a pooled Ordinary Least Squares (OLS) approach to estimate the relationship between firm performance and the female share on the board.

The return-based performance measures ROA and ROE are recorded in a decimal form (e.g., a 10% return is noted as "10"). Thus, the coefficient β_1 represents the estimated change in returns in percentage points (pp.) attributable to a complete shift in the board's female composition (from 0% to 100% women).

When market performance measures are used instead, coefficient β_1 represents the estimated change in the market to book ratio or Tobin's Q (in units) associated with complete change in the female share on the board. The error term $u_{i,t}$ accounts for unobserved factors that might influence firm performance.

Regression model 2: with control variables

$$\begin{aligned}(2)\ Firm\ performance_{i,t} &= \beta_0 + \beta_1 FS_{i,t} + \beta_2 BoardSize_{i,t} + \beta_3 BoardIndep_{i,t} + \beta_4 SDTimeBrd_{i,t} \\ &+ \beta_5 SDTimeInCo_{i,t} + \beta_6 SDBrdAge_{i,t} + \beta_7 log(FirmAge)_{i,t} + u_{i,t}\end{aligned}$$

The second model incorporates board and firm controls, forming a multiple regression model. Focusing on the accounting performance first, if the corporate board size grows by one member, the returns are expected to change by β_2 pp. Coefficient β_3 shows the pp change in returns if the fraction of independent members on board rose from 0% to 100%. Coefficients $\beta_4, \beta_5, \beta_6$ estimate the change in returns in pp associated with a 1 unit increase in the standard deviation of board members time in company, time on board or age, respectively.

Due to the log-transformation, the interpretation of the age control is slightly different. A one percent increase in firm's age is related to an $0.01\beta_7$ pp change in returns.

When the financial performance metrics are market to book ratio and Tobin's Q, the same calculations hold, except that percentage point differences become unit changes of dependent variables instead.

Regression model 3: with country and year dummies

$$(3)\ Firm\ performance_{i,k,t} = \beta_0 + \beta_1 FS_{i,k,t} + \sum_{m=1}^{6} \beta_m X_{m_{i,k,t}} + \theta_k Country_{i,k} + \delta_t Year_{c,t} + u_{i,k,t}$$

In addition to regression model 2, the third model includes dummy variables for each country *k* and year *t*. The country affiliation for each company *i* is constant through all observations. The coefficient θ_k represents the differential impact on firm performance attributable to being in country *k* (Sweden, Denmark, or Finland) compared to the baseline country, Norway, holding all other variables constant.

Vector $Year_{c,t}$ adds a dummy variable for each year *c* = 2001 to 2022, with 2000 as a base year. Each coefficient δ_t captures year-specific effects common to all firms each year, while numerically, it shows the difference in firm performance that year relative to the omitted year 2000. The subscripts are updated to match the new structure, where each company *i* in country *k* is observed at time *t*.

Regression model 4: with sector dummies

$$(4)\ Firm\ performance_{i,j,k,t} = \beta_0 + \beta_1 FS_{i,j,k,t} + \sum_{m=1}^{6} \beta_m X_{m_{i,j,k,t}} + \theta_k Country_{i,k} + \delta_t Year_{c,t} + \gamma_j Sector_{i,j} + u_{i,j,k,t}$$

The fourth regression adds sector dummies. Each company *i* belongs to one of the 36 sectors *j* and does not change it over time. Each coefficient γ_j captures the impact on financial performance of being in a specific sector *j*, relative to a baseline sector "Aerospace & Defence". While the main point of it is to account for sector differences in female share as shown in Table B1 in Appendix B, it could capture attributes and dynamics inherent to different sectors that could influence firm performance, such as technological intensity, regulatory environment, market competition, or capital intensity.

Regression model 5: with firm fixed effects

$$(5)\ Firm\ performance_{i,t} = \beta_0 + \beta_1 FS_{i,t} + \sum_{m=1}^{6} \beta_m X_{m_{i,t}} + \delta_t Year_{c,t} + \alpha_i + u_{i,t}$$

In the final regression, we exchange sector dummies for firm fixed effects. As the firms in our dataset do not change the country and the sector over time, their effects are absorbed by the firm-fixed effects, and they are removed from the model.

4.3.2 Models for estimating the effect of gender diversity on innovation

Upcoming models will assess whether board gender diversity affects innovation. Since the structure mostly overlaps with the developments in the previous chapter, to enhance conciseness, we represent control variables using summation notation where applicable.

Regression model 1: pooled OLS

$$(6)\ Innovation_{i,t} = \beta_0 + \ \beta_1 FS_{i,t} + u_{i,t}$$

The dependent variables for $Innovation_{i,t}$ includes both our proxies for innovation: R&D expenditures (input proxy) and patent applications filed (output proxy) by company *i* in time *t*. Both innovation metrics are log transformed. Thus, increasing the female fraction on the board by one unit is expected to change the R&D expenditures or patent applications by $(e^{\beta_1} - 1) * 100$ percent. We abstain from using the usual 100 * β_1 approximation, since its accuracy begins to deteriorate as $|\beta_1| > 0.2$ (Treiman, 2014, p.143)

Regression model 2: with control variables

$$\begin{aligned}(7)\ Innovation_{i,t} &= \beta_0 + \ \beta_1 FS_{i,t} + \beta_2 BoardSize_{i,t} + \beta_3 BoardIndep_{i,t} + \beta_4 SDTimeBrd_{i,t} \\ &+ \beta_5 SDTimeInCo_{i,t} + \ \beta_6 SDBrdAge_{i,t} + \beta_7 log(FirmAge)_{i,t} + u_{i,t}\end{aligned}$$

Same as before, the second model enhances the first by the addition of control variables. In this equation, $(e^{\beta_2} - 1) * 100\%$ is the expected change in R&D expenses if board size increases by one member, while $(e^{\beta_3} - 1) * 100\%$ is the effect on R&D going from 0 board independence to fully independent board. Calculating $(e^{\beta_{4,5,6}} - 1) * 100\%$ gives the changes in R&D spending linked to increase in the standard deviation of board members time on board, in company or age, respectively.

Given the log transformation on both sides of the equation, β_7 is the estimated difference in % in R&D spending if company's age increases by 1%. In all coefficient interpretations, R&D spending can be exchanged for the alternative metric "change in patent applications filed".

Regression model 3: with country and year dummies

$$(8)\ Innovation_{i,k,t} = \beta_0 + \beta_1 FS_{i,k,t} + \sum_{m=1}^{6} \beta_m X_{m_{i,k,t}} + \theta_k Country_{i,k} + \delta_t Year_{c,t} + u_{i,k,t}$$

In the next model, we add the country and year dummies. A calculation of $(e^{\theta_k} - 1) * 100\%$ can be used to estimate the changes in R&D spending or patent applications filed attributed to the company being located in country k (Sweden, Denmark, or Finland) instead of Norway, all other variables equal. Coefficient δ_t captures year-specific effects. The control variables are the same as in the previous model, the only change is the notation.

Regression model 4: with sector dummies

$$(9)\ Innovation_{i,j,k,t} = \beta_0 + \beta_1 FS_{i,j,k,t} + \sum_{m=1}^{6} \beta_m X_{m_{i,j,k,t}} + \theta_k Country_{i,k} + \delta_t Year_{c,t} + \gamma_j Sector_{i,j} + u_{i,j,k,t}$$

The fourth model includes sector fixed effects, accounting for the fact that the importance of and dedication to innovation efforts will vary by the industry the firm operates in.

Regression model 5: with firm fixed effects

$$(10)\ Innovation_{i,t} = \beta_0 + \beta_1 FS_{i,t} + \sum_{m=1}^{6} \beta_m X_{m_{i,t}} + \delta_t Year_{c,t} + \alpha_i + u_{i,t}$$

The final model, with the addition of firm fixed-effects, shifts the focus to within-firm analysis. It allows us to better account for heterogeneity among firms in aspects like corporate culture, management style, strategy, firm-specific resources and capabilities. However, it comes at the cost of missing out on between-firm comparisons.

4.3.3 Models for estimating the effect of innovation on financial performance

The final group of regressions in the mediator analysis are dedicated to testing whether innovation is associated with significant changes in the financial performance when controlling for gender diversity.

Regression model 1: pooled OLS with gender control

$$(11)\ Firm\ performance_{i,t} = \beta_0 + \beta_1 FS_{i,t} + \beta_2 log(1 + R\&D)_{i,t} + \beta_3 log(1 + Patents)_{i,t} + u_{i,t}$$

As we must control for diversity when testing for the effects of innovation, our first model is already a multiple regression. Coefficient β_1 shows the expected pp change in accounting returns or units in market performance associated with one unit increase in female board representation.

Coefficient $\frac{\beta_2}{100}$is the anticipated change in ROE or ROA in pp if R&D expenditures are raised by 1%, while $\frac{\beta_3}{100}$ is the shift in ROE or ROA if a firm files 1% more patent applications. Coefficient interpretations are similar for the market performance measures, except for the changes in units instead of percentage points.

Regression model 2: with controls

$$\begin{aligned}(12)\ Firm\ performance_{i,t} &= \beta_0 + \beta_1 FS_{i,t} + \beta_2 log(1 + R\&D)_{i,t} + \beta_3 log(1 + Patents)_{i,t} \\ &+ \beta_4 BoardSize_{i,t} + \beta_5 BoardIndep_{i,t} + \beta_6 SDTimeBrd_{i,t} \\ &+ \beta_7 SDTimeInCo_{i,t} + \beta_8 SDBrdAge_{i,t} + \beta_9 log(FirmAge)_{i,t} + u_{i,t}\end{aligned}$$

In the next model, firm and board controls are added, but pooled OLS estimation is still used. The interpretations of β_1, β_2 and β_3 remain the same as in the previous regression. The meaning of coefficients by the control variables is the same as explained in chapter 4.3.1.

Regression model 3: with country and year dummies

$$\begin{aligned}(13)\ Firm\ performance_{i,k,t} &= \beta_0 + \beta_1 FS_{i,k,t} + \beta_2 log(1 + R\&D)_{i,k,t} + \beta_3 log(1 + Patents)_{i,k,t} \\ &+ \sum_{m=1}^{6} \beta_m X_{m_{i,k,t}} + \theta_k Country_{i,k} + \delta_t Year_{c,t} + u_{i,k,t}\end{aligned}$$

The third model builds on the model 2, but with the addition of country dummies and year fixed effects. Note that control variables are now expressed using the summation notation.

Regression model 4: with sector dummies

$$(14)\ Firm\ performance_{i,j,k,t} = \beta_0 + \beta_1 FS_{i,j,k,t} + \beta_2 log(1 + R\&D)_{i,j,k,t} + \beta_3 log(1 + Patents)_{i,j,k,t} + \sum_{m=1}^{6} \beta_m X_{m_{i,j,k,t}} + \theta_k Country_{i,j,k,t} + \delta_t Year_{c,t} + \gamma_j Sector_{i,j} + u_{i,j,k,t}$$

Again, the fourth model adds another dimension to the equation by introduction of sector fixed effects, while the rest remains the same as in the previous model.

Regression model 5: with firm fixed effects

$$(15)\ Firm\ performance_{i,t} = \beta_0 + \beta_1 FS_{i,t} + \beta_2 log(1 + R\&D)_{i,t} + \beta_3 log(1 + Patents)_{i,t} + \sum_{m=1}^{6} \beta_m X_{m_{i,k,t}} + \theta_k Country_{i,k} + \delta_t Year_{c,t} + \alpha_i + u_{i,t}$$

In the final setup, firm fixed effects are utilized, yielding the sector effects and country dummies redundant.

4.4 Regression model in difference-in-differences analysis

In this subsection we describe the regression models used in difference-in-differences analysis. Following papers by Matsa and Miller (2013), as well as Yang et al. (2019), who are utilizing the same setup of quota effect and control groups, we skip the more simplistic models without the controls and fixed effects. To increase comparability with these papers, retain only board-level controls in our models. Also, we examine three different sets of fixed effects: year & sector; year & individual; industry-by-year & firm.

4.4.1 Models with firm performance as the dependent variable

The first group of DiD regression equations have firm performance measures as the outcomes.

Regression model 1: with controls, year, country and sector dummies

$$(16)\ Firm\ performance_{i,j,t} = \beta_1 Treat_i * Post2007_t + \beta_2 BoardSize_{i,j,t} + \beta_3 BoardIndep_{i,j,t} + \beta_4 SDTimeBrd_{i,j,t} + \beta_5 SDTimeInCo_{i,j,t} + \beta_6 SDBrdAge_{i,j,t} + \delta_t Year_{c,t} + \theta_k Country_{i,k} + \gamma_j Sector_{i,j} + u_{i,j,t}$$

In these three equations (16 to 18), *Firm performance*$_{i,j,t}$ denotes the performance (ROE, ROA, market to book ratio or Tobin's Q) for firm *i* in sector *j* in year *t*. Our primary variable of interest is the interaction term between the treatment indicator and a post-period indicator. The coefficient β_1 measures the differential effect on the performance metric of being in the treatment group (Norwegian firms) after the implementation of the gender quota law compared to the control group (firms from Sweden, Finland, and Denmark) in the same period. It is measured in β_1 pp. in case of ROA and ROE or $\beta_1$units for the market performance measures. Terms δ_t captures the time-specific effects for each year *t*, θ_k captures country effects, while γ_j allows for a different intercept for each sector.

Regression model 2: with controls, year dummies and firm fixed effects

$$(17)\ Firm\ performance_{i,t} = \beta_1 Treat_i * Post2007_t + \sum_{m=1}^{5} \beta_m X_{m_{i,t}} + \delta_t Year_{c,t} + \alpha_i + u_{i,t}$$

In the second model, the sector dummies are changed for firm-specific effects, accounting for unobserved characteristics unique to each firm. This makes both country and sector dummies redundant; all of their effects are captured by the firm fixed effects.

Regression model 3: with controls, year and firm fixed effects, and industry specific time trends

$$(18)\ Firm\ performance_{i,j,t} = \beta_1 Treat_i * Post2007_t + \sum_{m=1}^{5} \beta_m X_{m_{i,j,t}} + \lambda_i Year_t + \delta_t + \alpha_i + u_{i,j,t}$$

Finally, inspired by past research, we add a term $\lambda_i Year_t$ (Matsa and Miller, 2013; Yang et al. 2019). This term introduces a separate linear time trend for each industry. Hence, each λ_i is a linear estimation of how the returns or market metrics of firms in different industries *i* have been changing from beginning to the end of the coverage period. The authors refer to it as year-by-sector fixed effects (Matsa and Miller, 2013; Yang et al. 2019). Since we use within estimation here, instead of the year dummies, we include year fixed effects.

4.4.2 Models with innovation as the dependent variable

In the second group of difference-in-differences regression equations, we shift our focus from financial performance to innovation, with both innovation proxies as dependent variables.

Regression model 1: with controls, year, country and sector dummies

$$(19)\ Innovation_{i,j,t} = \beta_1 Treat_i * Post2007_t + \beta_2 BoardSize_{i,j,t} + \beta_3 BoardIndep_{i,j,t} + \beta_4 SDTimeBrd_{i,j,t} + \beta_5 SDTimeInCo_{i,j,t} + \beta_6 SDBrdAge_{i,j,t} + \delta_t Year_{c,t} + \theta_k Country_{i,k} + \gamma_j Sector_{i,j} + u_{i,j,t}$$

In the three innovation DiD equations, $Innovation_{i,j,t}$ contains either R&D expenses or patent applications for firm *i* in sector *j* in year *t*. Here, the $(e^{\beta_1} - 1) * 100\%$ is the implied negative effect of gender quota on the R&D spending or patent applications.

Regression model 2: with controls, year dummies and firm fixed effects

$$(20) Innovation_{i,t} = \beta_1 Treat_i * Post2007_t + \sum_{m=1}^{5} \beta_m X_{m_{i,t}} + \delta_t Year_{c,t} + \alpha_i + u_{i,t}$$

In this model, we retain the control variables and use firm fixed effects, losing country and sector dummies.

Regression model 3: with controls, year and firm fixed effects, and industry specific time trends

$$(21)\ Innovation_{i,j,t} = \beta_1 Treat_i * Post2007_t + \sum_{m=1}^{5} \beta_m X_{m_{i,j,t}} + \lambda_i Year_t + \delta_t + \alpha_i + u_{i,j,t}$$

The final setup has year and firm fixed effects, and separate linear time trends for each sector.

5. Results

In this section, we report the empirical outcomes of our research. Firstly, we cover the results gathered from our regression models. Secondly, we perform robustness tests, evaluating the reliability and consistency of our findings.

5.1 Innovation mediation analysis results

We begin with a step-by-step coverage of the mediator analysis. We follow the Barron and Kenny's (1986) procedure, revealing the effects in an appropriate order.

5.1.1 Direct effect of gender diversity on firm performance

Table 5.1: Regression results with accounting performance as dependent variable

	Dependent variable:									
	ROA					ROE				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
FemaleShare	6.410**	8.387***	13.133***	10.819***	-0.881	10.367*	13.497**	20.289***	16.860***	3.507
	(2.785)	(2.633)	(3.155)	(2.988)	(3.023)	(5.495)	(5.330)	(6.063)	(5.833)	(6.533)
BoardSize		0.938***	0.816***	0.747***	-0.165		1.543***	1.417***	1.405***	-0.067
		(0.149)	(0.160)	(0.209)	(0.226)		(0.299)	(0.323)	(0.393)	(0.555)
BoardIndep		0.960	-0.732	1.766	2.237		2.536	-1.517	2.926	7.236
		(1.572)	(1.842)	(1.647)	(2.376)		(2.874)	(3.366)	(3.159)	(5.074)
SDTimeBrd		0.387**	0.326*	0.148	-0.056		0.167	0.113	0.010	-0.405
		(0.177)	(0.176)	(0.198)	(0.172)		(0.370)	(0.373)	(0.394)	(0.446)
SDTimeInCo		0.449***	0.458***	0.487***	0.077		1.157***	1.167***	1.053***	0.171
		(0.130)	(0.128)	(0.171)	(0.167)		(0.261)	(0.260)	(0.305)	(0.351)
SDBrdAge		0.177	0.179	0.100	0.070		0.232	0.262	0.122	0.273
		(0.148)	(0.147)	(0.148)	(0.143)		(0.295)	(0.293)	(0.292)	(0.359)
log(Age)		2.193***	2.001***	1.017***	4.094		3.156***	2.683***	1.368*	8.394*
		(0.403)	(0.392)	(0.399)	(2.499)		(0.798)	(0.775)	(0.791)	(4.758)
Denmark			2.234	6.325***				4.931	11.429***	
			(1.792)	(2.086)				(3.755)	(3.976)	
Finland			5.076***	3.852**				10.594***	8.514***	
			(1.444)	(1.571)				(2.633)	(2.849)	
Sweden			2.115*	2.850**				3.395	4.191*	
			(1.228)	(1.289)				(2.325)	(2.413)	
Year dummies	No	No	Yes	Yes	Yes	No	No	Yes	Yes	Yes
Sector dummies	No	No	No	Yes	No	No	No	No	Yes	No
Firm FE	No	No	No	No	Yes	No	No	No	No	Yes
Observations	7,217	7,217	7,217	7,217	7,217	7,217	7,217	7,217	7,217	7,217
R^2	0.003	0.092	0.107	0.225	0.030	0.002	0.054	0.067	0.132	0.019
Adjusted R^2	0.003	0.091	0.103	0.218	-0.108	0.002	0.053	0.063	0.124	-0.119

*p<0.1; **p<0.05; ***p<0.01. Heteroskedasticity robust standard errors clustered at firm level reported in parentheses. Coefficients for year and sector dummies not included in the table.

In the first regressions, we assess the direct effect of board gender diversity on the firm performance, covering the accounting returns in Table 5.1. The simple one variable linear model in columns (1) and (6) show a positive association between female share and ROA/ROE. A ten-percentage point increase in female share on boards (for example, moving from 20% to 30%) is associated with 0.641 pp. improvement in ROA or 1.037 pp. in ROE. The effect on ROA is significant at 5% level, and only at 10% level on ROE; both models have a very low R^2, so gender diversity alone has low ability to explain the variance in returns.

Expanding the initial models with board and firm age controls, models in columns (2) and (7) have a dramatic R^2 gain. FemaleShare coefficients see an increase in statistical significance and size, where now, all else equal, a ten-percentage point increase in women share on boards is associated with 0.84 pp. better ROA or 1.35 pp. ROE. From the control variables, board size, diversity in terms of time spent in company, as well as age of the company appear to be important predictors. For example, in case of ROA (column 2), an increase in board size by one member is associated with 0.94 pp. higher returns, a 1% increase in firm's age is associated with 0.022 pp. growth in ROA, while 1 unit increase in the standard deviation of board members' time spent in the company is associated with 0.45 pp. higher ROA, all else equal.

Introduction of year and country dummies in models in columns (3) and (8) leads to further improvement in the explanatory power. Compared to the reference group (Norwegian firms), Finnish companies show substantially higher returns. The coefficient on Danish and Swedish firms is also positive, but not significant. The effects of control variables remain largely unchanged compared to the previous regressions in columns (2) and (7). However, the female share coefficients see a noticeable hike, indicating that comparing companies within the same country and same year, higher board gender diversity is a solid predictor of better performance.

Even after accounting for sector specifics with dummy variables in models in columns (4) and (9), the coefficient on FemaleShare remains positive and significant. Thus, out of two firms in the same sector in the same country in the same year, the one with a higher female fraction is expected to perform significantly better.

As indicted by table 3.3, the median board has 7 seats, of which 29% are held by females, corresponding to about 2 females in a 7-member board. Swapping one male board member for female would represent an increase in female share by ~0.14. All else equal, model in column (4) predicts such a change would elevate ROA by 1.54 pp. or, based on column (9), improve

ROE by 2.41 pp., which are sizable improvements given that median ROA in our sample is 3.90% and median ROE is 9.47%. Based on column (4), similar ROA improvement could be achieved by increasing the board size by about 2.07 members or the firm becoming 154.56% older, all else equal. Based on column (9), all else equal, exchanging one male board member for a female board member on a median board has an effect on ROE comparable to increasing board size by 1.71 seats or growth in firm age by about 176%, everything else unchanged.

The regression results completely change when employing firm fixed effects in columns (5) and (10). Almost none of the coefficients are significant, including FemaleShare, which implies that from a statistical standpoint, the effect of board gender diversity on accounting returns is indiscernible from zero.

Table 5.2: Regression results with market performance as dependent variable

	Dependent variable:									
	Market to Book Ratio					Tobin's Q				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
FemaleShare	-0.066	-0.255	-0.214	-0.207	-1.044	-0.387	-0.567*	-0.514	-0.412	-0.643*
	(0.627)	(0.616)	(0.714)	(0.644)	(0.640)	(0.351)	(0.344)	(0.419)	(0.354)	(0.333)
BoardSize		0.014	-0.015	0.017	0.017		-0.019	-0.040	-0.018	0.015
		(0.052)	(0.051)	(0.046)	(0.064)		(0.029)	(0.029)	(0.025)	(0.028)
BoardIndep		0.509	0.508	0.402	-0.001		0.334*	0.321	0.149	-0.123
		(0.315)	(0.363)	(0.334)	(0.464)		(0.186)	(0.204)	(0.179)	(0.193)
SDTimeBrd		0.021	0.020	-0.006	-0.036		0.051	0.044	0.039	-0.010
		(0.072)	(0.068)	(0.061)	(0.049)		(0.037)	(0.035)	(0.028)	(0.025)
SDTimeInCo		-0.012	0.001	0.037	0.041		-0.036*	-0.023	-0.005	0.030*
		(0.040)	(0.038)	(0.037)	(0.038)		(0.021)	(0.021)	(0.018)	(0.017)
SDBrdAge		-0.065*	-0.060*	-0.041	0.040		-0.047**	-0.046**	-0.032*	0.010
		(0.036)	(0.035)	(0.032)	(0.035)		(0.022)	(0.021)	(0.018)	(0.016)
log(Age)		-0.438***	-0.445***	-0.216**	-0.478		-0.283***	-0.280***	-0.123**	-0.050
		(0.102)	(0.101)	(0.092)	(0.488)		(0.057)	(0.059)	(0.051)	(0.306)
Denmark			1.829***	1.050**				0.921***	0.259	
			(0.562)	(0.527)				(0.267)	(0.239)	
Finland			-0.267	-0.317				-0.166	-0.181	
			(0.297)	(0.304)				(0.163)	(0.158)	
Sweden			0.546**	0.017				0.514***	0.146	
			(0.258)	(0.272)				(0.157)	(0.147)	
Year dummies	No	No	Yes	Yes	Yes	No	No	Yes	Yes	Yes
Sector dummies	No	No	No	Yes	No	No	No	No	Yes	No
Firm FE	No	No	No	No	Yes	No	No	No	No	Yes
Observations	7,217	7,217	7,217	7,217	7,217	7,217	7,217	7,217	7,217	7,217
R^2	0.00001	0.014	0.069	0.170	0.060	0.001	0.027	0.085	0.244	0.066
Adjusted R^2	-0.0001	0.013	0.065	0.163	-0.073	0.001	0.026	0.081	0.237	-0.066

*p<0.1; **p<0.05; ***p<0.01. Heteroskedasticity robust standard errors clustered at firm level reported in parentheses. Coefficients for year and sector dummies not included in the table.

Similarly to table 5.1, table 5.2 contains the results of regressing firm performance on board gender diversity, but using the market performance metrics. The lower statistical significance, particularly in the context of our primary variable of interest, FemaleShare, is immediately apparent. The model in column (1) suggests that an increase of women fraction on board by 10 pp. is associated with a market to book ratio decrease by 0.0066 or Tobin's Q decline by 0.039, based on model in column (6). Neither of these effects are statistically significant. As a reference, table 3.3 showed that the median market to book ratio was 3.86 and median Tobin's Q was 1.90.

Models in columns (2) and (7) add control variables. The effect of board gender diversity exhibits a more negative effect, where a 10 pp. increase in female fraction is associated with 0.057 unit decline in Tobin's Q, which, for the median company, would mean a 3% decline. Looking at the control variables, age is the most important measure, with 10% increase in firms age being linked to 0.044 decline in market to book ratio (column 2) or 0.028 lower Tobin's Q (7), an effect significant at a 10% level. Additionally, markets also have a negative perception of board members' age diversity.

Addition of year and country dummies in models in columns (3) and (8) leads to just slight changes in the coefficients compared to the models in columns (2) and (7). It indicates, however, that on average, Danish and Swedish companies have much higher valuations than Norwegian companies.

Yet, most of the cross-country market performance differences disappear when sector dummies are added in models in columns (4) and (9). The only difference, compared to Norwegian companies, is in Danish companies having a higher market to book ratio. The negative effect of board age dispersion and firm age loses some of its strength and significance, compared to models in (3) and (8). FemaleShare coefficients remain insignificant.

When firm fixed effects are used in models in columns (5) and (10), almost all coefficients lose the significance. Surprisingly, FemaleShare has an effect that is significant at the 10% cutoff in column (10), where 10 pp. increase in women fraction on boards is linked to about 0.064 unit decline in Tobin's Q. In addition, increase in the standard deviation of board members' time spent in the company now has a slightly positive effect.

5.1.2 Effect of gender diversity on innovation

We now shift our focus to the next step in the mediation analysis, trying to establish a link between board gender diversity and innovation efforts of companies.

Table 5.3: Regression results with innovation as dependent variable

	Dependent variable:									
	Log(1+RD)					Log(1+Patents)				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
FemaleShare	-3.381**	-6.375***	-3.808**	-1.766	-0.288	0.242	-0.178	-0.451	-0.051	-0.443**
	(1.440)	(1.368)	(1.587)	(1.403)	(0.637)	(0.304)	(0.293)	(0.350)	(0.311)	(0.188)
BoardSize		0.850***	0.823***	0.824***	0.122*		0.228***	0.230***	0.229***	0.027
		(0.112)	(0.119)	(0.111)	(0.063)		(0.027)	(0.029)	(0.028)	(0.019)
BoardIndep		6.719***	4.578***	3.747***	0.202		1.231***	0.739***	0.604***	-0.113
		(0.728)	(0.835)	(0.746)	(0.479)		(0.166)	(0.168)	(0.142)	(0.131)
SDTimeBrd		-0.094	-0.113	0.008	0.084		-0.067*	-0.063	-0.047	0.029
		(0.179)	(0.185)	(0.157)	(0.084)		(0.040)	(0.040)	(0.036)	(0.019)
SDTimeInCo		0.043	0.050	0.032	-0.044		0.060*	0.053	0.049	-0.007
		(0.155)	(0.162)	(0.136)	(0.070)		(0.035)	(0.036)	(0.030)	(0.016)
SDBrdAge		-0.308***	-0.290***	-0.243***	-0.040		-0.061***	-0.064***	-0.062***	-0.009
		(0.079)	(0.077)	(0.066)	(0.035)		(0.019)	(0.018)	(0.016)	(0.009)
log(Age)		0.999***	0.733**	0.887***	-0.882		0.288***	0.221***	0.252***	-0.532**
		(0.335)	(0.335)	(0.305)	(0.565)		(0.082)	(0.082)	(0.076)	(0.215)
Denmark			1.735	0.422				0.433	0.390	
			(1.272)	(0.991)				(0.280)	(0.242)	
Finland			4.912***	5.072***				0.336	0.460**	
			(0.945)	(0.881)				(0.237)	(0.216)	
Sweden			1.280*	0.792				0.042	0.069	
			(0.750)	(0.700)				(0.144)	(0.139)	
Year dummies	No	No	Yes	Yes	Yes	No	No	Yes	Yes	Yes
Sector dummies	No	No	No	Yes	No	No	No	No	Yes	No
Firm FE	No	No	No	No	Yes	No	No	No	No	Yes
Observations	7,217	7,217	7,217	7,217	7,217	7,217	7,217	7,217	7,217	7,217
R^2	0.004	0.160	0.193	0.385	0.051	0.0004	0.201	0.251	0.375	0.279
Adjusted R^2	0.004	0.159	0.189	0.379	-0.083	0.0003	0.200	0.247	0.369	0.177

*p<0.1; **p<0.05; ***p<0.01. Heteroskedasticity robust standard errors clustered at firm level reported in parentheses. Coefficients for year and sector dummies not included in the table.

The simple OLS regressions (1) and (6) indicate that replacing an all-male board with all female board is associated with 96.60% ($(e^{-3.381} - 1) * 100$ %) cut in R&D expenditures and 27.4% growth in patent applications filed, although this effect is statistically insignificant. A more realistic 10 pp. increase in female share on board is predicted to lead to 28.69% ($(e^{-0.3381} - 1) * 100$ %) reduction on R&D spending or 2.45% growth in patents.

The negative relation of women on boards and R&D spending becomes even more pronounced after inclusion of control variables in the model in column (2). In column (2), a 10 pp. increase in gender diversity is related to 47.13% reduction in R&D spending. The inclusion of control variables has also turned the FemaleShare coefficient negative in column (7) where patents are the regression outcome. Now, in column (7), a 10 pp. increase in female share is associated with 1.76% reduction in patent applications, although this effect is not statistically significant.

The association between female share and R&D expenses or patent applications remains negative after country and year effects are added in the models in columns (3) and (8). The scope of the negative effect of board gender diversity improvements on R&D expenditures in model in column (3) is comparable to the one observed in column (1).

Our independent variable, FemaleShare, loses all statistical significance in models (4) and (9) when sector differences are accounted for. In model (5) with firm fixed effects, the female to R&D spending link remains insignificant. However, statistically significant negative effect of female board representation on patent applications appears in column (10), where a 10 pp. increase in female fraction is linked to 4.33% reduction in patent applications.

The results recognize other important factors affecting the innovation activities. Innovative companies tend to have larger boards, where the estimated effect on R&D expenditure growth due to addition of another board member, all else equal, ranges from 12.98% in model (5) up to 134% in model (3). Even more importantly, innovative companies have higher share of independent board members. In the most extreme case in model (2), all else equal, an increase in board independence by 10 pp. is associated with a 95.80% growth in R&D spending. In the case of R&D spending, models (2-4) predict close to 1:1 relationship with firm age, with 1% age increase being associated with 0.73% to 1% increase in R&D costs. The direction of the board size, independence and firm age impact is similar when patents are the dependent variable, although the effects are smaller. Finally, board age diversity is associated with lower R&D spending and patent applications in most models.

5.1.3 Effect of innovation on firm performance, controlling for gender diversity

Although regressions in this subsection resemble the ones in the diversity to performance analysis, here our focus is on innovation's effect on the performance, controlling for gender diversity and we begin by looking at regressions with accounting metrics as outcomes.

Table 5.4: Regression results with accounting performance as dependent variable

	Dependent variable:									
	ROA					ROE				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
FemaleShare	5.556**	6.868***	12.034***	10.757***	-1.041	8.620	10.623**	18.326***	16.559***	3.259
	(2.815)	(2.633)	(3.113)	(3.000)	(3.046)	(5.570)	(5.405)	(6.051)	(5.873)	(6.537)
log(1 + RD)	-0.180**	-0.238***	-0.280***	-0.042	-0.239**	-0.367***	-0.463***	-0.544***	-0.186	-0.322
	(0.077)	(0.071)	(0.075)	(0.065)	(0.117)	(0.141)	(0.135)	(0.143)	(0.131)	(0.226)
log(1+ Patents)	1.007***	-0.002	-0.072	0.235	-0.206	2.091***	0.422	0.240	0.564	-0.350
	(0.277)	(0.269)	(0.284)	(0.253)	(0.321)	(0.513)	(0.489)	(0.518)	(0.482)	(0.729)
BoardSize		1.141***	1.063***	0.727***	-0.131		1.840***	1.809***	1.429***	-0.018
		(0.163)	(0.178)	(0.220)	(0.222)		(0.329)	(0.363)	(0.415)	(0.555)
BoardIndep		2.563*	0.604	1.781	2.262		5.124*	0.796	3.284	7.262
		(1.552)	(1.788)	(1.673)	(2.362)		(2.913)	(3.300)	(3.236)	(5.078)
SDTimeBrd		0.365**	0.289	0.160	-0.030		0.151	0.067	0.038	-0.368
		(0.182)	(0.187)	(0.196)	(0.169)		(0.373)	(0.386)	(0.392)	(0.442)
SDTimeInCo		0.460***	0.476***	0.477***	0.065		1.152***	1.182***	1.032***	0.155
		(0.135)	(0.141)	(0.168)	(0.163)		(0.261)	(0.272)	(0.302)	(0.345)
SDBrdAge		0.103	0.093	0.104	0.059		0.115	0.119	0.112	0.257
		(0.148)	(0.147)	(0.149)	(0.142)		(0.298)	(0.294)	(0.293)	(0.357)
log(Age)		2.432***	2.222***	0.994**	3.774		3.496***	3.028***	1.391*	7.923*
		(0.442)	(0.426)	(0.411)	(2.464)		(0.849)	(0.821)	(0.811)	(4.716)
Denmark			2.751	6.251***				5.771	11.288***	
			(1.816)	(2.079)				(3.763)	(3.964)	
Finland			6.476***	3.955**				13.186***	9.200***	
			(1.561)	(1.647)				(2.818)	(2.937)	
Sweden			2.476**	2.866**				4.082*	4.300*	
			(1.209)	(1.290)				(2.271)	(2.406)	
Year dummies	No	No	Yes	Yes	Yes	No	No	Yes	Yes	Yes
Sector dummies	No	No	No	Yes	No	No	No	No	Yes	No
Firm FE	No	No	No	No	Yes	No	No	No	No	Yes
Observations	7,217	7,217	7,217	7,217	7,217	7,217	7,217	7,217	7,217	7,217
R^2	0.010	0.101	0.120	0.226	0.033	0.008	0.061	0.077	0.133	0.020
Adjusted R^2	0.009	0.100	0.116	0.218	-0.105	0.008	0.060	0.073	0.125	-0.119

*p<0.1; **p<0.05; ***p<0.01. Coefficients for year and sector dummies not reported.
Heteroskedasticity robust standard errors clustered at firm level reported in parentheses.

In Table 5.4 models (1) and (6) indicate similar findings, where higher R&D spending negatively affects the returns, while both patents and female diversity have a positive relationship with returns, although the effect of gender on ROE lacks statistical significance. In column (1), we observe that, all else equal, 10 pp. increase in female share is linked to 0.56 pp. higher ROA, 10 pp. hike in R&D expenditures could lower ROA by 0.018 pp, while 10 pp. more patent applications are associated with 0.10 pp. higher ROA. Meanwhile, column (6) indicates that, all else equal, 10 pp. increase in female share is related to 0.86 pp. higher ROE, 10 pp. higher R&D spending could lower ROE by 0.037 pp, while 10 pp. higher patent application count is associated with 0.21 pp. higher ROE.

When additional controls are introduced in (2) and (7), female share gains statistical significance, R&D effect becomes slightly more negative, while patent effect loses the significance. The pattern is similar when year and country dummies are introduced in columns (3) and (8). When accounting for sector specifics in models (4) and (9), the statistical significance on both innovation measures disappears. Additional sign of the negative impact of R&D spending on ROA is seen in column (5), where, with firm fixed effects included, the coefficient of log(1+RD) is negative. Overall, we observe that ROE is a more sensitive measure, with the coefficients of independent and control variables being more sizable than in the case when ROA is the dependent variable.

We now shift focus to the table 5.5 with market performance metrics as the dependent variables. Contrary to the negative effects of innovation proxies on ROA and ROE, the innovation measures have a positive link to the market performance in most regression setups. The relationship between R&D expenditures and market to book ratio is positive and significant in the first regression in column (1) and remains that way in all models but the firm-fixed effect one in column (5), with the effect peaking in column (3) in model with controls, country and year dummies. In model in column (3), holding other factors constant, a 10% increase in R&D spending is associated with a 0.0066 units higher market to book ratio.

The relationship between R&D expenses and Tobin's Q shows similar patterns, with significant positive effect in regressions in columns (6-9), but not (10) with firm-fixed effects. All else equal, a doubling of R&D expenses could lift Tobin's Q by 0.020 to 0.052 units.

Patents show a positive association with market performance in 6 of the 10 models. Based on the significant ones, a 10% rise in patent applications filed, all else equal, is linked to about 0.015 - 0.020 increase in market to book ratio or 0.009 – 0.012 higher Tobin's Q.

Looking at the control variables, all else equal, older companies can expect to have lower market valuations. Additionally, everything else held constant, a higher board is linked to worse market performance. Compared to Norwegian companies, depending on the specific model, Finnish firms on average are likely to have a worse market performance while Danish firms are likely to have higher market to book ratios and Tobin's Q than comparable Norwegian companies.

Table 5.5: Regression results with market performance as dependent variable

	Dependent variable:									
	Market to Book Ratio					Tobin's Q				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
FemaleShare	0.065	0.110	0.105	-0.150	-1.057*	-0.263	-0.268	-0.271	-0.371	-0.630*
	(0.616)	(0.594)	(0.702)	(0.641)	(0.639)	(0.347)	(0.333)	(0.405)	(0.351)	(0.329)
log(1 + RD)	0.046***	0.052***	0.066***	0.028*	-0.010	0.039***	0.044***	0.052***	0.020**	0.005
	(0.016)	(0.016)	(0.016)	(0.015)	(0.017)	(0.010)	(0.009)	(0.009)	(0.010)	(0.010)
log(1+Patents)	0.094	0.197***	0.151**	0.146**	-0.022	0.027	0.115***	0.101**	0.090**	0.028
	(0.074)	(0.075)	(0.071)	(0.067)	(0.086)	(0.044)	(0.045)	(0.043)	(0.040)	(0.051)
BoardSize		-0.075	-0.104**	-0.039	0.018		-0.083***	-0.106***	-0.056**	0.014
		(0.048)	(0.050)	(0.047)	(0.063)		(0.029)	(0.029)	(0.026)	(0.028)
BoardIndep		-0.082	0.096	0.207	-0.002		-0.103	0.008	0.019	-0.121
		(0.317)	(0.356)	(0.335)	(0.462)		(0.174)	(0.190)	(0.178)	(0.191)
SDTimeBrd		0.039	0.037	0.001	-0.034		0.063*	0.056	0.043	-0.011
		(0.070)	(0.067)	(0.061)	(0.049)		(0.036)	(0.034)	(0.028)	(0.025)
SDTimeInCo		-0.026	-0.010	0.029	0.040		-0.045**	-0.031	-0.010	0.031*
		(0.040)	(0.039)	(0.037)	(0.038)		(0.021)	(0.021)	(0.019)	(0.018)
SDBrdAge		-0.037	-0.031	-0.025	0.040		-0.026	-0.024	-0.022	0.011
		(0.034)	(0.033)	(0.031)	(0.035)		(0.020)	(0.019)	(0.018)	(0.016)
log(Age)		-0.547***	-0.527***	-0.278***	-0.499		-0.360***	-0.340***	-0.164***	-0.031
		(0.106)	(0.102)	(0.093)	(0.487)		(0.060)	(0.059)	(0.052)	(0.306)
Denmark			1.649***	0.981*				0.787***	0.215	
			(0.537)	(0.526)				(0.242)	(0.240)	
Finland			-0.640**	-0.527*				-0.455***	-0.325**	
			(0.300)	(0.302)				(0.167)	(0.158)	
Sweden			0.456*	-0.016				0.443***	0.123	
			(0.254)	(0.270)				(0.149)	(0.141)	
Year dummies	No	No	Yes	Yes	Yes	No	No	Yes	Yes	Yes
Sector dummies	No	No	No	Yes	No	No	No	No	Yes	No
Firm FE	No	No	No	No	Yes	No	No	No	No	Yes
Observations	7,217	7,217	7,217	7,217	7,217	7,217	7,217	7,217	7,217	7,217
R^2	0.016	0.040	0.097	0.178	0.060	0.026	0.072	0.135	0.255	0.067
Adjusted R^2	0.016	0.039	0.092	0.170	-0.073	0.026	0.071	0.131	0.248	-0.066

*p<0.1; **p<0.05; ***p<0.01. Coefficients for year and sector dummies not reported.
Heteroskedasticity robust standard errors clustered at firm level reported in parentheses.

5.1.4 Establishing mediation

With all three links covered, we summarize the observations and determine whether a mediation effect of innovation has been detected.

The other researchers utilizing Baron and Kenny's (1986) approach to test for innovation as a mediator between board gender diversity and financial performance limited their methodology to use of one regression model in each step (Miller & Del Carmen Triana, 2009; Bouchmel et al., 2022). This makes the recognition of mediation effect easier as each step requires only to confirm whether the relationship tested is significant, whereas in our case, the multiple options make the process less straightforward. Thus, we have created multiple summary tables to have a clear overview of the mediation recognition process.

Tables 5.6 to 5.9 contain the mediation analysis findings split by the potential mediator (R&D expenses or patents) and the performance metrics (accounting or market). The top row shows which mediator (one of the two innovation proxies) and performance measures we are considering. In every table, each column (1) to (10) represents the corresponding regression columns from result tables 5.1 to 5.5.

In tables 5.6 to 5.9, the first row shows whether a statistically significant relationship was found between gender diversity and the corresponding performance measure. The sign represents the direction of the effect, while an empty cell means the relationship was not found to be significant and is, thus, irrelevant, as statistical significance is required in all three steps for a mediating effect to be recognized. The second row shows whether the potential mediator was found to be affected by gender diversity. The third row shows whether this mediator was found to affect the performance measures. If the effect was significant in all three steps, a mediation effect is present, marked by "X" in the final row.

Table 5.6: Summary of direction and significance of effects in mediation analysis using accounting performance as dependent variables and R&D expenses as a mediator

Mediator: R&D costs	*ROA*					*ROE*				
Relationship/Column	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Diversity/Performance	+	+	+	+		+*	+	+	+	
Diversity/Innovation	-	-	-			-	-	-		
Innovation/Performance	-	-	-		-	-	-	-		
Mediates	**X**	**X**	**X**			**X***	**X**	**X**		

**Only at 10% threshold*

Table 5.6 considers whether R&D costs mediate the relationship between gender diversity and firm performance, measured by ROA or ROE. For both dependent variables, the first three regression models have established a statistically significant relationship between our variables of interest in all three steps. The model in column (6) is the only one that we would have to disregard if the more prudent 5% threshold is used instead of 10% cutoff. Overall, the evidence is more in favor of confirming the mediation effect of R&D expenses in the relationship between board gender diversity and firm performance. On the other hand, the mediation is not confirmed by the more robust models with sector or firm fixed effects.

Table 5.7: Summary of direction and significance of effects in mediation analysis using accounting performance metrics as dependent variables and patents as a mediator

Mediator: Patents	*ROA*					*ROE*				
Relationship/Column	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Diversity/Performance	+	+	+	+		+*	+	+	+	
Diversity/Innovation					-					-
Innovation/Performance	+					+				
Mediates										

**Only at 10% threshold*

Compared to table 5.6, in table 5.7, patent applications become the potential mediator, while ROA and ROE remain as the performance metrics. None of the models have found a mediating effect, even if 10% significance cutoff is used. While we observe a significant relationship between gender diversity and accounting performance in most models, female share on boards has a weak connection to patent applications filed by the firm. Additionally, patents are also not a strong predictor of ROA or ROE. Thus, we reject patents as a potential mediator here.

Table 5.8: Summary of direction and significance of effects in mediation analysis using market performance metrics as dependent variables and R&D expenses as a mediator

Mediator: R&D costs	*Market to Book Ratio*					*Tobin's Q*				
Relationship/Column	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Diversity/Performance							+*			+*
Diversity/Innovation	-	-	-			-	-	-		
Innovation/Performance	+	+	+	+*		+	+	+	+	
Mediates							**X***			

**Only at 10% threshold*

In table 5.8, we shift the focus to market performance metrics as the dependent variables and first look at R&D expenses as the potential mediator. The model in column (7) is the only one that finds significant relationships in all three steps, and only at 10% level of significance. In this case, the situation is the inverse of the one observed in table 5.7, since gender diversity is linked to changes in R&D spending, which are found to affect both market performance metrics. However, there is a lack of direct effect of gender diversity on market performance. Thus, we find weak evidence of R&D spending as a mediator in this relationship.

Table 5.9: Summary of direction and significance of effects in mediation analysis using market performance metrics as dependent variables and patents as a mediator

Mediator: Patents	*Market to Book Ratio*					*Tobin's Q*				
Relationship/Column	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Diversity/Performance							+*			+*
Diversity/Innovation					-					-
Innovation/Performance		+	+	+			+	+	+	
Mediates										

**Only at 10% threshold*

Table 5.9 summarizes our exploration into innovation mediating the relationship between gender diversity and firm performance, or, with specific proxies: whether patents mediate the relationship between female share on board and market performance, measured by either market to book ratio or Tobin's Q. Due to lack of significant effects, especially in both gender related links, we reject the idea of patents as a mediator in this relationship.

In summary, if the usual 5% statistical significance cutoff is used, we find evidence that innovation mediates the relationship between gender diversity and firm performance only in the setup where innovation proxy is R&D costs and performance is measured as either ROA or ROE. This finding is still sensitive to the type of fixed effects used.

Practically, then, the mediation plays out in an unexpected manner. Using estimates from regression table 5.1 in column (3), a 10 pp. increase of females on board, all else equal, is associated with 1.31 pp higher ROA. However, table 5.3 in column (3) reveals that such diversity increase, all else equal, is associated with 28.69% cut in R&D expenses. Column (3) in table 5.4, all else equal, predicts this 28.69% cut in R&D expenses would improve ROA by $((e^{-0.2869 * (-0.280)} - 1) = 0.084$ pp., all else equal. So now, when controlling for innovation in table 5.4 column (3), a 10 pp. increase in females on board is associated with 1.20 pp. improvement in ROA. Thus, some of the positive effect on ROA initially attributed to female diversity was capturing the fact that women are associated with cuts in R&D spending. Yet since the R&D expenses lower ROA, these cuts are beneficial. When accounting for these reductions (holding constant for R&D in the final regression), the "pure" female effect is lower than initially predicted.

5.2 Difference-in-differences regression results

In this subsection we present the results of our difference-in-differences analysis. Firstly, with firm performance measures as the dependent variables, followed by the innovation proxies.

5.2.1 Results with firm performance as the dependent variable

Table 5.10: DiD regression results with accounting performance

	Dependent variable:					
	ROA			ROE		
	(1)	(2)	(3)	(4)	(5)	(6)
Treat:Post2007	-0.862	-1.547*	0.191	3.389	2.052	3.793
	(1.836)	(0.921)	(1.022)	(3.893)	(2.407)	(2.666)
BoardSize	0.924***	-0.145	-0.206	1.631***	-0.014	-0.130
	(0.209)	(0.130)	(0.131)	(0.392)	(0.340)	(0.342)
BoardIndep	2.891*	2.417**	1.751*	4.610	7.375***	4.864*
	(1.651)	(0.988)	(1.000)	(3.138)	(2.582)	(2.606)
SDTimeBrd	0.246	-0.016	-0.034	0.141	-0.304	-0.428
	(0.199)	(0.151)	(0.154)	(0.393)	(0.395)	(0.403)
SDTimeInCo	0.512**	0.099	0.067	1.091***	0.206	0.334
	(0.168)	(0.122)	(0.124)	(0.297)	(0.318)	(0.323)
SDBrdAge	0.085	0.056	0.086	0.112	0.266	0.322
	(0.148)	(0.086)	(0.087)	(0.292)	(0.225)	(0.226)
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes
Country dummies	Yes	No	No	Yes	No	No
Sector dummies	Yes	No	No	Yes	No	No
Firm FE	No	Yes	Yes	No	Yes	Yes
Sector-by-year FE	No	No	Yes	No	No	Yes
Observations	7,217	7,217	7,217	7,217	7,217	7,217
R^2	0.070	0.027	0.051	0.046	0.018	0.045
Adjusted R^2	0.061	-0.110	-0.089	0.037	-0.121	-0.096

*p<0.1; **p<0.05; ***p<0.01. Standard errors clustered at firm level. Coefficients of year, country and sector dummies not reported.

Table 5.10 shows the results of regressions with ROA and ROE as the dependent variables. The combination of year dummies and fixed effects in models in column (1) and (4) does not yield statistically significant estimates for our variable of interest – interaction term between belonging to treatment group (Norway) and post-2007 period. The coefficient is also not significant in regressions in column (3) and (6), where year dummies, sector fixed effects and separate linear trends for each industry are included.

In fact, the only significant coefficient for the interaction term is in model in column (2), where year dummies and firm fixed effects are used. In this case, the coefficient of -1.547 indicates that, in comparison to the change in ROE observed in the control group from pre- to post-quota years, Norwegian companies experienced a decrease of 1.547 percentage points in their ROE. This implies a negative effect of gender quota on the performance. However, this effect is significant only at 10% level.

Table 5.11: DiD regression results with market performance

	Dependent variable:					
	Market to Book Ratio			Tobin's Q		
	(1)	(2)	(3)	(4)	(5)	(6)
Treat:Post2007	-0.449	-0.594***	-0.488**	0.036	-0.116	-0.146
	(0.395)	(0.206)	(0.230)	(0.203)	(0.102)	(0.113)
BoardSize	0.002	0.012	0.015	-0.032	0.014	0.013
	(0.045)	(0.029)	(0.029)	(0.024)	(0.014)	(0.015)
BoardIndep	0.349	0.001	0.046	0.092	-0.134	-0.104
	(0.341)	(0.221)	(0.224)	(0.184)	(0.109)	(0.111)
SDTimeBrd	-0.020	-0.044	-0.036	0.030	-0.012	-0.008
	(0.060)	(0.034)	(0.035)	(0.027)	(0.017)	(0.017)
SDTimeInCo	0.026	0.040	0.041	-0.010	0.031**	0.034**
	(0.046)	(0.027)	(0.028)	(0.018)	(0.013)	(0.014)
SDBrdAge	-0.038	0.038**	0.026	-0.031*	0.009	0.004
	(0.036)	(0.019)	(0.019)	(0.018)	(0.010)	(0.010)
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes
Country dummies	Yes	No	No	Yes	No	No
Sector dummies	Yes	No	No	Yes	No	No
Firm FE	No	Yes	Yes	No	Yes	Yes
Sector-by-year FE	No	No	Yes	No	No	Yes
Observations	7,217	7,217	7,217	7,217	7,217	7,217
R^2	0.034	0.059	0.075	0.037	0.065	0.084
Adjusted R^2	0.026	-0.074	-0.062	0.028	-0.068	-0.052

*p<0.1; **p<0.05; ***p<0.01. Standard errors clustered at firm level.
Coefficients of year, country and sector dummies not reported.

Table 5.11 summarizes the results from with the same regressions as in table 5.6, except that the dependent variables are the market performance measures. None of the models (4-6) suggest that after the implementation of board quota, listed Norwegian companies have significantly deviated from the path of Tobin's Q values in the control group. Regression models with market to book ratio, however, show a contrasting situation. While the interaction term lacks significance in the model in column (1), models in columns (2-3), indicate that in the after-quota years, market to book ratio in Norwegian listed companies has declined by 0.488 to 0.594 units relative to the change in market to book ratios in control group's companies in the same time period.

5.2.2 Results with innovation as the dependent variable

Finally, we explore if the gender quota has affected innovation in Norway, which, through common trend assumption, would imply a link between gender diversity and innovation. Table 5.12 contains DiD regression outcomes when innovation proxies are the dependent variables.

We observe conflicting patterns. The positive coefficient by Treat & Post2007 interaction term in the model in column (1) implies a strong positive effect of the quota on the R&D spending in Norway, while the interaction term's coefficient in model (4) implies no effect of quota on patenting activity. Exchanging country and sector dummies for the more stringent firm-fixed effects, the effect of quota no longer seems to affect the R&D spending (column 2), while model (5) indicates a strong negative effect on the patenting activity in Norway brought by the reform. This is similar to findings in models in columns (3) and (6). Coefficient -0.424, using the exponential transformation, indicates that the quota and the subsequent increase in the female representation has led to a -34.56% reduction in patent applications in Norwegian firms relative to the changes in the patenting activities in the control group's companies.

Table 5.12: DiD regression results with innovation

	Dependent variable:					
	Log(1+RD)			Log(1+Patents)		
	(1)	(2)	(3)	(4)	(5)	(6)
Treat:Post2007	1.597**	-0.189	-0.003	-0.140	-0.475***	-0.424***
	(0.665)	(0.202)	(0.222)	(0.126)	(0.060)	(0.066)
BoardSize	0.868***	0.116***	0.100***	0.249***	0.024***	0.016*
	(0.110)	(0.029)	(0.029)	(0.029)	(0.008)	(0.009)
BoardIndep	3.736***	0.188	0.034	0.644***	-0.103	-0.125*
	(0.718)	(0.217)	(0.217)	(0.141)	(0.064)	(0.065)
SDTimeBrd	0.060	0.074**	0.083**	-0.030	0.022**	0.016
	(0.160)	(0.033)	(0.034)	(0.035)	(0.010)	(0.010)
SDTimeInCo	0.080	-0.048*	-0.075***	0.061**	-0.008	-0.007
	(0.139)	(0.027)	(0.027)	(0.030)	(0.008)	(0.008)
SDBrdAge	-0.253***	-0.039**	-0.032*	-0.066***	-0.010*	-0.007
	(0.066)	(0.019)	(0.019)	(0.016)	(0.006)	(0.006)
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes
Country dummies	Yes	No	No	Yes	No	No
Sector dummies	Yes	No	No	Yes	No	No
Firm FE	No	Yes	Yes	No	Yes	Yes
Sector-by-year FE	No	No	Yes	No	No	Yes
Observations	7,217	7,217	7,217	7,217	7,217	7,217
R^2	0.378	0.048	0.088	0.364	0.275	0.299
Adjusted R^2	0.373	-0.086	-0.046	0.358	0.172	0.195

*p<0.1; **p<0.05; ***p<0.01. Standard errors clustered at firm level.
Coefficients of year, country and sector dummies not reported.

5.3 Robustness testing

In this subsection, we perform multiple robustness tests to see how sensitive our findings are in relation to variations in data. For DiD regressions, we propose sensitivity to time and inclusion of oil & gas sector as factors that might notably affect our results. For the mediator analysis, we focus on the influence brought by the selected time and zero R&D observations.

5.3.1 Oil & gas sector exclusion in DiD

As explained in section 3.4.2. when describing dependent variables, the oil and gas sector is distinct from other sectors due to its performance's sensitivity to the oil prices. While energy prices are input costs that affect all sectors, the fluctuations of the returns in the oil and gas sector brought by the oil price will be markedly larger. Additionally, the oil and gas sector in our study, particularly in Norway, is much bigger and more influential than in neighboring countries like Sweden, Denmark, and Finland, reducing the comparability between the treatment and control groups in our analysis. Recognizing this disparity, studies like those by Yang et al. (2019) and Matsa and Miller (2013) have opted to exclude oil companies from their regression models to mitigate this bias. Thus, we rerun the DiD regressions without the observations from the oil and gas sector.

Table C1 in Appendix C reports the DiD regression results with firm performance measures as dependent variables after the oil and gas sector has been excluded. Compared to the original results in tables 5.10 and 5.11, there are a few notable changes. The negative effect at 10% level of Treat:Post2007 interaction term with ROA as the dependent variable in column (2) has now lost its significance. This suggests that a considerable share of the seemingly worse performance of Norwegian companies after the quota in terms of ROA is attributable to the bad returns in the oil and gas sector's firms during the years of low oil prices (2015-2017 & 2020). In table C1, none of the models with accounting returns implies a significant negative long-term effect of the quota. Looking at the market performance models, the effects on Tobin's Q are still insignificant. Two of the market to book ratio models maintain the significant negative effect, although the significance has decreased compared to initial models. Overall, our findings are sensitive to the inclusion of oil and gas sector's firms.

With innovation measures as DiD regression outcomes, the results without oil and gas sector (Table C2, Appendix C) are similar to the initial findings (Table 5.12). A negative effect on patents is found in two models, a positive effect on R&D expenditures in one of the models.

5.3.2 Shortened timeframe – DiD and mediation

On both ends of our study coverage, there are potentially distorting elements. In 2000 to 2003, we lack the patent data coverage, so we begin our shortened timeframe from the year 2004. At the other end of the time scale, we have COVID-19, which introduced significant economic volatility and business challenges that were not typical of the usual business environment. Thus, years beyond 2019 are disturbed by pandemic and the turbulence it caused in the performance, making it harder to isolate the effects of the policy intervention from the extraordinary global events. Although fixed effects should be able to capture some of them, we still decided to have 2019 as the final year for our shortened timeframe robustness tests.

Difference in diffferences results with shortened timeframe

We begin by running DiD regressions in the years 2004 to 2019. The results when firm performance measures are the outcome variables can be seen in table C3 in Appendix C. Given that plenty of observations were from the final years, sample size shrinks from 7217 to 4589 observations. Apart from the effect on ROE, where the interaction term remains insignificant in all three model specifications, the statistical significance of the interaction term improves. The coefficients of the interaction term with ROA as the dependent variable are now significant at 5% and 1% level, respectively, and suggest a 3.66 to 3.95 pp decline in ROA in Norwegian firms due to the quota. The interaction term in the market-to-book ratio models is now significant at a 5% level in all three regression models, suggesting about a 0.9 to 1.08 unit decline in the market-to-book ratio in Norway related to the quota. The Tobin's Q model with firm fixed effects also shows a negative effect after quota in Norway, too. Hence, our DiD findings are sensitive to the time period selected.

Results using DiD regressions on the data from the limited time period and innovation proxies as outcomes are shown in table C4 in Appendix C. In this case, we observe that the implied negative association that was observed in the initial regressions in table 5.12 completely disappears. Meanwhile the previously found positive effect after quota on R&D expenditures remains in this robustness test.

Mediator analysis with shortened timeframe

Both considerations for why we wanted to shorten the time covered in the robustness tests hold valid for mediation analysis, too. Thus, tables C5, C6, C7, C8 and C9 in the Appendix C contain the results of running the whole mediation analysis as before, but with limited years.

In the first link, gender diversity to performance, table C5 is the limited equivalent of the initial table 5.1. After exclusion of 2000 to 2003 and 2020 to 2022 in table C5, we lose some significance of the FemaleShare coefficient and R^2 declines. Yet, the general pattern holds, indicating a strong positive effect of gender diversity on both ROA and ROE in most models.

The same relationship is under scrutiny in tables 5.2 and C6, but with market performance as the dependent variable. While the full sample regressions failed to establish a significant association between female share and market to book ratio, two of the models do show a negative link significant at 10% level in the limited sample. In the limited sample, two models also show a negative relationship between female share and Tobin's Q, significant at 5%. Such strength of effects was not present in the initial regressions in table 5.2.

Moving on to the second step, relationship between gender diversity and innovation, table 5.3 covered the full sample, while table C7 in has the results on the limited sample. When R&D spending is the outcome variable, the first three models in both cases show a statistically significant negative link between female share and R&D spending, but in the shortened timeframe regressions, the significance is stronger, at 1% in all three cases. When sector or firm effects are added, the significance of female share disappears again in the limited sample, just like in the case of the full sample. The previously significant negative link between gender diversity and patents observed in the full sample in model (10) with firm fixed effects no longer holds in the limited sample. However, two other models now establish a negative link between gender diversity and patents in table C7.

Table C8 in Appendix C, like table 5.4, aims to establish that innovation affects the returns (ROA and ROE), controlling for board gender diversity. After shortening the sample, the effect of R&D spending on ROA and ROE remains negative but loses some of its strength and significance. The effect of patents on ROA in the limited sample becomes positive in four regression models. Even more in line with our positive expectations are the effects of patents on ROE in table C8 in Appendix C, where the coefficients are positive and statistically significant at 10% level (at least) in four regression models.

Table C9 in Appendix C covers innovation's effect on market returns. The differences between the limited and the full sample's results in table 5.5 are minimal as most models still point to innovation having a positive effect on market performance. Interestingly, none of the FemaleShare coefficients in table C9 are significant, unlike in table C6 (same regressions, but without innovation controls), where a few model setups pointed at statistically significant negative relationship between females and market performance. Using mediator analysis mindset, this implies that a large fraction of the initially observed negative effect of females on the market metrics came from the reduction in R&D spending associated with women.

To visualize the changes, we recreated the only mediator analysis table that contained significant mediation in the full sample (table 5.6) using the findings from the shortened timeframe, presented in table 5.13. Out of the 5 initially significant models, three have passed our shortened timeframe robustness test and maintained the significance.

Table 5.13: Direction and significance of effects in mediation analysis using accounting performance as dependent variables and R&D expenses as a mediator in 2004-2019

Mediator: R&D costs			*ROA*					*ROE*		
Relationship/Column	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Diversity/Performance		+	+	+			+*	+	+	
Diversity/Innovation	-	-	-		-	-	-			
Innovation/Performance	-	-	-			-	-	-		
Mediates		**X**	**X**				**X***	**X**		
Mediated in full sample	*X*	*X*	*X*			*X**	*X*	*X*		

**Only at 10% threshold*

5.3.3 Excluding zero-innovation observations

Considering reasons for the negative association of board gender diversity and innovation, we thought the low variance in R&D spending across time in Norway could be distorting the results (based on figure 3.7). However, after we excluded just 4 of the largest R&D spenders, all four countries seem to have stable trends (figure 3.8). Thus, we thought of a different potential culprit - firms with no R&D expenses, which comprise about 55% of our data. For many firms, diversity will have no effect on "innovation", skewing the results. To see how that affects our results, we regress gender diversity on innovation proxies in a subsample of innovative companies. That is, we use only observations with non-zero R&D expenses.

Using the same approach as in the second step of mediation analysis, the regression results in this "innovative sample" are seen in Table C10 in Appendix C. Contrary to the full sample findings, 9 out of 10 regression models now show a positive effect of diversity on the innovation proxies. Hence, the estimates of our main models are affected by the large number of zero-RD observations. Although they must remain in the sample for generalizability, this illustrates why there could be counterintuitive negativity in the gender to innovation link.

6. Discussion

At the beginning of the thesis, we asked two related research questions. Given the way the mediator analysis is constructed, answering the second one, "*Does innovation mediate the relationship between boardroom gender diversity and firm performance?"* was not possible without covering the first: *"Does boardroom gender diversity lead to an improved firm performance?*". In this chapter, we take a step back to reflect on what our empirical analysis has revealed in the pursuit of answering the two questions.

Researchers have been actively contributing to the body of knowledge in the field of board gender diversity and firm performance. However, we wanted to extend our study beyond a correlational relationship between these two elements, trying to grasp one of the possible ways *how* can the females on boards bring changes that affect the performance. As explained in the introduction, we believe the Nordics have an appropriate background to suggest innovation as a possible middle step through which females could impact firm performance, implying that innovation mediates this relationship. As of now, we have not seen such mediator analysis carried out in the timeframe and geography we cover. Additionally, we employed DiD regression to cross-check our findings in mediator analysis where applicable.

6.1 Gender Diversity and Firm Performance

This leads to the first hypothesis: *Gender diversity has a positive effect on the financial performance of firms.* Due to the mixed evidence, we are unable to neither accept nor deny it.

Considering accounting returns as an outcome, tests in the mediator analysis are in strong favor of gender diversity. Except for the models with firm fixed effects, all other regression setups display a strong positive association with female shares on boards and accounting returns. With slight decreases in statistical significance, this relationship remained positive in the shortened timeframe check.

Within the mediator analysis, we find weak evidence of gender diversity impacting the market performance. None of the full sample models we used established a significant relationship if the 5% cutoff was used. The shorter timeframe tests show some indication of a negative relationship between gender diversity and Tobin's Q in the simplest models, which disappears when controls in the form of dummy variables are introduced.

In contrast to positive/neutral sentiment in mediator analysis, tests of diversity to performance link using difference-in-differences methodology offer a neutral/negative stance. In the full sample, we find no long-term negative effect on ROE in Norway after the quota, while one model indicates a negative effect on ROA of 1.55 pp., but just at a 10% level, which disappears if the oil and gas sector companies are excluded.

However, when using the shorter sample of years 2004-2019, two of three DiD models show significant evidence that after the introduction of the quota, from 2008, listed Norwegian firms have fallen behind relative to the control group's firms in terms of ROA. This finding might be more appropriate than the one in the full sample because, as Figure 3.1 shows, the years 2000-2003 and 2020 to 2022 might be violating the common trend assumption, where Norwegian firms show a noticeably more volatile median ROA pattern relative to the control group than in years 2004 to 2019. Matsa and Miller (2013) suggest that the introduction of more female board members led to increased labor costs and higher employment levels, as these firms were less inclined to lay off employees, even in challenging economic times.

Using market performance as the outcome, DiD regressions in the full sample suggest that gender quota has left a negative effect on the market market-to-book ratio in Norwegian companies. With some differences in strength and significance, this effect persists both when the oil and gas sector is excluded as well as when the time period is shortened. This relationship is in line with Yang et al. (2019), which found a significant negative effect of gender diversity on market-based performance. The authors suggest that the quota's implementation may have led to a reduction in firm risk, which in turn could have influenced the market's perception and valuation of these firms, as reflected in Tobin's Q.

6.2 Gender Diversity and Innovation

In the next step of the mediator analysis, we had to test whether gender diversity affects innovation activities, and we assumed that *gender diversity has a positive effect on innovation.* Same as in the previous step, we find mixed evidence, leaving us unable to decide whether to accept or reject it. With R&D spending as the innovation proxy, 3 out of 5 models show a negative association with gender diversity. Importantly, this effect is no longer significant in models with sector dummies or firm fixed effects, which are better equipped to account for the large innovation disparities across the sectors. Only one model shows a significant negative association between gender and patents. These findings show little change in the shorter timeframe robustness test.

Findings by DiD models with innovation as the outcome differ. The full sample regressions point towards a negative effect of the quota on patenting activity by listed Norwegian firms, but this effect is not present in the shorter timeframe test. Yet one of the models shows a significant positive effect of quota on R&D investments in Norway, which withstands the oil and gas sector's exclusion and shortened timeframe tests.

We believe the distortions caused by the large fraction of non-innovative observations (0 R&D spending and/or 0 patents) to be the likeliest culprit for the negative association between female share on boards and innovation efforts. In the test of this relationship in the "innovative" subsample, excluding 0 R&D spending observations, most models show a strong positive association between gender diversity and innovation. This would also explain why in the full sample, most of the negative effects disappeared when within-sector or within-firm comparisons were made using sector dummies or firm FE. Compared to the pooled estimates, these account for the fact that innovation activities are not a norm in some of the sectors.

The negative relationship between gender diversity and innovation is in line with Cropley et al. (2017). They argue only adding women to the workforce is not enough and the work environment itself (organizational climate and cognitive processes) might need to change to truly benefit from gender diversity in terms of innovation.

6.3 Firm's Innovation and Firm Performance

Following the mediator analysis guidelines, the next step involved examining whether innovation affects firm performance. The literature led us to a hypothesis that *innovation has a positive effect on firm performance.* In an aggregated manner, we again find mixed evidence. When split up, R&D spending has a negative relationship with accounting performance in pooled models and is neutral when fixed effects are added, regardless of whether the full or shortened sample is used. Patents generally have a neutral (in the full sample) or neutral/positive (in the shortened sample) association with accounting returns.

This is different in the case of innovation and market performance. While some of the models lack significance, both innovation proxies are positively associated with market performance.

Three things are worth noting here. Firstly, the divergence between innovation's negative effects on accounting performance and positive effects on market performance is rooted in the differences between the focus of these measures. Accounting, by definition, is backward-looking, in contrast to forward-looking market ratios that attempt to price in all future developments of a company. Since it takes time for innovation efforts to materialize in benefits, market metrics are better at capturing the effects of innovation accurately.

Secondly, the shortened timeframe excludes the COVID-19 downturn. Thus, compared to the full sample, a larger proportion of the years are with good economic conditions. In turn, after the exclusion of these years, the effect of R&D spending on ROA and ROE got less negative. Given the stability of R&D expenses throughout the years, shown in figures 3.7 and 3.8, the "less negative" effect in the sample with years of better returns implies how R&D spending is less burdensome when the economic environment is good. Additionally, in the shortened timeframe, the effect of patents changed from neutral to positive. Hence, when the economy is doing well, patents can indicate better accounting returns. Yet, when the economic downturn occurs, patents cannot prevent ROA and ROE drops.

Thirdly, although the direction of the effect innovation (proxied by R&D spending) has on accounting returns is unexpected, the effects are relatively small. In the full sample, all else equal, a realistic 10% increase in R&D spending is associated with up to 0.03 pp. decrease in ROA (table 5.4, column (3)) or 0.05 pp. decrease in ROE (table 5.4, column (8)). Possibly, the direction could be "fixed" by better matching of investments and benefits in terms of timing. Yet lagging the R&D expenses by one year did not make a significant difference in our case. It might also be the case that ROA and ROE are aggregated measures to capture the nuances of R&D returns.

The native effect of R&D spending on the accounting performance aligns with Visnjic et al. (2016), who find that a mix of service and product innovation results in short-term performance decline, but long-term performance benefits. They suggest that integrating new service models with product innovations can initially be resource-intensive and disruptive; however, over time, this strategy is expected to enhance customer engagement and loyalty, leading to sustained and improved performance.

6.4 Mediating Effect of Innovation on Gender Diversity and Firm's Performance

Finally, at the beginning of the mediation analysis, we set the hypothesis that *innovation positively mediates the relationship between gender diversity and a firm's performance.* This is confirmed only under specific conditions. That is, innovation mediates the relationship between gender diversity and firm performance if the proxy for innovation is R&D spending, *accounting returns are used (ROA or ROE),* and the models do not include sector or firm fixed effects. Moreover, this relationship is not a *positive* mediation, where we assumed gender diversity would lead to increased innovation, which in turn leads to improved firm performance. We found gender diversity to decrease innovation (R&D spending), which leads to improved accounting returns. While we do observe a few specific model setups where mediation is confirmed even after the robustness checks, none of these include the sector or firm fixed effects. Thus, our evidence in favor of mediation is weak.

6.5 Limitations and suggestions for future research

In the process of writing the thesis, we have recognized a few possible limitations, primarily related to the data. For example, for non-Norwegian companies, we found no alternative data source for board characteristics than BoardEx. As shown by the company count split by years in table 3.2, there are bursts in how many firms BoardEx covers. If BoardEx is systematically biased in what companies are covered in their data, this bias would affect the generalizability of our findings.

Similarly, patents are an imperfect innovation proxy. We could not construct a way to inspect how close to the actual patent application count Orbis IP coverage gets. Additionally, not all valuable innovations get patented and even if they do, the revenue impact and significance of each patent varies. However, we followed an aggregated patent approach in line with the previous research and feasibility.

We also suggest some alternative approaches for future research. For instance, using the yearly average market capitalization for the calculation of market to book ratio and Tobin's Q. We decided to use the company's financial year-end stock price for market capitalization calculation as that ensures matching of accounting and market performance. However, the use of average market capitalization should be less sensitive to random price fluctuations, possibly revealing slightly different outcomes.

Given the flexibility of Baron and Kenny’s (1986) mediation framework, one might use generalized method of moments (GMM) estimation to better account for endogeneity of the data. Since the range of female diversity has been increasing, there could be a chance to test non-linearity of the effect of diversity.

With the unexpected findings of the negative effect of diversity on innovation and innovation on accounting returns, a time series analysis of how these effects change depending on the number of lags chosen would be valuable research. Intuitively, you should “give time” to newly appointed females to implement the changes in innovation and time for these innovation modifications to show their effect on performance.

Finally, we generally observed that female representation on boards has a negative association with R&D spending, while their effect on patenting activity is more ambiguous. This implies similar level of patent generation with decreased R&D investments, which essentially means more productive innovation. We believe this could be the foundation of intriguing future research.

7. Conclusion

In this thesis, we have investigated the relationship between boardroom gender diversity and firm performance in the Nordics (excluding Iceland) from 2000 to 2022, focusing on innovation as a possible mediator in this relationship. We separate firm performance into accounting returns (ROA & ROE) and market performance (market-to-book ratio and Tobin's Q). Additionally, we utilized difference-in-differences (DiD) using gender quotas in Norway in 2008 as an alternative way to test the impact of gender on performance and innovation.

We find gender diversity to have no effect on market performance and a positive effect on accounting returns, although this effect is not significant when firm fixed effects are included. DiD regressions contrast these findings, suggesting that the quota and the subsequent gender diversity increase has led to a long-term negative effect on market to book ratio and ROA of listed Norwegian companies, although the effect on ROA is sensitive to the choice of years.

In pooled models, we observe a negative association between females on board and innovation (R&D spending), which becomes insignificant with the addition of sector or firm fixed effects and turns positive in a restricted sample of non-0 R&D spending observations. Depending on the specific setup, the effect of females on patents varies from weakly negative to weakly positive. DiD points to negative effects on patents and positive effects on R&D spending of the quota, although these indicators are sensitive to the type of fixed effects and years used.

We find the effect of R&D spending to be negative on the accounting returns and positive on market performance, although the significance is reduced with sector or firm fixed effects. Patents have a neutral to slightly positive effect on accounting returns, depending on the fixed effects and years chosen, and a positive influence on market performance.

Overall, there is little proof of innovation as a mediator in the board gender diversity and firm performance relationship. While we do find a few model specifications where mediation persists after robustness tests, none of them hold when sector or firm effects are introduced.

Our study contributes to the literature on gender diversity, innovation, and firm performance by providing a comprehensive analysis of the Nordic region. The mixed results suggest that the relationship between boardroom gender diversity, innovation, and firm performance is complex and sensitive to the choice of measures, time period, and methodology, leaving space for more research in the future.

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Appendix A – Variable description

Table A1: Dependent variables

Variable name	*Description*	*Calculation*
ROA*	Return on assets	Net income / total assets * 100
ROE*	Return on equity	Net income / total equity * 100
Market to Book*	Market to book ratio	Year-end market cap / total equity
Tobin*	Tobin's Q	Year-end market cap / total assets

*Winsorized at 1st and 99th percentile

Table A2: Independent variable

Variable name	*Description*
Female Share	Fraction of females on the corporate board

Table A3: Control variables

Variable name	*Description*
Board Size	Number of board members
Independent Share	Fraction of independent board members
SD Time on board	Standard deviation of board members' time on the board
SD Time in company	Standard deviation of board members' time in the company
SD Age	Standard deviation of board members' age
Age*	Years since incorporation, a firm's age
Sector	Firm's sector based on the FTSE International classification
Country	Country of the firm's head office
Assets**	Total assets measured in EUR, proxy for firm's size
Debt to equity**	Debt to equity ratio, a measure of financial leverage

*In analysis, we use the natural logarithm of this variable; **Not used in regressions due to multicollinearity concerns

Table A4: Mediator variables

Variable name	*Description*
R&D*	Research and development expenditures in EUR, proxy for the innovation input
Patents*	Patent applications filed by the firm

*In analysis, we use the log(1+value) transformation of these variables

Appendix B – Sample description

Table B1: Average diversity, financial performance, innovation and size split by sectors

Sector	*N*	*Female Share*	*ROA*	*ROE*	*M/B*	*Tobin*	*Patents*	*R&D (mEUR)*	*Assets (bEUR)*
Software & Computer Services	815	0.24	-1.25	-0.73	4.06	1.96	130.52	110.24	1.21
Diversified Industrials	675	0.23	5.01	12.10	2.72	1.30	96.06	76.71	3.38
Pharmaceuticals and Biotechnology	502	0.28	-22.65	-31.52	5.75	3.86	58.88	91.84	0.82
Health	479	0.23	-1.96	-0.09	6.02	3.53	26.07	15.47	0.68
Construction & Building Materials	433	0.23	3.36	7.51	1.74	0.69	33.74	15.34	2.31
Oil & Gas	379	0.32	-1.55	-2.04	2.40	0.98	24.99	18.59	6.64
Transport	376	0.23	2.53	4.62	1.96	0.71	6.47	21.68	4.21
Real Estate	333	0.31	3.96	10.21	1.13	0.45	0.03	0.02	3.47
Engineering & Machinery	323	0.30	4.15	9.46	3.38	1.29	43.04	23.13	1.45
Business Services	271	0.31	3.51	7.06	3.60	1.63	2.80	3.54	0.61
Food Producers & Processors	270	0.31	2.50	6.37	2.43	1.04	8.06	4.36	1.12
Electronic & Electrical Equipment	222	0.27	-5.93	-3.78	4.58	2.71	12.27	12.22	0.36
Telecommunication Services	202	0.25	4.38	12.31	2.87	1.40	551.33	474.17	10.31
General Retailers	197	0.31	4.48	11.55	2.69	1.06	8.14	4.50	1.11
Household Products	183	0.33	6.76	13.04	2.54	1.15	94.96	44.02	2.51
Information Technology Hardware	174	0.21	-6.75	-11.04	5.30	3.19	32.39	18.61	0.31
Chemicals	143	0.34	0.90	0.61	3.77	1.83	33.82	14.83	2.15
Leisure & Hotels	136	0.30	4.00	-0.26	2.93	1.26	0.29	0.08	2.14
Steel & Other Metals	134	0.28	2.56	4.52	1.49	0.71	50.07	25.72	4.98
Renewable Energy	128	0.26	-7.35	-7.09	4.83	2.58	60.22	9.63	2.06
Forestry & Paper	127	0.22	3.57	8.75	1.28	0.64	73.17	40.93	9.16
Media & Entertainment	115	0.27	1.68	4.84	2.74	1.44	0.30	1.24	1.25
Clothing & Personal Products	87	0.33	14.61	27.15	5.00	2.79	1.43	1.28	2.43
Leisure Goods	74	0.29	5.81	7.03	5.82	3.06	9.72	4.36	0.68
Automobiles & Parts	73	0.23	3.63	6.43	1.78	0.90	35.41	41.96	2.50
Beverages	66	0.23	5.47	12.08	2.80	1.13	15.35	4.63	5.18
Food & Drug Retailers	53	0.37	6.17	19.01	3.75	1.14	0.08	0.00	2.40
Electricity	48	0.38	3.25	10.12	2.55	1.34	10.10	18.58	17.25
Containers & Packaging	43	0.26	3.70	7.49	2.87	1.13	24.49	10.71	2.39
Mining	43	0.15	-15.22	-12.19	2.03	1.75	0.16	0.10	0.18
Tobacco	29	0.32	15.16	-14.19	6.09	2.58	11.28	9.69	1.69
Aerospace & Defence	28	0.30	2.16	9.70	3.41	1.45	23.68	46.49	1.60
Utilities - Other	22	0.30	3.79	7.19	2.15	0.87	1.09	0.00	2.55
Consumer Services	12	0.47	5.47	15.89	3.09	1.07	0.00	0.00	0.62
Education	12	0.42	5.45	11.68	1.90	0.95	0.00	0.00	0.74
Publishing	10	0.32	-7.26	-18.99	8.00	3.24	0.00	3.52	0.30
	7217	**0.27**	**0.05**	**2.41**	**3.37**	**1.71**	**59.71**	**49.35**	**2.62**

Table B2: Correlation matrix based on Spearman's correlation coefficient.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
(1) FemaleShare	-														
(2) ROA	.04*	-													
(3) ROE	.04*	.91*	-												
(4) M/B	.03	.27*	.26*	-											
(5) Tobin	-.01	.27*	.21*	.84*	-										
(6) BoardSize	-.07*	.20*	.19*	.01	-.06*	-									
(7) IndepShare	.27*	.00	.00	.04*	.06*	-.21*	-								
(8) SD TimeBrd	-.09*	.23*	.20*	-.04*	-.04*	.25*	-.09*	-							
(9) SD TimeCo	-.11*	.25*	.24*	-.03*	-.06*	.35*	-.14*	.88*	-						
(10) SD Age	-.04*	.06*	.04*	-.05*	-.06*	.14*	-.14*	.16*	.13*	-					
(11) Leverage	.06*	-.01	.11*	-.05*	-.46*	.20*	-.01	.08*	.12*	.04*	-				
(12) Age	.02	.22*	.20*	-.08*	-.12*	.30*	.06*	.43*	.47*	.04*	.16*	-			
(13) Assets	.15*	.25*	.27*	-.19*	-.32*	.55*	.05*	.21*	.27*	.02	.37*	.39*	-		
(14) RD	-.07*	.08*	.05*	.16*	.20*	.32*	.15*	.13*	.17*	-.10*	-.09*	.23*	.28*	-	
(15) Patents	.02	.09*	.07*	.21*	.23*	.29*	.15*	.12*	.16*	-.08*	-.09*	.25*	.29*	.65*	-

* $p < .05$

Appendix C – Robustness test tables

Table C1: DiD regression results without oil and gas sector, firm performance

	Dependent variable:											
	ROA			ROE			Market to Book Ratio			Tobin's Q		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Treat:Post2007	0.341	-0.254	0.469	4.800	2.828	3.962	-0.257	-0.448**	-0.408*	0.090	-0.099	-0.109
	(2.082)	(0.981)	(1.042)	(4.389)	(2.512)	(2.658)	(0.422)	(0.227)	(0.243)	(0.217)	(0.114)	(0.121)
BoardSize	0.927***	-0.112	-0.175	1.708***	0.204	0.087	0.009	0.027	0.032	-0.029	0.022	0.022
	(0.218)	(0.130)	(0.131)	(0.405)	(0.333)	(0.334)	(0.046)	(0.030)	(0.031)	(0.025)	(0.015)	(0.015)
BoardIndep	2.629	2.325**	1.519	4.153	6.912***	4.079	0.306	-0.155	-0.115	0.074	-0.244**	-0.214*
	(1.740)	(0.991)	(1.003)	(3.268)	(2.536)	(2.557)	(0.366)	(0.230)	(0.233)	(0.198)	(0.115)	(0.116)
SDTimeBrd	0.239	-0.035	-0.068	0.031	-0.321	-0.469	-0.009	-0.055	-0.048	0.037	-0.017	-0.013
	(0.207)	(0.152)	(0.156)	(0.401)	(0.389)	(0.397)	(0.064)	(0.035)	(0.036)	(0.029)	(0.018)	(0.018)
SDTimeInCo	0.524***	0.104	0.079	1.143***	0.337	0.490	0.030	0.045	0.047	-0.010	0.034**	0.038***
	(0.171)	(0.121)	(0.123)	(0.295)	(0.309)	(0.313)	(0.037)	(0.028)	(0.029)	(0.018)	(0.014)	(0.014)
SDBrdAge	0.117	0.038	0.061	0.284	0.362	0.423*	-0.032	0.046**	0.033	-0.030	0.011	0.007
	(0.153)	(0.087)	(0.087)	(0.299)	(0.222)	(0.223)	(0.033)	(0.020)	(0.020)	(0.019)	(0.010)	(0.010)
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country dummies	Yes	No	No	Yes	No	No	Yes	No	No	Yes	No	No
Sector dummies	Yes	No	No	Yes	No	No	Yes	No	No	Yes	No	No
Firm FE	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
Sector-by-year FE	No	No	Yes	No	No	Yes	No	No	Yes	No	No	Yes
Observations	6,838	6,838	6,838	6,838	6,838	6,838	6,838	6,838	6,838	6,838	6,838	6,838
R^2	0.228	0.032	0.056	0.141	0.021	0.053	0.171	0.059	0.076	0.241	0.066	0.085
Adjusted R^2	0.220	-0.108	-0.086	0.133	-0.121	-0.089	0.163	-0.076	-0.064	0.233	-0.069	-0.053

*p<0.1; **p<0.05; ***p<0.01. Standard errors clustered at firm level. Year, country and sector dummies not reported.

Table C2: DiD results without oil and gas sector, innovation

	Dependent variable:					
	Log (1+RD)			Log (1+Patents)		
	(1)	(2)	(3)	(4)	(5)	(6)
Treat:Post2007	1.829**	-0.017	0.066	-0.079	-0.546***	-0.472***
	(0.724)	(0.220)	(0.231)	(0.129)	(0.066)	(0.069)
BoardSize	0.829***	0.101***	0.084***	0.244***	0.015*	0.006
	(0.112)	(0.029)	(0.029)	(0.030)	(0.009)	(0.009)
BoardIndep	3.857***	0.200	0.029	0.596***	-0.139**	-0.165**
	(0.748)	(0.222)	(0.223)	(0.141)	(0.066)	(0.067)
SDTimeBrd	0.145	0.076**	0.083**	-0.017	0.015	0.009
	(0.163)	(0.034)	(0.035)	(0.036)	(0.010)	(0.010)
SDTimeInCo	0.047	-0.046*	-0.073***	0.054*	-0.005	-0.003
	(0.139)	(0.027)	(0.027)	(0.031)	(0.008)	(0.008)
SDBrdAge	-0.253***	-0.025	-0.018	-0.063***	-0.004	-0.001
	(0.069)	(0.019)	(0.019)	(0.016)	(0.006)	(0.006)
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes
Country dummies	Yes	No	No	Yes	No	No
Sector dummies	Yes	No	No	Yes	No	No
Firm FE	No	Yes	Yes	No	Yes	Yes
Sector-by-year FE	No	No	Yes	No	No	Yes
Observations	6,838	6,838	6,838	6,838	6,838	6,838
R^2	0.376	0.052	0.094	0.365	0.278	0.304
Adjusted R^2	0.370	-0.085	-0.042	0.359	0.174	0.199

*p<0.1; **p<0.05; ***p<0.01. Standard errors clustered at firm level.
Year, country, sector dummies not reported.

Table C3: DiD regression results from 2004 to 2019, firm performance

	Dependent variable:											
	ROA			ROE			Market to Book Ratio			Tobin's Q		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Treat:Post2007	-3.947**	-3.655***	-1.510	-3.679	-2.331	1.899	-1.056**	-1.075***	-0.900***	-0.202	-0.217**	-0.189
	(1.861)	(1.033)	(1.116)	(4.072)	(2.677)	(2.884)	(0.449)	(0.224)	(0.241)	(0.192)	(0.108)	(0.116)
BoardSize	0.777***	-0.090	-0.189	1.494***	-0.071	-0.275	-0.0003	0.026	0.033	-0.027	0.025	0.027
	(0.233)	(0.163)	(0.165)	(0.430)	(0.422)	(0.426)	(0.046)	(0.035)	(0.036)	(0.026)	(0.017)	(0.017)
BoardIndep	3.636*	3.841***	3.750***	6.795*	11.547***	9.709***	0.213	0.056	0.004	0.078	-0.128	-0.105
	(1.944)	(1.185)	(1.206)	(3.776)	(3.069)	(3.118)	(0.367)	(0.257)	(0.261)	(0.200)	(0.123)	(0.125)
SDTimeBrd	0.237	-0.181	-0.164	-0.007	-0.542	-0.484	-0.010	-0.035	-0.025	0.038	-0.002	0.005
	(0.201)	(0.184)	(0.189)	(0.435)	(0.478)	(0.488)	(0.064)	(0.040)	(0.041)	(0.030)	(0.019)	(0.020)
SDTimeInCo	0.422**	0.049	-0.028	0.982***	0.265	0.261	0.027	0.028	0.022	-0.008	0.016	0.013
	(0.172)	(0.147)	(0.151)	(0.337)	(0.382)	(0.391)	(0.037)	(0.032)	(0.033)	(0.017)	(0.015)	(0.016)
SDBrdAge	0.135	0.046	0.026	0.187	0.474*	0.473*	-0.002	0.075***	0.060***	-0.013	0.021*	0.014
	(0.161)	(0.104)	(0.106)	(0.317)	(0.269)	(0.273)	(0.033)	(0.023)	(0.023)	(0.018)	(0.011)	(0.011)
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country dummies	Yes	No	No	Yes	No	No	Yes	No	No	Yes	No	No
Sector dummies	Yes	No	No	Yes	No	No	Yes	No	No	Yes	No	No
Firm FE	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
Sector-by-year FE	No	No	Yes	No	No	Yes	No	No	Yes	No	No	Yes
Observations	4,589	4,589	4,589	4,589	4,589	4,589	4,589	4,589	4,589	4,589	4,589	4,589
R^2	0.197	0.015	0.040	0.128	0.015	0.044	0.179	0.063	0.093	0.261	0.062	0.087
Adjusted R^2	0.186	-0.160	-0.141	0.116	-0.160	-0.135	0.168	-0.103	-0.077	0.252	-0.105	-0.084

*p<0.1; **p<0.05; ***p<0.01. Standard errors clustered at firm level. Year, country and sector dummies not reported.

Table C4: DiD results from 2004 to 2019, innovation

	Dependent variable:					
	Log (1+RD)			Log (1+Patents)		
	(1)	(2)	(3)	(4)	(5)	(6)
Treat:Post2007	1.857**	0.185	0.217	0.202	-0.005	-0.066
	(0.674)	(0.225)	(0.241)	(0.132)	(0.055)	(0.059)
BoardSize	0.878***	0.045	0.047	0.281***	0.018**	0.015*
	(0.127)	(0.035)	(0.036)	(0.036)	(0.009)	(0.009)
BoardIndep	3.993***	0.376	0.366	0.795***	-0.121*	-0.120*
	(0.861)	(0.258)	(0.261)	(0.189)	(0.063)	(0.064)
SDTimeBrd	0.050	0.049	0.069*	-0.045	0.008	0.012
	(0.180)	(0.040)	(0.041)	(0.045)	(0.010)	(0.010)
SDTimeInCo	0.078	-0.011	-0.034	0.076*	0.012	0.004
	(0.156)	(0.032)	(0.033)	(0.039)	(0.008)	(0.008)
SDBrdAge	-0.329***	-0.009	-0.012	-0.076***	0.001	0.003
	(0.084)	(0.023)	(0.023)	(0.021)	(0.006)	(0.006)
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes
Country dummies	Yes	No	No	Yes	No	No
Sector dummies	Yes	No	No	Yes	No	No
Firm FE	No	Yes	Yes	No	Yes	Yes
Sector-by-year FE	No	No	Yes	No	No	Yes
Observations	4,589	4,589	4,589	4,589	4,589	4,589
R^2	0.402	0.013	0.047	0.368	0.036	0.068
Adjusted R^2	0.394	-0.162	-0.132	0.359	-0.135	-0.107

*p<0.1; **p<0.05; ***p<0.01. Standard errors clustered at firm level. Year, country, sector dummies not reported.

Table C5: Mediator analysis 2004-2019, regression results of the effect of gender diversity on accounting performance

	Dependent variable:									
	ROA					ROE				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
FemaleShare	5.636	7.724**	13.606***	9.656***	-0.187	7.032	10.972*	23.490***	17.862***	8.791
	(3.431)	(3.136)	(3.703)	(3.256)	(3.123)	(6.849)	(6.481)	(7.504)	(6.796)	(6.718)
BoardSize		0.887***	0.727***	0.635***	-0.093		1.638***	1.315***	1.295***	-0.096
		(0.178)	(0.184)	(0.231)	(0.280)		(0.348)	(0.370)	(0.438)	(0.695)
BoardIndep		1.405	1.032	2.891	3.487		2.816	1.995	5.616	11.182*
		(1.762)	(2.032)	(1.918)	(2.542)		(3.250)	(3.808)	(3.708)	(5.973)
SDTimeBrd		0.318	0.271	0.150	-0.210		-0.046	-0.136	-0.125	-0.613
		(0.194)	(0.187)	(0.200)	(0.208)		(0.424)	(0.416)	(0.433)	(0.507)
SDTimeInCo		0.403***	0.418***	0.435**	0.037		1.148***	1.180***	1.023***	0.251
		(0.141)	(0.139)	(0.172)	(0.180)		(0.303)	(0.302)	(0.339)	(0.370)
SDBrdAge		0.189	0.246	0.164	0.066		0.266	0.389	0.228	0.487
		(0.161)	(0.161)	(0.163)	(0.175)		(0.325)	(0.324)	(0.319)	(0.440)
log(Age)		1.582***	1.585***	0.613	3.525		1.912**	1.928**	0.529	7.175
		(0.465)	(0.456)	(0.437)	(3.267)		(0.966)	(0.947)	(0.915)	(6.094)
Denmark			4.021**	7.742***				8.823**	15.617***	
			(1.842)	(2.195)				(3.938)	(4.424)	
Finland			4.288***	3.124*				9.415***	7.172**	
			(1.479)	(1.608)				(2.799)	(3.190)	
Sweden			2.014	2.204				4.512*	4.417	
			(1.356)	(1.387)				(2.634)	(2.806)	
Year dummies	No	No	Yes	Yes	Yes	No	No	Yes	Yes	Yes
Sector dummies	No	No	No	Yes	No	No	No	No	Yes	No
Firm FE	No	No	No	No	Yes	No	No	No	No	Yes
Observations	4,589	4,589	4,589	4,589	4,589	4,589	4,589	4,589	4,589	4,589
R^2	0.002	0.074	0.086	0.200	0.013	0.001	0.046	0.059	0.131	0.016
Adjusted R^2	0.002	0.072	0.081	0.190	-0.162	0.001	0.045	0.054	0.119	-0.158

*p<0.1; **p<0.05; ***p<0.01. Coefficients for year and sector dummies not reported.
Heteroskedasticity robust standard errors clustered at firm level reported in parentheses.

Table C6: Mediator analysis 2004-2019, regression results of the impact of gender diversity on market performance

	Dependent variable:									
	Market to Book Ratio					Tobin's Q				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
FemaleShare	-1.485*	-1.446*	-0.477	-0.597	-0.981	-0.839**	-0.898**	-0.160	-0.052	-0.323
	(0.778)	(0.746)	(0.865)	(0.764)	(0.639)	(0.410)	(0.397)	(0.469)	(0.380)	(0.310)
BoardSize		0.040	-0.019	0.019	0.028		-0.002	-0.047	-0.019	0.025
		(0.054)	(0.053)	(0.048)	(0.063)		(0.031)	(0.031)	(0.026)	(0.030)
BoardIndep		-0.029	0.301	0.238	-0.007		0.087	0.217	0.087	-0.142
		(0.368)	(0.408)	(0.358)	(0.517)		(0.207)	(0.226)	(0.193)	(0.202)
SDTimeBrd		0.044	0.025	0.008	-0.029		0.068*	0.046	0.045	-0.001
		(0.073)	(0.069)	(0.065)	(0.045)		(0.038)	(0.036)	(0.030)	(0.021)
SDTimeInCo		-0.017	0.003	0.034	0.028		-0.037*	-0.019	-0.005	0.016
		(0.041)	(0.040)	(0.038)	(0.040)		(0.021)	(0.021)	(0.017)	(0.016)
SDBrdAge		-0.036	-0.037	-0.006	0.080**		-0.035	-0.037*	-0.015	0.022
		(0.037)	(0.037)	(0.033)	(0.039)		(0.022)	(0.021)	(0.018)	(0.017)
log(Age)		-0.478***	-0.470***	-0.257**	-0.747		-0.272***	-0.263***	-0.109**	-0.065
		(0.118)	(0.118)	(0.106)	(0.568)		(0.062)	(0.063)	(0.051)	(0.373)
Denmark			1.823***	0.928				1.159***	0.447*	
			(0.593)	(0.568)				(0.296)	(0.253)	
Finland			-0.281	-0.296				-0.089	-0.095	
			(0.304)	(0.296)				(0.153)	(0.145)	
Sweden			0.553*	-0.026				0.637***	0.263*	
			(0.290)	(0.305)				(0.171)	(0.152)	
Year dummies	No	No	Yes	Yes	Yes	No	No	Yes	Yes	Yes
Sector dummies	No	No	No	Yes	No	No	No	No	Yes	No
Firm FE	No	No	No	No	Yes	No	No	No	No	Yes
Observations	4,589	4,589	4,589	4,589	4,589	4,589	4,589	4,589	4,589	4,589
R^2	0.004	0.018	0.065	0.180	0.060	0.004	0.025	0.085	0.263	0.061
Adjusted R^2	0.003	0.016	0.060	0.169	-0.106	0.004	0.024	0.080	0.253	-0.105

*p<0.1; **p<0.05; ***p<0.01. Coefficients for year and sector dummies not reported.
Heteroskedasticity robust standard errors clustered at firm level reported in parentheses.

Table C7: Mediator analysis 2004-2019, regression results of the impact of gender diversity on innovation

	Dependent variable:									
	Log (1+RD)					Log (1+Patents)				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
FemaleShare	-7.128***	-8.175***	-5.225***	-2.448	0.117	-0.936**	-0.870**	-0.292	0.374	-0.245
	(1.954)	(1.738)	(1.932)	(1.744)	(0.687)	(0.466)	(0.416)	(0.489)	(0.427)	(0.159)
BoardSize		0.851***	0.828***	0.842***	0.045		0.267***	0.251***	0.252***	0.019
		(0.132)	(0.141)	(0.128)	(0.067)		(0.034)	(0.036)	(0.034)	(0.016)
BoardIndep		6.871***	4.928***	4.097***	0.402		1.063***	0.859***	0.740***	-0.117
		(0.883)	(0.985)	(0.876)	(0.475)		(0.216)	(0.222)	(0.187)	(0.110)
SDTimeBrd		-0.145	-0.151	0.011	0.053		-0.086*	-0.089*	-0.069	0.010
		(0.203)	(0.210)	(0.177)	(0.088)		(0.050)	(0.051)	(0.045)	(0.013)
SDTimeInCo		0.085	0.084	0.042	-0.009		0.069	0.069	0.066*	0.012
		(0.175)	(0.184)	(0.154)	(0.063)		(0.045)	(0.046)	(0.039)	(0.010)
SDBrdAge		-0.432***	-0.386***	-0.321***	-0.011		-0.080***	-0.074***	-0.069***	0.001
		(0.102)	(0.098)	(0.085)	(0.042)		(0.025)	(0.024)	(0.021)	(0.008)
log(Age)		0.821**	0.633	0.825**	-0.564		0.327***	0.294***	0.352***	-0.174
		(0.393)	(0.389)	(0.361)	(0.854)		(0.107)	(0.107)	(0.101)	(0.145)
Denmark			1.646	0.459				0.639*	0.666**	
			(1.488)	(1.216)				(0.379)	(0.329)	
Finland			4.874***	5.056***				0.559*	0.747***	
			(1.111)	(1.031)				(0.299)	(0.272)	
Sweden			1.200	0.657				0.151	0.217	
			(0.903)	(0.857)				(0.194)	(0.189)	
Year dummies	No	No	Yes	Yes	Yes	No	No	Yes	Yes	Yes
Sector dummies	No	No	No	Yes	No	No	No	No	Yes	No
Firm FE	No	No	No	No	Yes	No	No	No	No	Yes
Observations	4,589	4,589	4,589	4,589	4,589	4,589	4,589	4,589	4,589	4,589
R^2	0.016	0.169	0.201	0.407	0.014	0.005	0.219	0.232	0.386	0.039
Adjusted R^2	0.015	0.168	0.197	0.399	-0.162	0.004	0.217	0.227	0.378	-0.132

*p<0.1; **p<0.05; ***p<0.01. Coefficients for year and sector dummies not reported.
Heteroskedasticity robust standard errors clustered at firm level reported in parentheses.

Table C8: Mediator analysis 2004-2019, regression results of the effect of innovation on accounting performance, controlling for gender diversity

	Dependent variable:									
	ROA					ROE				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
FemaleShare	5.273	6.356**	12.505***	9.374***	-0.199	6.132	8.144	21.023***	16.787**	8.868
	(3.389)	(3.077)	(3.677)	(3.266)	(3.120)	(6.791)	(6.449)	(7.490)	(6.876)	(6.715)
log(1 + RD)	-0.186**	-0.184**	-0.220**	-0.034	-0.096	-0.447***	-0.449***	-0.528***	-0.211	-0.341
	(0.087)	(0.083)	(0.088)	(0.076)	(0.171)	(0.165)	(0.161)	(0.169)	(0.154)	(0.282)
log(1 + Patents)	1.026***	0.158	0.168	0.536*	-0.095	2.447***	0.964*	0.997*	1.495***	0.150
	(0.315)	(0.303)	(0.307)	(0.284)	(0.479)	(0.603)	(0.573)	(0.581)	(0.563)	(0.934)
BoardSize		1.001***	0.867***	0.528**	-0.087		1.762***	1.501***	1.096**	-0.084
		(0.193)	(0.201)	(0.246)	(0.277)		(0.376)	(0.401)	(0.467)	(0.693)
BoardIndep		2.502	1.972	2.631	3.515		4.873	3.740	5.373	11.337*
		(1.772)	(2.011)	(1.951)	(2.543)		(3.305)	(3.811)	(3.816)	(5.988)
SDTimeBrd		0.305	0.252	0.188	-0.204		-0.028	-0.127	-0.019	-0.596
		(0.198)	(0.195)	(0.194)	(0.208)		(0.424)	(0.424)	(0.428)	(0.506)
SDTimeInCo		0.408***	0.424***	0.401**	0.038		1.119***	1.155***	0.934***	0.246
		(0.144)	(0.147)	(0.164)	(0.178)		(0.302)	(0.310)	(0.331)	(0.368)
SDBrdAge		0.122	0.173	0.191	0.066		0.149	0.260	0.263	0.483
		(0.163)	(0.161)	(0.162)	(0.174)		(0.331)	(0.326)	(0.320)	(0.439)
log(Age)		1.681***	1.675***	0.452	3.454		1.964**	1.969**	0.177	7.009
		(0.500)	(0.487)	(0.449)	(3.246)		(0.999)	(0.979)	(0.923)	(6.039)
Denmark			4.276**	7.401***				9.054**	14.719***	
			(1.872)	(2.189)				(3.946)	(4.411)	
Finland			5.267***	2.893*				11.431***	7.121**	
			(1.590)	(1.688)				(2.958)	(3.283)	
Sweden			2.253*	2.110				4.995**	4.230	
			(1.316)	(1.383)				(2.532)	(2.784)	
Year dummies	No	No	Yes	Yes	Yes	No	No	Yes	Yes	Yes
Sector dummies	No	No	No	Yes	No	No	No	No	Yes	No
Firm FE	No	No	No	No	Yes	No	No	No	No	Yes
Observations	4,589	4,589	4,589	4,589	4,589	4,589	4,589	4,589	4,589	4,589
R^2	0.011	0.079	0.093	0.203	0.014	0.012	0.052	0.067	0.134	0.017
Adjusted R^2	0.010	0.077	0.088	0.192	-0.162	0.011	0.050	0.061	0.122	-0.158

*p<0.1; **p<0.05; ***p<0.01. Coefficients for year and sector dummies not reported.
Heteroskedasticity robust standard errors clustered at firm level reported in parentheses.

Table C9: Mediator analysis 2004-2019, regression results of the effect of innovation on market performance, controlling for gender diversity

	Dependent variable:									
	Market to Book Ratio					Tobin's Q				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
FemaleShare	-1.105	-0.902	-0.119	-0.590	-0.965	-0.534	-0.461	0.134	-0.016	-0.305
	(0.751)	(0.706)	(0.851)	(0.771)	(0.637)	(0.397)	(0.377)	(0.454)	(0.380)	(0.309)
log(1 + RD)	0.041**	0.046***	0.059***	0.026	-0.006	0.041***	0.043***	0.052***	0.026**	0.007
	(0.017)	(0.016)	(0.017)	(0.016)	(0.017)	(0.010)	(0.010)	(0.010)	(0.011)	(0.011)
log(1+Patents)	0.095	0.195**	0.162**	0.156**	0.061	0.017	0.099**	0.082*	0.075*	0.077
	(0.077)	(0.080)	(0.076)	(0.072)	(0.084)	(0.047)	(0.048)	(0.046)	(0.043)	(0.048)
BoardSize		-0.051	-0.108**	-0.042	0.027		-0.065**	-0.111***	-0.060**	0.023
		(0.053)	(0.053)	(0.050)	(0.063)		(0.031)	(0.031)	(0.028)	(0.030)
BoardIndep		-0.551	-0.130	0.015	0.002		-0.313	-0.109	-0.075	-0.135
		(0.363)	(0.399)	(0.364)	(0.516)		(0.191)	(0.208)	(0.193)	(0.201)
SDTimeBrd		0.067	0.049	0.018	-0.030		0.083**	0.061*	0.049	-0.002
		(0.071)	(0.068)	(0.066)	(0.045)		(0.037)	(0.035)	(0.030)	(0.021)
SDTimeInCo		-0.034	-0.013	0.023	0.028		-0.048**	-0.029	-0.011	0.015
		(0.041)	(0.040)	(0.039)	(0.040)		(0.020)	(0.020)	(0.018)	(0.016)
SDBrdAge		-0.001	-0.002	0.013	0.080**		-0.008	-0.011	-0.001	0.022
		(0.034)	(0.034)	(0.032)	(0.038)		(0.020)	(0.019)	(0.017)	(0.017)
log(Age)		-0.579***	-0.556***	-0.334***	-0.739		-0.339***	-0.320***	-0.157***	-0.047
		(0.121)	(0.120)	(0.107)	(0.569)		(0.066)	(0.064)	(0.053)	(0.375)
Denmark			1.622***	0.813				1.021***	0.385	
			(0.573)	(0.576)				(0.272)	(0.259)	
Finland			-0.661**	-0.546*				-0.388**	-0.282*	
			(0.308)	(0.301)				(0.161)	(0.148)	
Sweden			0.458	-0.078				0.562***	0.229	
			(0.286)	(0.304)				(0.161)	(0.146)	
Year dummies	No	No	Yes	Yes	Yes	No	No	Yes	Yes	Yes
Sector dummies	No	No	No	Yes	No	No	No	No	Yes	No
Firm FE	No	No	No	No	Yes	No	No	No	No	Yes
Observations	4,589	4,589	4,589	4,589	4,589	4,589	4,589	4,589	4,589	4,589
R^2	0.022	0.047	0.098	0.190	0.061	0.037	0.079	0.147	0.279	0.063
Adjusted R^2	0.021	0.046	0.093	0.179	-0.107	0.037	0.077	0.141	0.269	-0.104

*p<0.1; **p<0.05; ***p<0.01. Coefficients for year and sector dummies not reported.
Heteroskedasticity robust standard errors clustered at firm level reported in parentheses.

Table C10: Regression results of the impact of gender diversity on innovation in subsample of non-0 R&D expense observations

	Dependent variable:									
	Log(1+RD)					Log(1+Patents)				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
FemaleShare	0.182	0.295	1.355**	1.718***	0.494*	1.396***	1.105**	0.882	0.907*	-0.499*
	(0.538)	(0.496)	(0.570)	(0.488)	(0.285)	(0.526)	(0.513)	(0.622)	(0.521)	(0.273)
BoardSize		0.367***	0.347***	0.358***	0.102***		0.286***	0.274***	0.263***	0.037
		(0.038)	(0.041)	(0.034)	(0.024)		(0.036)	(0.040)	(0.040)	(0.025)
BoardIndep		1.083***	0.967***	0.610***	-0.157		1.477***	0.739**	0.757***	-0.410**
		(0.281)	(0.295)	(0.218)	(0.180)		(0.322)	(0.318)	(0.267)	(0.206)
SDTimeBrd		-0.007	-0.025	-0.007	0.044		-0.063	-0.080	-0.089*	0.034
		(0.052)	(0.055)	(0.053)	(0.031)		(0.055)	(0.054)	(0.053)	(0.030)
SDTimeInCo		0.064	0.073	0.058	0.003		0.103**	0.098**	0.104***	-0.002
		(0.046)	(0.049)	(0.042)	(0.018)		(0.042)	(0.041)	(0.039)	(0.019)
SDBrdAge		-0.086**	-0.084***	-0.074***	0.005		-0.045	-0.047	-0.055*	0.005
		(0.034)	(0.032)	(0.027)	(0.014)		(0.037)	(0.035)	(0.032)	(0.015)
log(Age)		0.185*	0.169	0.311***	-0.114		0.286**	0.251**	0.313**	-0.361
		(0.112)	(0.106)	(0.105)	(0.201)		(0.127)	(0.124)	(0.126)	(0.294)
Denmark			0.687*	0.822**				0.651*	0.681*	
			(0.366)	(0.322)				(0.391)	(0.372)	
Finland			0.639**	0.930***				0.193	0.388	
			(0.279)	(0.257)				(0.346)	(0.342)	
Sweden			0.433*	0.578***				0.257	0.266	
			(0.244)	(0.216)				(0.275)	(0.289)	
Year dummies	No	No	Yes	Yes	Yes	No	No	Yes	Yes	Yes
Sector dummies	No	No	No	Yes	No	No	No	No	Yes	No
Firm FE	No	No	No	No	Yes	No	No	No	No	Yes
Observations	3,234	3,234	3,234	3,234	3,234	3,234	3,234	3,234	3,234	3,234
R^2	0.0002	0.340	0.355	0.472	0.104	0.009	0.237	0.336	0.424	0.513
Adjusted R^2	-0.0001	0.338	0.349	0.461	-0.013	0.009	0.235	0.329	0.413	0.449

*p<0.1; **p<0.05; ***p<0.01. Coefficients for year and sector dummies not reported.
Heteroskedasticity robust standard errors clustered at firm level reported in parentheses.