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The effect of board gender diversity on firm performance

By Tim van der Weerd (s1087926)

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Supervisor: Vincent Delabastita

Radboud Universiteit

Abstract

This thesis examines the effect of board gender diversity on firm performance in Europe. After controlling for endogeneity, it is found that the effect of board gender diversity on firm performance is significantly positive but diminishing. Furthermore, the effect of gender quotas on firm performance was examined by studying the binding French gender quota and the non-binding Spanish gender quota. This thesis finds a positive and significant effect of both the French binding quota and the Spanish non-binding quota on firm performance when using a difference-in-difference model. When using a triple-difference model, no statistically significant results were found. This thesis contributes to the inconclusive literature on the effect of board gender diversity on firm performance by allowing for a non-linear relationship and by studying this relationship on a European level. Moreover, by studying a case of a binding quota as well as a non-binding quota, this thesis provides new insights into how the effect of gender quotas on firm performance differs between binding- and non-binding gender quotas.

Table of Contents

1. Introduction p. 3
2. Literature review p. 6
2.1. Effect of board gender diversity on firm performance p. 6
2.2. Theories on board gender diversity p. 7
2.3. Gender quotas p. 10
2.3.1.Effect of gender quotas on firm performance p. 10
2.3.2.French gender quota p. 11
2.3.3.Spanish gender quota p. 12
2.4. Hypotheses p. 12
3. Data & Methodology p. 14
3.1. Data p. 14
3.2. Dependent variable p. 14
3.3. Explanatory variable p. 14
3.4. Control variables p. 15
3.5. Descriptive statistics on European level p. 16
3.6. Descriptive statistics Gender Quota p. 17
3.6.1.Descriptive statistics French quota p. 17
3.6.2.Descriptive statistics Spanish quota p. 21
3.7. Econometric model p. 25
4. Empirical results p. 31
5. Robustness check p. 40
6. Conclusion p. 46
7. Bibliography p. 48
8. Appendix p. 53
8.1. Appendix A: Gender quotas p. 53
8.2. Appendix B: Data and Methodology p. 56
8.3. Appendix C: Results p. 64
8.4. Appendix D: Robustness check p. 68

1. Introduction

Over the past years, the topic of board gender diversity has received an increasing amount of attention. The share of female board directors has increased significantly over the past decade, rising from 22.6% in 2016 to 30.7% in 2021 (Deloitte, 2022). This growth is most likely driven by the fact that multiple European countries have introduced board gender quotas that either encourage or legally oblige firms to increase gender diversity within their boards. In 2006, Norway was the first country to adopt a legally binding gender quota (Matsa & Miller, 2013). Afterwards, multiple countries followed suit by introducing either binding quotas or non-binding quotas, including France, Italy, Belgium and Spain (European Commission, 2012). On a European level, the European Parliament approved the directive on 'improving the gender balance among non-executive directors of listed companies' on 22 November 2022, obliging EU member states to ensure that 40% of all non-executive directors and 33% of all directors of listed companies are female (European Commission, 2022).

There are various reasons why people call for increased board gender diversity and why several countries have already implemented gender quotas. Firstly, there are moral reasons; from a fairness and equity perspective, one might believe that there should be equal chances and representation for both genders. According to this principle, both sexes should have equal power and influence (Yu & Madison, 2021). Since companies exert a great amount of influence on society, these companies should be directed by an equal share of both sexes as well (Yu & Madison, 2021). A second argument of advocates of board gender diversity is that gender diversity would improve firm performance. This is also the main argument given by European Commission president Ursula von der Leyen in her speech during the presentation of the 'European Women on Boards' Gender Diversity Award': "Why diversity? Why women on board? Because all research and economic studies show that companies that embrace diversity are more successful. This is true in business, politics and society as a whole" (Von der Leyen, 2022).

This thesis focuses on the latter argument; the effect of board gender diversity on firm performance. Although several theories, such as the human capital theory, resource dependence theory and agency theory suggest that having a more gender diverse board would improve firm performance, previous studies find mixed results on the relationship between board gender diversity and firm performance. In addition, when a gender quota for boards is introduced, the relationship between board gender diversity and firm performance might be further affected. On the one hand, assuming that firms compose their board in such a way that shareholder value is maximized, a gender quota will distort this optimal composition (Ahern & Dittmar, 2012) and thus negatively affect firm performance. On the other hand, prejudices against women driven by stereotypes or discrimination can result in the pre-quota board composition being sub-optimal (Comi et al., 2020). In this case, a gender quota can help firms to overcome these prejudices and reach the actual optimal board composition, which in turn would improve firm performance (Comi et al., 2020).

This thesis will empirically study whether board gender diversity affects firm performance. In addition, the effect of board gender quotas on firm performance will be examined. This leads to the following research question: *What is the effect of board gender diversity and gender quotas on firm performance?*

To answer this research question, this thesis analyzes board director panel data combined with financial firm-level panel data from 2000 until 2022 from 7,294 unique European firms. Firstly, a Fixed Effects model will be used to study the effect of board gender diversity on firm performance within this sample. This Fixed Effects model addresses possible omitted variable bias that might arise from relevant variables being excluded from the regression. This Fixed Effects model addresses this form of

endogeneity by controlling for unobserved time-constant firm characteristics and by including control variables. Another form of endogeneity that might arise in this research is reverse causality, meaning that firm performance might affect gender diversity instead of gender diversity affecting firm performance. Therefore, this thesis employs an instrumental variable approach as well as a lagged independent variable approach to account for the issue of reverse causality. The results of this model will provide new insights to the inconclusive literature on the relationship between board gender diversity and firm performance by examining this relationship on a European level, opposed to most studies examining just one particular country or industry. Also, a long time span is studied, including recent data from up till 2022, compared to most previous literature studying less recent data. Moreover, previous literature does not always account for potential endogeneity, while this study uses multiple methods to control for endogeneity.

Secondly, to study how the relationship between board gender diversity and firm performance changes as board gender diversity increases, a quadratic term of board gender diversity is included in the regressions. Most studies only test for a linear relationship between board gender diversity and firm performance, while this relationship could very well be non-linear. Especially based on the critical mass theory, which states that a minority group will only be able to exert influence on decision-making processes when a certain threshold is reached (Torchia, Calabrò & Huse, 2011), it can be hypothesized that the relationship between board gender diversity and firm performance is non-linear. Therefore, this study will allow for non-linearity in this relationship.

Finally, a third model will be used to study whether board gender quotas have a positive or negative impact on firm performance, and whether this effect differs between binding- and non-binding quotas. In order to find how this impact differs between binding- and non-binding quota, one country will be studied per type of quota. The binding quota that will be studied is the French quota and the non-binding quota that will be studied is the Spanish quota. Using a difference-in-differences (DD) approach as well as a triple-difference (DDD) approach, the effect of these quotas on firm performance will be examined. The outcome of this study can have important policy implications, as it indicates whether having a quota - and what kind of quota - is beneficial in terms of achieving gender diversity as well as optimal firm performance. Most studies that examined the effect of gender quota on firm performance studied the Norwegian case, as this was the first binding board gender quota that was introduced (Matsa & Miller, 2013). Since nearly every other gender quota was implemented in the last 15 years, empirical evidence on the effect of these gender quotas on firm performance is limited (Yu & Madison, 2021). Concerning the French and Spanish gender quotas studied in this thesis, to the best of this thesis' knowledge, the effect of these quotas on firm performance have only been studied by Maghin (2022) and Comi et al. (2020) respectively. Furthermore, extant literature calls for more empirical cross-country research on board gender diversity and gender quotas (Burzynska & Contreras, 2020), as studies typically focus on one particular country (Terjesen, Couto & Francisco, 2016). Also, there are only very few examinations of whether the type of approach to improve gender diversity (free market approach, soft quota and binding quota) matters for the effect on firm performance (Ben Slama, Ajina & Lakhal, 2019). Moreover, most studies on gender quotas only focus on a particular sector or only focus on listed firms or large firms, excluding all other sectors or firm types. Therefore, this study adds to the literature by providing new evidence on how the effect of gender quotas on firm performance differs between binding- and non-binding quotas in a multi-country analysis.

This thesis finds a positive effect of gender diversity on firm performance when using a Fixed Effects regression with an instrumental variable for board gender diversity. When including a quadratic term of gender diversity into the regressions, a positive but diminishing effect of board gender diversity on firm performance is found in the Fixed Effects regression with the instrumental variable for board

gender diversity, proving that the relationship is non-linear. This finding of a positive but diminishing effect conflicts with the idea of the critical mass theory, which would predict a negative relationship turning positive once the critical mass is reached.

Concerning the studied gender quotas, both the French binding quota and the Spanish non-binding quota are found to have a small but statistically significant effect on firm performance when using domestic untreated firms as a control group in a difference-in-differences model. For both quotas, no significant effect was found when using Swiss firms as a control group, or when including both control groups in a triple-difference model.

The structure of this thesis will be as follows: Section two provides a literature review of previous research on the effect of board gender diversity and gender quotas on firm performance. Section 3 gives a description of the data and discusses the methodology. Section 4 displays and discusses the results of the performed regressions. Section 5 presents and discusses the results of the performed robustness check. Finally, in Section 6 a conclusion will be drawn.

2. Literature review

This section discusses the previous literature pertaining to board gender diversity and gender quotas. In the first part of this section the findings of previous studies on the relationship between board gender diversity and firm performance will be discussed, as well as the methodology of these studies. The second part discusses theories that could possibly explain the relationship between board gender diversity and firm performance. The third part examines the literature on the effect of gender quotas on firm performance and provides information on the gender quotas that will be studied in this thesis, being the French and Spanish gender quotas. Finally, hypotheses will be formed based on the studied literature.

2.1 Effect of board gender diversity on firm performance

Various studies have been conducted to examine the effect of board gender diversity on firm performance. Previous research provides contradicting findings; some studies find a positive relationship between gender diversity and firm performance, while other studies find a negative relationship. Brahma, Nwafor and Boateng (2021) find a positive relationship between firm performance and gender diversity in their study of FTSE 100 firms between 2005 and 2016 in Great Britain. This relationship is found to be even stronger when there are three or more women in the board (Brahma et al., 2021). Brahma et al. (2021) account for endogeneity by using past values of all explanatory variables as instruments. Campbell and Mínguez-Vera (2008) study the Spanish market between 1995 and 2000. They conduct an event study and find board diversity to positively impact Tobin's Q. They rule out the possibility of a reversed relationship as they employed a causality test in which the effect of firm performance on gender diversity was tested and found to be insignificant.

Liu, Wei and Xie (2014) find a positive effect of board gender diversity on firm performance for Chinese listed firms between 1999 and 2011. Their study uses three methods to address potential endogeneity. Firstly, they use a model in which the gender diversity variable and board characteristic variables are lagged with one year, arguing it takes time for female directors and board characteristics to influence firm performance. Secondly, they use a model with the percentage of women in the firm's industry and the percentage of female employment in the firm's industry as instruments for board gender diversity. These instrumental variables are chosen because the share of women within a firm's board can be affected by the percentage of women (directors) in the industry in which the firm operates. Thirdly, a regression with a lagged return on assets variable is used via the Arellano-Bond method.

Song, Yoon & Kang (2020) studied the effect of board diversity on firm performance in the US lodging industry and find this effect to be positive, concluding that the benefits of having a gender diverse board, such as more effective problem solving and creativity, outweigh the costs, such as lacking cohesion and communication problems. Because of possible endogeneity and causality problems, Song et al. (2020) use a 2SLS estimator with instrumental variables and fixed effects. Following Liu et al. (2014), they use the industry average of gender diversity, and the average age of firm board members as instrumental variables for board diversity. Carter, Simkins and Simpson (2003) also studied the US market and find a positive relationship between board diversity and firm performance for Fortune 1000 firms.

However, there are also studies that find a negative relationship. Adams and Ferreira (2009) find that for a sample of US firms, female directors are more involved in monitoring than male directors. They conclude that over-monitoring by more gender diverse boards is one of the reasons why they find a negative relationship between board diversity and firm performance. Their study uses firm fixed effects to address omitted variables problems. Also, because of reverse causality concerns, their study

includes “the fraction of male directors on the board who sit on other boards on which there are female directors” as an instrumental variable (Adams & Ferreira, 2009). Böhren and Ström (2010) studied the effect of gender diversity on firm performance among Norwegian firms between 1989 and 2002 (prior to the gender quota) and find the effect to be negative.

Finally, there are also studies finding no relationship at all. Carter, D’Souza, Simkins and Simpson (2010) study the relationship between gender diversity of boards and financial performance among US corporations from the S&P 500 index. They find no causal relationship between board diversity and financial performance. Wang & Clift (2009) studied the top 500 Australian listed companies and find no relationship between board diversity and firm performance. They therefore conclude that a higher degree of board diversity can be achieved without damaging shareholder value (Wang & Clift, 2009).

There are several possible explanations for why different studies on the effect of board diversity on firm performance have contradicting findings. Firstly, the differences in the studied sample and time period can be a reason for a differing findings (Campbell and Mínguez-Vera, 2008; Joecks, Pull and Vetter, 2013). As noted by Joecks et al. (2013), studies using a sample with on average lower board diversity are likely to find a negative relationship between board diversity and firm performance, while studies using a sample with on average high board diversity are likely to find a positive relationship, assuming the critical mass theory holds. Similarly, Wang & Clift (2009) note that the reason they did not find a strong relationship between board diversity and firm performance in their study might be due to the fact that their sample consists of very few female directors and that their results might have been different had the critical mass been reached. The critical mass theory will be further explored later in this section. Secondly, it becomes apparent from the previously discussed studies that estimation methods vary between different studies. Studies use different types of regressions and use different control variables. Also, different approaches are taken to control for endogeneity. Thirdly, the legal and institutional context matters (Campbell and Mínguez-Vera, 2008; Smith, 2014).

2.2 Theories on board gender diversity

Several theories exist that could explain why gender diversity impacts firm performance. In this section, the theories most commonly discussed in the literature will be reviewed.

Human capital theory

The first theory that could explain a positive relationship between gender diversity and firm performance is the human capital theory. According to the human capital theory, a firm will benefit from the unique skills and experiences of their employees (Taljaard, Ward & Muller, 2015). If women possess different skills and experiences compared to men, the total accumulated human capital of a firm would increase as boards become more diverse (Carter et al., 2010).

Extant literature describes several differences in skills, experiences and characteristics between men and women in relation to decision making. Kim and Starks (2016) find that women are more likely to possess expertise in risk management, sustainability, human resources, corporate governance, compliance and governance than men, and argue that this can explain a positive effect of board gender diversity on firm performance. Kramer, Konrad, Erkut and Hooper (2006) conducted a survey and find that respondents believe that women bring value to the board by “providing different perspectives, expanding the content of board discussions, raising issues that pertain to multiple stakeholders, asking tough questions, and using their interpersonal skills to promote collaboration” (Kramer et al., 2006). Moreover, men are found to be overconfident and less cautious compared to women, resulting in male directors issuing more debt and approving more acquisitions (Huang & Kisgen, 2013).

Various papers study whether the effect of diversity on firm performance indeed stems from differences in skills and characteristics; Maghin (2022) researched the effect of the French gender quota on firm performance and suggests that their finding of a positive effect of the quota on firm performance could be (partly) ascribed to increased heterogeneity of the board. Iranzo, Schivardi & Tosetti (2008) focus on the skill mix of employers, and find that skill dispersion has a positive effect on a firm's productivity.

Besides the channels previously described, the unique skills, experiences and perspectives of female board directors positively impact firm performance through other channels as well. Two theories that each describe a specific way in which these female features impact firm performance are the resource dependence theory and the agency theory. They respectively argue that female director's unique skills, experiences and perspectives increase linkages to external resources and reduce agency costs. These two theories will next be discussed in more detail.

Resource dependence theory

The resource dependence theory, first introduced by Pfeffer and Salancik, views a firm as an "open system, dependent on contingencies in the external environment" (Hillmann, Withers & Collins, 2009), meaning that a firm's success depends on external resources. Following this theory, linkages to these external resources are crucial, and board directors can provide these linkages (Hillman et al., 2009). In the original theory of Pfeffer and Salancik, board directors can increase access to external resources in four ways; advice and counsel, access to information channels, access to resources, and legitimacy (Hillmann et al., 2009). It can be expected that increased board gender diversity will lead to more linkages to external resources through each of these four channels, as more gender diverse boards benefit from broader perspectives, expertise and networks (Yang, Riepe, Moser, Pull & Terjesen, 2019). Specifically, concerning advice and counsel, more diverse boards do a better job at deliberating complex issues (Liu et al., 2014). Satisfying society's norms and values on gender equality adds to a firm's legitimacy (Liu at al., 2014). Regarding the access to information channels and resources, women's experiences and perspectives enable them to better connect to female customers and women in general (Liu et al., 2014).

Agency theory

The agency theory focuses on the relationship between a principal and an agent, and the conflicts that arise from this relationship. In a principal agent relationship, the principle delegates work or decision making authority to the agent (Jensen & Meckling, 1976). Problems arise when there is a conflict of interest between the principal and the agent. The principal can try to make the agent act in its interest, but this leads to agency costs (Jensen & Meckling, 1976). In a business context, owners (shareholders) can be seen as the principals and managers as agents (Jensen & Meckling, 1976). Gender diversity is believed to reduce agency costs. This belief is closely linked to the human capital theory, according to which women provide different skills, experiences and perspectives compared to men. Following the agency theory, an increase in the heterogeneity of human capital can decrease agency costs; women's fresh perspectives and unique human capital can "help correct informational biases in strategy formulation and problem solving" (Francoeur, Labelle & Sinclair-Desgagné, 2008). Moreover, due to heterogeneity in perspectives, more diverse boards do a better job at monitoring the agents, being the managers (Carter et al., 2003), which reduces agency costs. Terjesen et al. (2016) list various characteristics of women that contribute to increased monitoring; women are more likely to raise questions, take on more active roles in the board, apply stricter ethical standards and attend more meetings. Adams and Ferreira (2009) also suggest that more gender diverse boards put more effort into monitoring, as they find that female directors have a higher attendance rate, men are more likely

to attend when a board is more gender diverse, and women join monitoring committees more often than men.

Critical mass theory

Another relevant theory is the critical mass theory. In a sociological sense, the critical mass theory suggests that "when the minority group reaches a critical mass, a qualitative change will take place in the nature of group interactions" (Torchia et al., 2011). Applying this theory to the case of board gender diversity, women are unlikely to have an impact within the board until the minority group of women has grown into a considerable minority (Broome, Conley & Krawiec, 2010). Only when a certain threshold, the so-called critical mass, is reached, the minority group's influence on decision-making increases (Torchia et al., 2011). The underrepresentation of women leads to female board directors being regarded as a symbol or token (Torchia et al., 2011). These tokens are seen as representatives of the female gender, rather than as individuals (Joecks et al., 2013). Stereotyping makes it difficult for these women to have influence on the decision-making process (Torchia et al., 2011); their opinions are often put in doubt and they are distrusted, resulting in a feeling of isolation and self-doubt (Torchia et al., 2011).

Previous studies find that at least three women are needed to constitute a critical mass. Based on a survey, Kramer et al. (2006) concludes that three women are needed to constitute a critical mass. Torchia et al. (2011) empirically find the critical mass to also be at least three women. Liu et al. (2014) find a similar result in the Chinese market, finding boards with three or more female directors to have a larger positive effect on firm performance than boards with less than three female directors. Joecks et al. (2013) study the German market and find the effect of gender diversity on firm performance to follow a U-shape; starting with zero female directors, adding female directors first has a negative impact on firm performance, but when a critical mass of 30% has been reached, gender diversity starts to have a positive impact on firm performance.

The crux of the critical mass theory is that when the critical mass is not reached, the unique characteristics, skills and perspectives offered by women are not fully utilized. According to the human capital theory, resource dependency theory and agency theory, this would cause a firm to miss out on financial performance, as having more heterogeneous characteristics, skills and perspectives positively affects firm performance.

Role incongruity theory

Whereas the previous theories could explain a positive relationship between board gender diversity and firm performance, there are also theories that suggest that this relationship might be negative. One of them is the role incongruity theory. According to this theory, there is a discrepancy between the perceived characteristics of women and the perceived characteristics required in leadership roles (Eagly & Karau, 2002). This so-called perceived incongruity between the female gender role and leadership roles leads to the belief that women are less suitable to fulfil leadership roles (Eagly & Karau, 2002). Also, this incongruity causes people to be more critical towards the actions of women in leadership roles than men in leadership roles (Eagly & Karau, 2002). Moreover, several theories emphasize that heterogeneity within a group might not be beneficial. For example, the similar-attraction paradigm states that heterogeneity within a group might lead to conflicts and communication problems as people with different backgrounds might not completely understand and trust each other (Song et al., 2020). This theory stating that heterogeneity will negatively impact firm performance conflicts with the human capital theory, resource dependence theory and agency theory, as these theories emphasize how heterogeneity within a board will positively impact firm performance

through the unique characteristics and perspectives of women, increased linkages to external resources and reduced agency costs.

2.3 Gender quotas

Board gender equality can be achieved in various ways. One way is to let the market improve gender diversity among boards. However, board diversity usually does not improve sufficiently in the absence of regulatory measures (Allen & Overy, 2022). For this reason, several European countries have implemented gender quota. Some of these are binding quotas, others are non-binding quotas. Whereas binding quotas ensure that a particular degree of board diversity is reached, it remains to be questioned to what degree non-binding gender quota will increase board diversity. With non-binding gender quotas, companies that do not comply with the quota face no direct punishments and can continue their business. Instead, they typically only receive recommendations and warnings (De Cabo, Terjesen, Escot & Gimeno, 2019). Still, there might be incentives for firms to comply with non-binding gender quotas. One of them is that it is favorable for firms to preserve a good relationship with the government, as for many firms the government is an important customer (De Cabo et al., 2019). Firms might choose to comply as they are dependent on government subsidies and contracts (De Cabo et al., 2019). Despite the fact that many European countries have non-binding quotas in place, research on non-binding gender quotas is considerably more limited than on binding gender quotas.

Binding quotas have turned out highly effective in terms of achieving a higher degree of board diversity; whereas in European countries with non-binding quotas the share of women in boards has increased from 12.4% in 2010 to 30.7% in 2022, this share has increased from 10.6% in 2010 to 38.8% in 2022 in countries with binding quotas (Allen & Overy, 2022). In European countries with no quota at all, the share of women in boards has only increased from 13.2% in 2010 to 18% in 2022 (Allen & Overy, 2022).

2.3.1 Effect of gender quotas on firm performance

As previously discussed, most studies that examine the relationship between board diversity and firm performance find a positive relationship. Also, multiple theories can explain why gender diversity would positively affect firm performance. Based on the human capital theory, resource dependence theory and agency theory, firms are expected to profit from unique female perspectives, characteristics and skills. This would especially be the case if the critical mass is reached. Therefore, it seems logical that gender quotas would have a positive effect on firm performance, as they encourage or even legally oblige firms to increase gender diversity and reach the critical mass. However, this is not necessarily the case, as quotas themselves might affect firm performance.

One of the main possible explanations as to why quotas affect firm performance regards the idea that boards are chosen in such a way that shareholder value and firm value is maximized (Comi et al., 2020). Quotas force firms to change their boards, which disturbs this optimal board composition (Ahern & Dittmar, 2012). Binding gender quotas force firms to appoint more female directors, even though they are not necessarily the most competent candidates (Terjesen, Aguilera & Lorenz, 2015; Comi et al., 2020). Ahern and Dittmar (2012) mention this as one possible explanation for their finding that the Norwegian gender quota reduced firm performance in Norway.

Furthermore, forced inclusion of female board members changes board characteristics and board structure, which in turn can have an impact on firms performance. It can cause changes in board size, the number of new directors and leadership styles (Leszczyńska, 2018). Also, team dynamics and cooperation might change as people doubt the fairness of the selection procedure (Leszczyńska, 2018). Research has shown that the collective identity of group members depend on the fairness of the group

procedures; the more fairly the individuals perceive the procedures, the more they identify with the group (Leszczyńska, 2018). Concerning board characteristics, Ahern and Dittmar (2012) find that the gender quota in Norway led to less experienced boards as more women were included. In their sample, only 31% of the newly included female directors have CEO experience, compared to 65% of the male directors forced to leave due to the quota and 69% of the remaining male directors. Also, the new female directors are on average 46 years old, compared to an average age of 53 for exiting male directors and 54 for remaining male directors. Ahern and Dittmar (2012) argue that firms prefer more experienced board members since the retained male directors have on average more CEO experience, are older and have served longer in the board than the leaving male directors.

An argument that explains why gender quotas might positively affect firm performance is related to prejudices against women. As mentioned before, it can be assumed that firms choose boards in such a way that firm value is maximized. However, due to prejudices against women, the judgement of the shareholders and managers that appoint board directors could be inaccurate as they do not fully value the actual abilities of female board members (Comi et al., 2020). These prejudices can be caused by negative stereotypes and discrimination and can result in shareholders and managers appointing less female directors than they should based on qualifications (Comi et al., 2020). If firms indeed appointed less female directors than they optimally should, a forced increase in the share of female directors induced by a gender quota would make a firm profit from the undervalued skills and qualifications of female directors and would thereby increase firm performance (Comi et al., 2020). Since it is hard to determine whether or not shareholders and managers hold certain biases, and thus whether or not board composition is optimal, the effect of quotas on the optimality of board composition remains ambiguous.

2.3.2 French gender quota

Several European countries already introduced binding gender quotas. This section discusses the two gender quotas that will be studied in this thesis; the French and Spanish gender quotas. In addition, Table A1 in Appendix A provides an overview of active gender quotas in Europe. Appendix A also contains a review on some of the most studied gender quotas, including the Norwegian, Italian and Belgian gender quotas.

In 2011, France adopted the *Copé-Zimmerman law*, (officially called '*LOI n° 2011-103 du 27 janvier 2011 relative à la représentation équilibrée des femmes et des hommes au sein des conseils d'administration et de surveillance et à l'égalité professionnelle*') which encompasses a binding quota of 40% for both genders on boards (Maghin, 2022). Different from legislation in for example Norway and Italy, the applicability of the French quota law is not limit to listed companies. Instead, the quota applies to all listed companies, and unlisted companies with more than 500 employees and 50 million euro in either total assets or revenue ((République Française Légifrance, 2011). The quota became effective in 2017 (Maghin, 2022).

For listed firms, the Copé-Zimmerman law included an ad-interim quota of 20% that became effective in 2014 (Comi et al., 2020). Non-compliance leads to nullification of elected directors and suspension of director benefits (European Commission, 2012). Maghin (2022) studies how the exogenous change in governance caused by the French quota affects firm performance using a fuzzy difference-in-discontinuities design. Maghin (2022) finds that the increase in women in the board induced by the quota leads to increased firm performance. Specifically, after the quota was enforced, the more gender diverse boards employed less, but more qualified temporary workers, due to which firm's revenues grew (Maghin, 2022).

2.3.3 Spanish gender quota

In 2007 Spain was the first country in the European Union to introduce a gender quota (Comi et al., 2020). '*Law 3/2007 of 22 March 2007 on effective equality between men and women'* encourages firms to have at least 40% representation of each sex in company boards by 2015 (European Commission, 2012). The quota applies to firms that satisfy at least 2 out of 3 conditions; (1) total assets are higher than 11.4 million euros, (2) annual revenue is higher than 22.8 million euros, (3) the number of employees is greater than 250 (Palá-Laguna & Esteban-Salvador, 2016). This quota is non-binding and should be considered a recommendation; there are no sanctions for non-compliance (European Commission, 2012). However, whether or not a firm reaches the set target may be taken into account in the allocation of public contracts (European Commission, 2012) and subsidies (De Cabo et al., 2019). Also, reaching the target is taken into account in the assignment of an 'equality label' (European Commission, 2012). There are not many studies available that examine the effect of the Spanish quota on firm performance. Comi et al. (2020) do study this quota using a difference-in-difference approach, but do not find a statistically significant effect of the quota on firm performance.

2.4 Hypotheses

Based on the literature review, three hypotheses are formed, which this thesis hereafter aims to either accept or reject. Firstly, the hypothesis on the effect of board gender diversity on firm performance will be formed. Studies that researched this effect find conflicting results. This makes it difficult to form a hypothesis based on extant literature. However, based on the human capital theory, resource dependence theory and agency theory, it can be expected that board gender diversity has a positive effect on firm performance;

1. *Board gender diversity has a positive effect on firm performance.*

The second hypothesis concerns the question whether the relationship between board gender diversity and firm performance is linear or non-linear. Based on existing literature on the critical mass theory, it is expected that there exists a U-shaped relationship between board diversity and firm performance; only when a certain critical mass is reached, women can make a difference in the decision-making of the board and therefore fully utilize their aforementioned unique characteristics, skills and perspectives, which would positively affect firm performance according to the human capital theory, resource dependence theory and agency theory.

2. *There exists a non-linear relationship between board gender diversity and firm performance; when board gender diversity is low, the relationship is negative, but when the degree of board gender diversity increases, this relationship turns positive.*

Thirdly, the effect of binding- and non-binding gender quotas on firm performance needs to be hypothesized. Based on the critical mass theory, one would expect a positive effect of binding gender quotas on firm performance, as these quotas force firms to reach the critical mass (quotas are usually at least 30%). However, different theories give different indications on how gender quotas affect firm performance. On the one hand, gender quotas might distort the composition of optimally composed boards and have a negative impact on board characteristics. On the other hand, gender quotas can help firms to overcome prejudices towards women, leading to a more optimal board composition. Moreover, studies on the effect of binding quotas on firm performance provide mixed evidence. However, since the only available study on the French gender quota finds a positive effect on firm performance, it is expected that this thesis also finds the French gender quota to have a positive impact on firm performance. Less studies have been conducted on the effect of non-binding quotas on firm performance. Since non-binding quotas do not lead to forced replacement of directors and have no

sanctions, but do promote board gender diversity, it can be expected that non-binding quotas have a positive impact on firm performance.

3a. Binding gender quotas have a positive effect on firm performance

3b. Non-binding gender quotas have a positive effect on firm performance

3. Data & methodology

This section outlines the data and methodology used to answer the research question of this study. First, the composition of the dataset will be discussed. Next, the variables that will be used in the regressions will be discussed. Thereafter, the descriptive statistics of the main variables are provided. Finally, the econometric model that will be used is outlined.

3.1 Data

This thesis combines board director panel data with financial firm-level panel data. The sample consists of 59,465 observations from 7,294 European firms from 2000 until 2022. The board director data is obtained from Boardex and consists of panel data at the board director's level. The Boardex data is clustered per company and combined with financial data from Refinitiv. Combining the two datasets makes it possible to study the relationship between board gender diversity and firm performance. Finally, data on the listing status of firms was added from the Orbis database. Table B1 in Appendix B gives an overview of the used variables and their sources.

3.2 Dependent variable

In this research, firm performance is the dependent variable. Various measures of firm performance are used in literature. These measures can be categorized into two groups; accounting-based measures and market-based measures (Yang et al., 2019). Accounting-based measures include return on assets, return on equity (Yang et al., 2019) and operating return to assets (Matsa & Miller, 2013). Market-based measures include the market to book ratio and Tobin's Q (Yang et al., 2019). Whereas accounting-based measures reflect the fundamental value, market-based measures reflect investor's perception of the firm's value (Yang et al., 2019). Return on assets is calculated as a firm's net income divided by total assets (Berk & DeMarzo, 2020). Various papers use return on assets as a measure of firm performance, including Joecks et al. (2013), Ahern and Dittmar (2012) and Comi et al. (2020). Tobin's Q is another commonly used measure for firm performance. Tobin's Q is calculated as a firm's market value divided by its replacement value. If the market is in equilibrium, the value of Tobin's Q is equal to 1 (Bodie, Kane & Marcus, 2018). If Tobin's Q is larger than 1, shareholders are optimistic about the firm and its growth opportunities as they believe the firm's value is larger than the book value, while if Tobin's Q is smaller than 1, shareholders are pessimistic as they believe the company is worth less than its book value (Brahma et al., 2021; Terjesen et al., 2016). Tobin's Q is used as a measure of firm performance by, among others, Campbell and Mínguez-Vera (2008), Yang et al. (2019) and Magnanelli et al. (2020). Various studies use both measures, such as Brahma et al. (2021), Terjesen et al. (2016).

This thesis will use Tobin's Q as a measure of firm performance, as this measure reflects investor's perception of firm value. By using Tobin's Q, it can be measured how the market reacts to the appointment of female directors and to gender quota. As a robustness check, Return on Assets will be used as a measure of firm performance.

3.3 Explanatory variable

Board gender diversity will be the explanatory variable in this research of the effect of board diversity on firm performance. The share of female board directors will be used as a proxy for board gender diversity. In order to find whether the relationship between board gender diversity and firm performance is non-linear, a quadratic variable for board gender diversity will be created.

For the study of the effect of gender quotas on firm performance, dummy variables 'Treated' and 'Post quota' will be created. 'Treated' will take a value of one if a firm is affected by the quota and a value

of zero if the firm remains unaffected by the quota. 'Post-quota' takes a value of one for all years after the quota was announced and a value of zero for all years before the announcement. Also, the dummy variables 'Treated' and 'Post quota' will be interacted to study the effect of the quota on firm performance and will serve as the explanatory variable.

In the final part of the study, the dummy variable 'Country' will be introduced. This variable takes a value of one if the country in which a particular firm operates is the country in which the studied quota is in place, i.e. the treated country. It takes a value of zero if the country in which a particular firm operates is not the country in which the studied quota is in place. Firms from this untreated country will form an additional control group besides the control group consisting of untreated firms in the treated country. In addition, several interaction terms will be used in this final part of the research. The variables 'Country', 'Treated' and 'Post-quota' will be interacted to find the effect of the studied gender quota in the triple-difference regression and will serve as the explanatory variable.

3.4 Control variables

Next, several control variables are included to control for external factors which could have an effect on firm performance. Since the used Fixed Effects model already controls for time-invariant factors, only time-variant variables are included into the model as control variables. Based on literature, this thesis will use firm size, board size and leverage as control variables

The first commonly used control variable is firm size, as firm size is likely to affect firm performance. The most used measures of firm size are the number of employees (Torchia et al., 2011), total assets (Carter et al., 2003; Song et al., 2020), and market value of the firm (Brahma et al., 2021). In this thesis, the number of employees will be used as a measure of firm size.

The second used control variable is board size (Yang et al., 2019; Ahern & Dittmar, 2012; Torchia et al., 2011; Liu et al., 2014). The effect of board size on firm performance is ambiguous; some find a positive effect (Brahma et al., 2021), while others find a negative effect (Hermalin & Weisbach, 2001). A negative relationship between board size and firm performance can due to the fact that board size leads to problems in communication and decision making (Guest, 2009). Yermack (1996) studied the relationship between board size and market valuation and finds firms with smaller boards to have a higher firm value. Coles, Daniel and Naveen (2008) find a U-shaped relationship between firm performance and the number of board members, meaning that firm performance is highest for firms with either very small or very large boards.

The third control variable is the leverage/equity ratio, which is the firm's total debt as a percentage of total equity. Leverage affects firm performance in various ways. It affects the firm value through the tax shield effect and financial distress costs (Modigliani & Miller, 1958). Moreover, firms with high leverage might not approve certain projects despite these projects having a positive net present value (Ilyukhin, 2015). Due to these different channels through which leverage affects firm performance, the sign of the relationship is ambiguous; some studies have found leverage to have a negative impact on firm performance (Liu et al., 2014), while others have found a positive relationship (Song et al., 2020; Simionescu, Gherghina, Tawil & Sheikha, 2021).

Year dummies are included in order to control for economic fluctuation. This approach is also used by Joecks et al. (2013) and Ahern and Dittmar (2012).

Finally, there are several variables that are not used directly in the regressions, but that are used to determine whether a firm is subject to a gender quota or not. These are listing status, total assets and revenue. As previously discussed, being subject to the French gender quota depends on listing status,

number of employees, total assets and revenue. Being subject to the Spanish quota depends on the number of employees, total assets and revenue.

3.5 Descriptive statistics on European level

In this section, the descriptive statistics of the variables used in the regressions will be discussed. Before continuing with the analysis, the dependent variables Tobin's Q and Return on Assets will be screened for outliers. Figure B1 in Appendix B shows the density distribution of Tobin's Q and shows a number of large outliers. Similarly, Figure B2 in Appendix B shows the density distribution of Return on Assets. Again, it becomes apparent that there are extreme outliers.

Extant literature usually addresses outliers, albeit using different methods. One method to detect and delete outliers is using Studentized residuals and Cook's distance (Song et al., 2020; Matsa & Miller, 2013). Other studies use logarithms to address outliers (Comi et al., 2020; Magnanelli et al., 2020; Soare et al., 2021). However, since logarithms of negative values are undefined and the dependent variables in this study can take negative values, taking logarithms is not an option. Moreover, winsorizing (Yang et al., 2019; Garcia-Blandon et al., 2022) and truncating (Liu et al., 2014; Comi et al., 2020; Soare et al., 2021) the data at the top and bottom percentiles are two commonly used techniques. Sorting the observations by Tobin's Q and Return on Assets shows that the dataset contains some extreme values for both of these variables. To limit the impact of these observations, the data is truncated at the 1st and 99th percentile for the variables of Tobin's Q and Return on Assets. Most observations from the top and bottom percentile are from British firms and firms that are small in terms of employees, total assets and revenue. In fact, the values for Employees and the financial variables (Leverage/Equity ratio, Total Assets and Revenue) are zero or close to zero for many of these observations. This indicates that the financial data for these observations might be flawed. For this reason, the data is truncated rather than winsorized. Unless stated otherwise, all figures and tables in the remainder of this study will be using the truncated data.

Next, a visual analysis of the main variables will be performed using several figures. Figure B3 and Figure B4 in Appendix B show the density distribution of Tobin's Q and Return on Assets respectively after truncating these variables. The density distribution of Tobin's Q is right skewed, which is unsurprising as Tobin's Q cannot be smaller than zero. The density distribution of Return on Assets is slightly left-skewed. Figure B5 shows a slightly positive trend of Tobin's Q over time, while Figure B6 shows that Return on Assets remains on average around a value of 1.5 over time. Figure B7 displays a stark increase of the share of female board directors over time; this share increases from 5% in 2000 to about 28% in 2022. Finally, Figure B8 shows that Tobin's Q does not seem to depend on board gender diversity, while Figure B9 shows a positive relationship between Return on Assets and board gender diversity. This positive relationship is mainly driven by a low Return on Assets value for boards with a 0% share of female board

Table 1 presents the summary statistics of all relevant variables. Since all observations for which data was lacking for one of the variables were dropped, the number of observations is equal for all variables. The mean value for Tobin's Q is 1.686 and thus higher than one, indicating that on average the market value of firms is greater than the book value. The mean value for the Return on Assets is 1.439%. As this value is larger than zero, the Return on Assets is positive on average. The mean share of female directors in boards is 14.8%. The minimum share of female directors in boards is 0%, while the maximum share of female directors in boards is 80%, meaning there do not exist any boards in this sample that consist of women only. Looking at the control variables, a large variation can be observed in the number of employees and leverage/equity ratio. The number of directors per board in this sample is 8.646 on average and ranges from 1 to 35.

No multicollinearity was detected for the used variables based on the VIF factor. The Breusch–Pagan/Cook–Weisberg test detected heteroskedasticity for all regressions, hence robust standard errors are used in all regressions. Appendix B discusses the correlation among the variables and the mentioned tests in more detail.

Table 1: Descriptive Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
Tobin's Q	59546	1.686	1.222	.476	10.283
Return on Assets	59546	1.439	14.947	-96.6	35.22
Gender diversity	59546	.148	.153	0	.8
Employees	59546	12285.521	39511.829	0	721000
Leverage/Equity	59546	104.545	2596.001	-93200	513966.67
Board size	59546	8.646	4.225	1	35

Table B4 in Appendix B shows the distribution of observations across countries. It becomes apparent that the observations are relatively evenly spread across countries, except for one big outlier; all countries that are part of the United Kingdom together make up 40.34% of all observations. This large share for the United Kingdom can be explained by the nature of the design of Boardex, the database from which the board data was obtained; the observations for companies from the United Kingdom are part of a separate dataset, whereas all other observations for companies from European countries are part of the same dataset.

3.6 Descriptive statistics Gender Quota

Next the descriptive statistics relevant for Model 3 will be discussed. The same variables will be analyzed as in the European-wide analysis of the effect of board gender diversity on firm performance. However, since the samples used for the analysis of the studied gender quotas is different, the descriptive statistics will be discussed again for these samples as well. In Model 3, the analysis will be limited to the countries with the studied gender quota, being France and Spain, and the country used as a control group, being Switzerland. Switzerland was chosen as a control group as this country does not have any form of gender quota. From all countries without gender quota, Switzerland was the most suitable to be used as a control group in studying the French and Spanish gender quota, based on the number of observations in the sample and the socio-economic similarities.

3.6.1 Descriptive statistics French gender quota

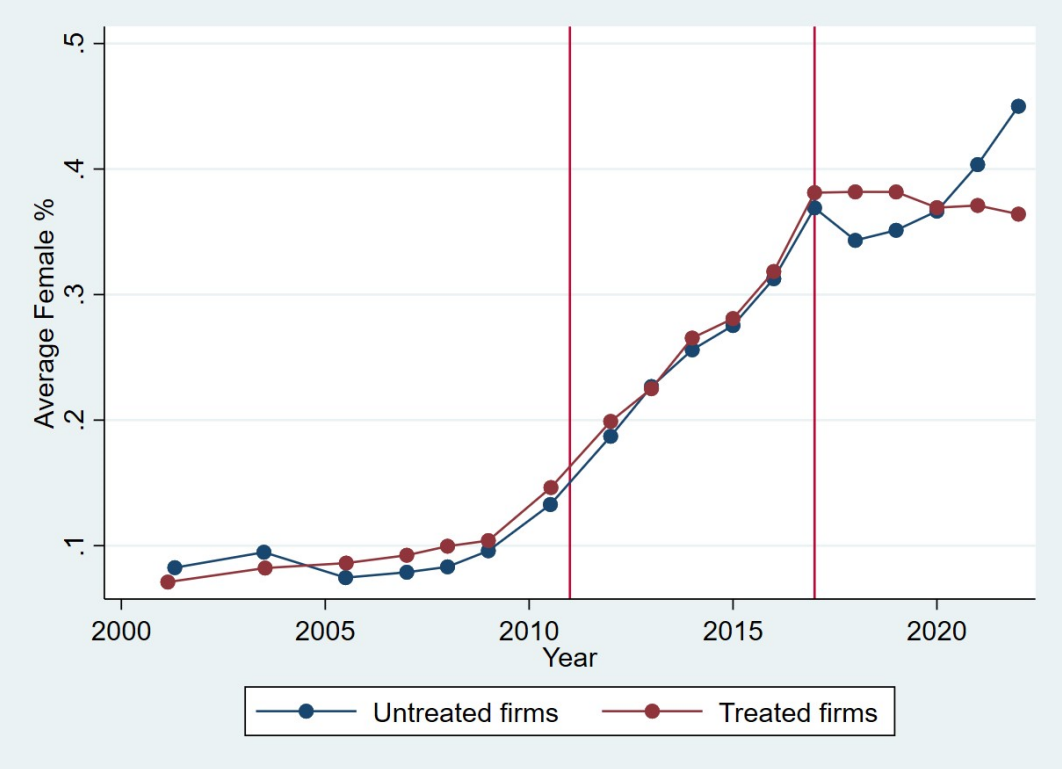
Table 2 shows the descriptive statistics for the sample of French firms, with the top panel displaying the descriptive statistics of the untreated firms that serve as the control group in the first part of the analysis of the French quota, and the bottom panel displaying the descriptive statistics of the treated firms that were affected by the French quota. Table 2 shows that there are 1330 observations for the control group, while there are 4918 observations for the treatment group. This large difference is due to the fact that the French quota applies to a wide range of firms. Whereas the mean value of Tobin's Q is similar between the untreated and treated firms, the mean value of Return on Assets is much larger for the untreated firms. Furthermore, the mean share of female board directors is larger for the treated firms. Figure 1 shows that the trend in the average share of female board directors is similar between the treated and untreated firms. No divergence between the two trends can be observed at the moment of announcement of the law in 2011. It can be seen that from 2017 (the year in which the quota became effective) onwards, the average share of female board directors suddenly stops growing and remains stable for the treated firms, whereas for the untreated firms, the average share of female board directors first decreases but later increases and surpasses the share of female board directors

among treated firms. Figure 2 shows that the development of Tobin's Q over time is similar between treated and untreated firms. No clear change can be observed at the moments the quota was announced or became active.

Table 2: Descriptive statistics: French firms

Untreated firms	N	Mean	SD	Min	Max
Tobin's Q	1330	1.483	.81	.626	8.099
Return on Assets	1330	2.828	9.635	-80.86	34.55
Gender diversity	1330	.174	.152	0	.625
Employees	1330	7498.94	15525.545	0	172400
Leverage/Equity	1330	20.82	2687.768	-93200	17842.86
Board size	1330	9.286	3.676	3	22
Treated firms					
Tobin's Q	4918	1.496	.969	.484	10.262
Return on Assets	4918	1.114	12.655	-94.82	34.8
Gender diversity	4918	.254	.173	0	.8
Employees	4918	28815.657	61765.962	0	495287
Leverage/Equity	4918	108.324	1961.226	-63129.85	108588.51
Board size	4918	10.344	4.413	2	33

Figure 1: Development of the share of female board directors in France



Data source: Boardex. The vertical red lines indicate the years in which the French gender quota was introduced (2011) and became effective (2017)

Figure 2: Development of Tobin's Q in France

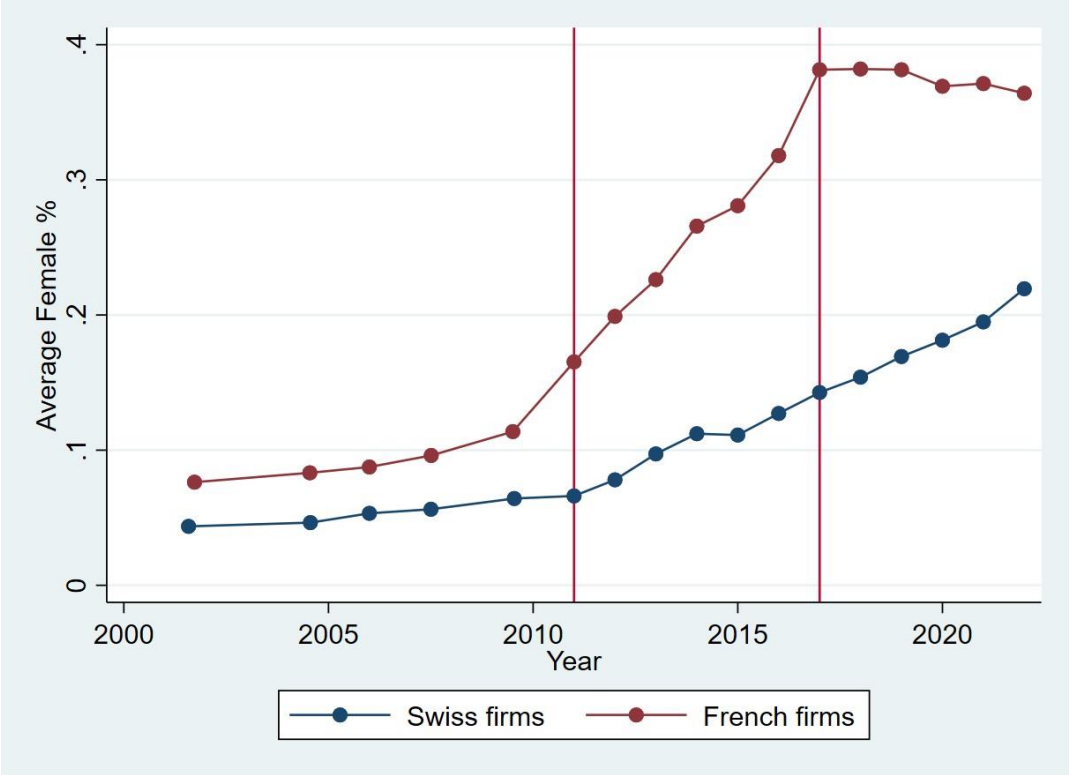
Data source: Refinitiv. The vertical red lines indicate the years in which the French gender quota was introduced (2011) and became effective (2017)

Next, the French firms will be compared to the Swiss firms. In Table 3, the bottom panel shows the descriptive statistics of the French treated firms, while the top panel presents the descriptive statistics of the control group consisting of Swiss firms that would have been treated if they had fallen under the French quota. As we still study the same group of treated firms, the number of observations on treated firms is again 4918. There are 2074 observations for Swiss firms in the control group, which is higher than the number of observations in the control group formed by untreated French firms. The mean value for Tobin's Q is slightly higher among the Swiss firms, while the mean Return on Assets is much higher among Swiss firms. The mean share of female board directors is more than twice as high for the French firms compared to the Swiss firms. Moreover, the mean value of employees, leverage/equity ratio and number of board directors is higher for the French firms. Figure 3 shows that during the studied time period, the average share of board directors has always been higher in France than in Switzerland. It can be observed that from 2011 onwards, the year in which the French gender quota was announced, the share of female board directors grew much harder in France than in Switzerland. As discussed before, this growth in France stopped as soon as the gender quota became active for all targeted firms in 2017. Meanwhile, the growth in Switzerland continues. Figure 4 shows that the average Tobin's Q follows a similar pattern throughout time for the Swiss and French firms, but that the average Tobin's Q is consistently about 0.5 higher for French firms. In Figure 4, no divergence from the pre-quota trend can be observed from the moment the French gender quota was either announced or became active.

Table 3: Summary statistics: Switzerland vs France

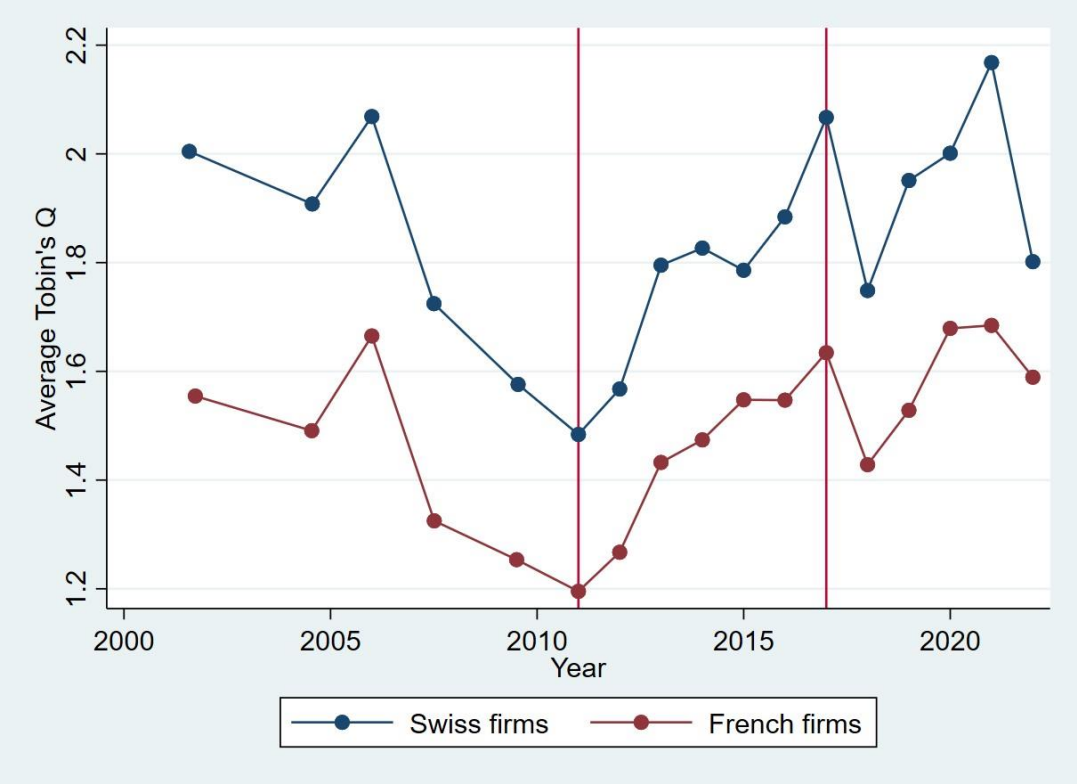
	N	Mean	SD	Min	Max
Swiss firms					
Tobin's Q	2074	1.87	1.325	.512	10.015
Return on Assets	2074	3.988	11.535	-92.53	34.05
Gender diversity	2074	.121	.125	0	.571
Employees	2074	16515.949	37999.18	0	339000
Leverage/Equity	2074	110.73	284.109	-2864.68	3236.14
Board size	2074	7.729	2.826	2	21
French firms					
Tobin's Q	4918	1.496	.969	.484	10.262
Return on Assets	4918	1.114	12.655	-94.82	34.8
Gender diversity	4918	.254	.173	0	.8
Employees	4918	28815.657	61765.962	0	495287
Leverage/Equity	4918	108.324	1961.226	-63129.85	108588.51
Board size	4918	10.344	4.413	2	33

Figure 3: Development of the share of female board directors for treated French and Swiss firms



Data source: Boardex. The vertical red lines indicate the years in which the French gender quota was introduced (2011) and became effective (2017)

Figure 4: Development of Tobin's Q for treated French and Swiss firms



Data source: Refinitiv. The vertical red lines indicate the years in which the French gender quota was introduced (2011) and became effective (2017).

3.6.2 Descriptive statistics Spanish quota

Finally, the Spanish quota will be studied. Table 4 presents the descriptive statistics for Spanish firms, making a distinction between treated and untreated firms. With 464 observations, the treatment group is smaller than the control group with 1397 observations. The mean value of both Tobin's Q and Return on Assets is slightly higher for the untreated firms. The mean share of female board directors is similar for the treated and untreated firms. As the quota targets large firms, it is unsurprising that the mean value of employees, leverage/equity ratio and number of board directors is higher for the treated firms compared to the untreated firms. Figure 5 displays the development of the average share of females in boards for both treated and untreated firms. Prior to the quota the share of female directors is higher among untreated firms than among treated firms. In 2007, the year in which the quota was announced, the shares are level between the treated and untreated firms. Ever since 2008, one year after the announcement of the quota in 2007, the share of female directors has been higher among treated firms. At the moment of the introduction of the quota in 2015, the average share of females in boards is about 20%, which is much lower than the set target of 40%. In the years after 2015, the share of female board directors keeps growing and in 2022 the treated firms on average finally reach the set target of 40%. However, since this is well after the introduction of the quota in 2015, it should be doubted whether this is actually the result of the gender quota. Figure 6 shows the development of Tobin's Q for both treated and untreated firms. Tobin's Q is consistently higher for untreated firms, except for in 2022, which seems to be an outlier in terms of Tobin's Q. No significant changes in Tobin's Q can be observed at the dates of announcement or introduction of the quota.

Table 4: Summary statistics: Spanish firms

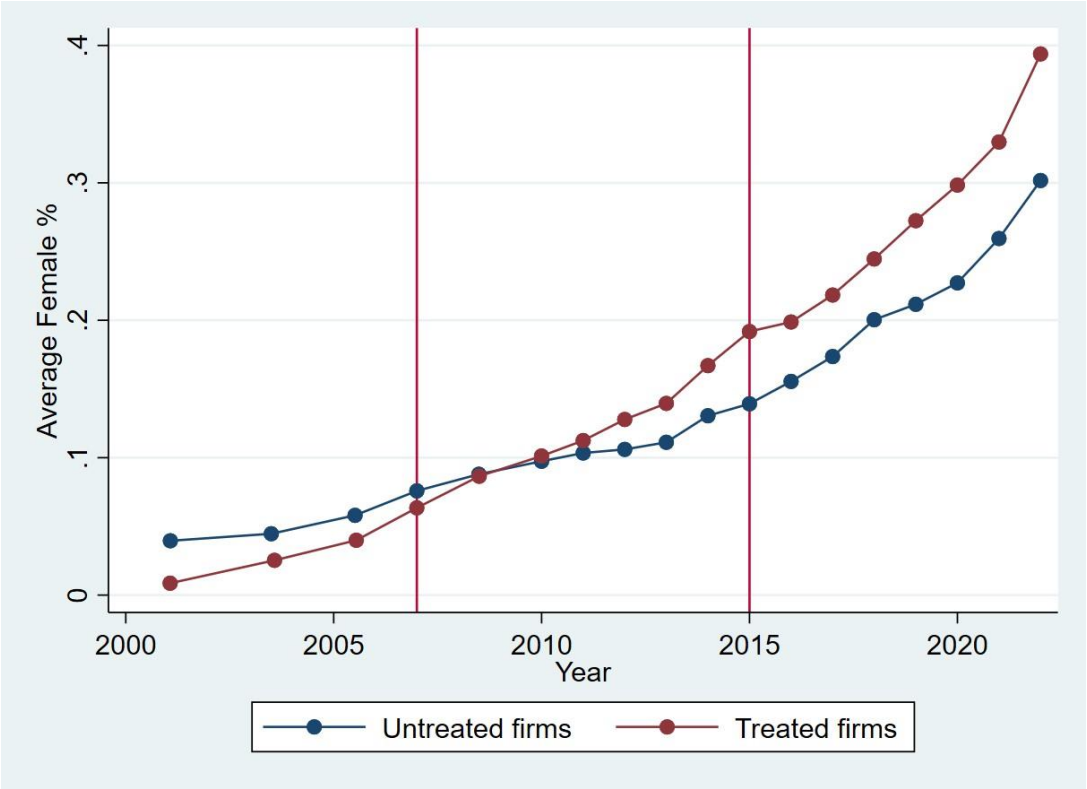
Untreated firms

	N	Mean	SD	Min	Max
Tobin's Q	1397	1.606	1.074	.519	9.912
Return on Assets	1397	3.697	9.243	-68.22	34.91
Gender diversity	1397	.142	.136	0	.667
Employees	1397	7983.055	18365.065	0	170350
Leverage/Equity	1397	62.013	2056.518	-71883.76	12260
Board size	1397	10.211	3.517	3	27

Treated firms

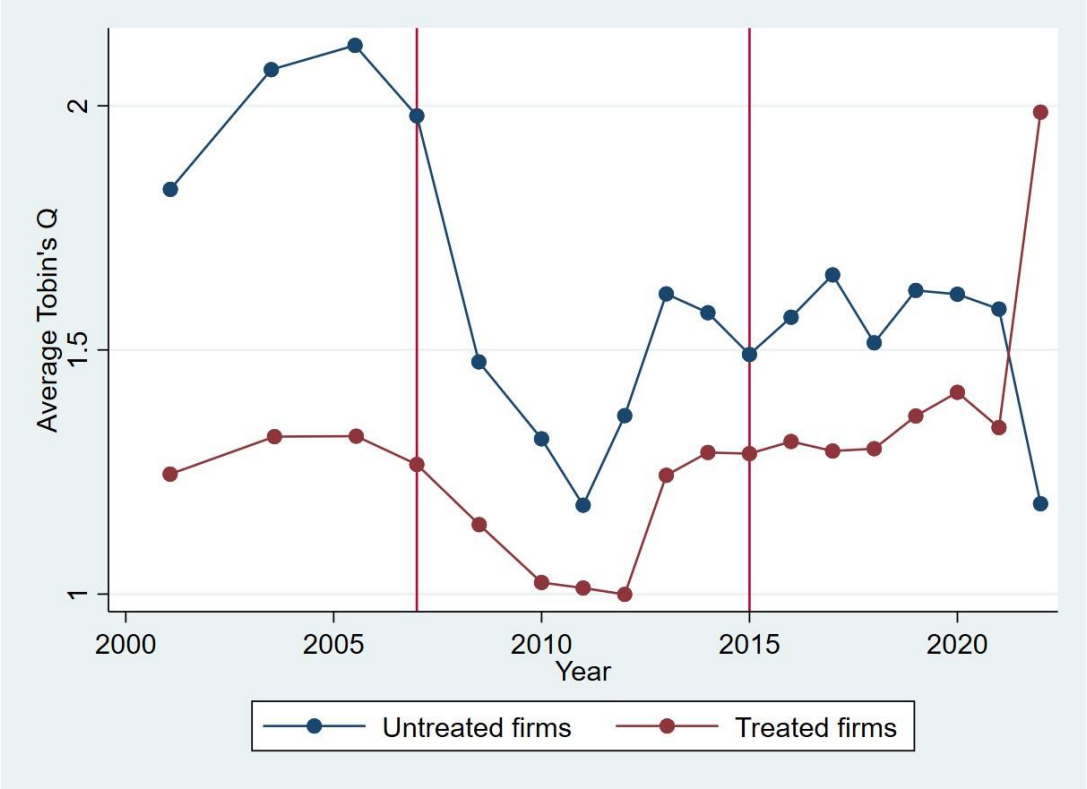
Tobin's Q	464	1.255	.623	.751	5.967
Return on Assets	464	3.258	3.985	-19.59	20.45
Gender diversity	464	.153	.127	0	.5
Employees	464	47679.476	56716.44	327	291027
Leverage/Equity	464	869.095	10400.507	0	223758.54
Board size	464	14.754	3.556	8	32

Figure 5: Development of the share of female board directors in Spain



Data source: Boardex. The vertical red lines indicate the years in which the Spanish gender quota was introduced (2007) and became effective (2015)

Figure 6: Development of Tobin's Q in Spain



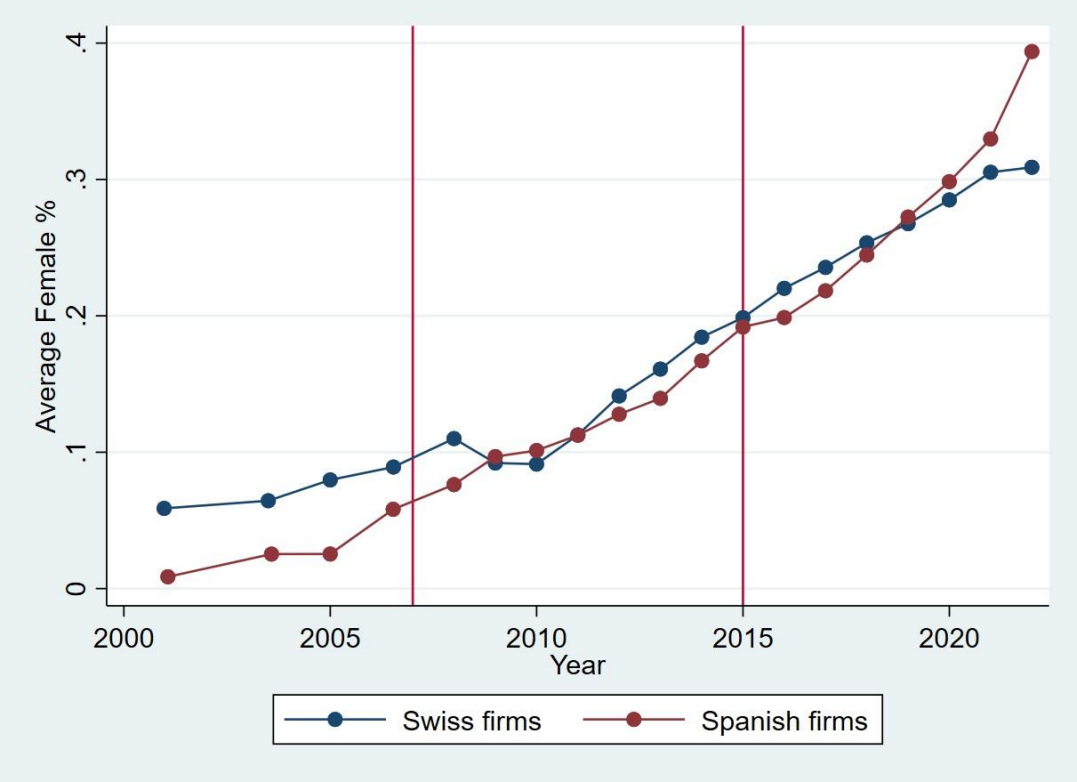
Data source: Refinitiv. The vertical red lines indicate the years in which the Spanish gender quota was introduced (207) and became effective (2015)

Next, the treated Spanish firms will be compared to a control group of Swiss firms. This control group of Swiss firms consists of firms that would have been treated if the Spanish quota had applied to them. Table 5 shows the descriptive statistics for the control group of Swiss firms in the top panel and for the treated Spanish firms in the bottom panel. The control group has 553 observations, while the treated group has 464 observations. The mean value for Tobin's Q, Return on Assets and the share of female board directors is slightly higher for the Swiss firms compared to the Spanish firms. Whereas the mean number of employees is similar between the control and treatment group, the mean leverage/equity ratio and number of directors is much higher among Spanish firms than among Swiss firms. Figure 7 displays the development over time of the average share of female board directors for Spanish and Swiss firms. Prior to 2009 the share of female board directors was higher in Switzerland than in Spain. Since 2009, the share of female board directors has been similar for Spanish and Swiss firms. Figure 8 shows that the trends of Tobin's Q over time are not similar for the treatment and control group. Until 2015 Tobin's Q is higher for Swiss firms than for Spanish firms. After 2015 Tobin's Q is similar between the two groups, until there are some large differences in the final two years.

Table 5: Summary statistics: Switzerland vs Spain

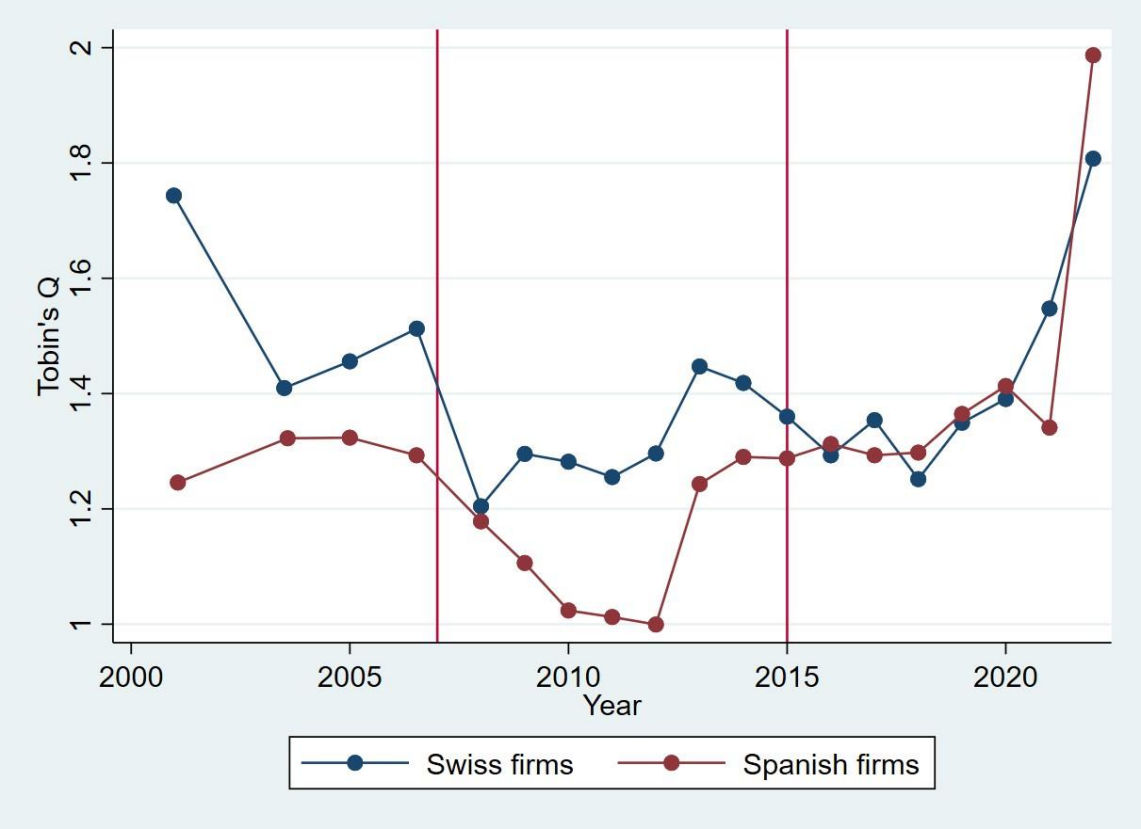
Swiss firms	N	Mean	SD	Min	Max
Tobin's Q	553	1.402	.7	.541	4.464
Return on Assets	553	3.716	5.049	-14.82	31.88
Gender diversity	553	.178	.121	0	.556
Employees	553	45671.083	63575.543	397	339000
Leverage/Equity	553	236.091	344.143	.33	2432.43
Board size	553	10.573	2.795	3	21
Spanish firms					
Tobin's Q	464	1.255	.623	.751	5.967
Return on Assets	464	3.258	3.985	-19.59	20.45
Gender diversity	464	.153	.127	0	.5
Employees	464	47679.476	56716.44	327	291027
Leverage/Equity	464	869.095	10400.507	0	223758.54
Board size	464	14.754	3.556	8	32

Figure 7: Development of the share of female board directors for treated Spanish and Swiss firms



Data source: Boardex. The vertical red lines indicate the years in which the Spanish gender quota was introduced (207) and became effective (2015)

Figure 8: Development of Tobin's Q for treated French and Swiss firms



Data source: Refinitiv. The vertical red lines indicate the years in which the Spanish gender quota was introduced (207) and became effective (2015)

3.7 Econometric model

In this section, the econometric model that will be used to answer the hypotheses will be discussed. Three models will be used, each linking to one hypothesis. All model choices will be elaborated on and descriptions of variables and subscripts will be provided. Model 1 and Model 2 both consist of four regressions; an OLS regression, a Fixed Effects regression, a Fixed Effects regression with an instrumental variable for board gender diversity and a Fixed Effects regression with lagged independent variables. Model 3 consists of two difference-in-difference regressions and one triple-difference regression. This final model is divided into two parts; Model 3a studies the French quota while Model 3b studies the Spanish gender quota.

Model 1: Effect of board gender diversity on firm performance

Using the variables discussed in the previous section, the following OLS regression model will be the first regression used to test the first hypothesis;

$$Tobin's\ Q_{it} = B_0 + B_1 Gender\ diversity_{it} + B_2 Employees_{it} + B_3 Leverage_{it} + B_4 Board\ size_{it} + B_5 year\ dummies_t + \mathcal{E}_{it}$$

In this equation and all following equations, subscript *i* denotes a particular firm and *t* denotes time in years. $\mathcal{E}$ represents the idiosyncratic error term. 'Year dummies' represents the dummies for each year.

Next, the Hausman Test was conducted to determine whether to use a Fixed Effects regression or a Random Effects regression. The null hypothesis is that there is no correlation between the explanatory variables and the error term in the Random Effects model. If the Random Effects model does have

correlation between the explanatory variables and the error term, the coefficients between the Random Effects model and Fixed Effects model would be statistically different. Therefore, if the null hypothesis is rejected, the Fixed Effects model is preferred over the Random Effects model. Conducting the Hausman test produces a chi2 value that is significant at a 1% significance level. Hence the null hypothesis is rejected and the Fixed Effects model is opted for in the second regression. By using a Fixed Effects regression, we control for firm fixed effects, i.e. unobserved time-constant factors, also called unobserved heterogeneity (Wooldridge, 2016) affecting firm performance. Since it controls for all time-invariant factors, all variables that are (close to) constant over time do not need to be included in the regression. For example, sector or country dummies do not need to be included, since they are constant over time and are thus already controlled for in the Fixed Effects regression. Possible endogeneity of board gender diversity due to omitted variable bias is thus addressed by controlling for these unobserved time-constant firm characteristics (Adams & Ferreira, 2009). Including fixed effects into the regression, the following regression will be used;

$$Tobin's\ Q_{it} = B_0 + B_1 Gender\ diversity_{it} + B_2 Employees_{it} + B_3 Leverage_{it} + B_4 Board\ size_{it} + B_5 year\ dummies_t + \mathcal{E}_{it} + a_i$$

Here, *a* represents the firm fixed effects i.e. unobserved heterogeneity. Since these fixed effects do not change over time, *a* only has an *i* subscript and no *t* subscript.

The next step is to take potential endogeneity and reverse causality into account. Endogeneity occurs when an explanatory variable is correlated with the error term (Wooldridge, 2016). This causes the estimates to be biased and not causal, as it is uncertain whether the found effect on the dependent variable is truly caused by the endogenous explanatory variable (Yang et al., 2019). In the study of the effect of board gender diversity on firm performance, endogeneity mainly arises due to omitted variable bias and reverse causality (Adams & Ferreira, 2009; Yang et al., 2019). Omitted variable bias arises when a relevant independent variable is not included in the regression (Wooldridge, 2016). Examples of possible omitted variable bias in this study are that Human Resources policies (Smith, 2014) or focus on Corporate Social Responsibility (Soare et al., 2021) are omitted variables that are related to firm performance as well as gender diversity; firms with good HR policies and focus on CSR might tend to have more gender diverse boards as well as better firm performance. This thesis controls for omitted variable bias by including control variables and, as previously mentioned, by using fixed effects which control for unobserved time-constant firm characteristics. Concerning reverse causality, it might be the case that not only board gender diversity affects firm performance, but that this relationship also goes in the opposite direction. One reason why this might be the case is that it might be costly to replace male directors with female directors from outside their usual predominantly male pool of candidates (Maghin, 2022). Hence, financially better performing firms will be better able to replace male directors with female directors as they have more resources available (Maghin, 2022). Moreover, better firm performance might also be an incentive for women to enter the board of a particular firm (Liu et al., 2014).

Several approaches can be taken to account for endogeneity. One of them is to replace the endogenous variable with an instrumental variable that is related to the endogenous variable but unrelated to the dependent variable. Following Liu et al. (2014) and Song et al. (2020), to control for endogeneity, the sector average of board gender diversity is proposed as an instrumental variable for board gender diversity. The idea is that the sector average of board gender diversity is related to the board gender diversity, but not to firm performance. If board diversity increases in a certain industry, it is likely that this development positively affects the board diversity of a particular firm in this industry (Song et al., 2020.) The Durbin-Wu Hausman test was conducted to test for endogeneity. This test compares the estimates of the Fixed Effects model and the (Fixed Effects) 2 Stage Least Squares (2SLS)

model including the instrumental variable for board gender diversity. If the variable that is suspected to be endogenous is indeed endogenous, the difference between the estimates of the Fixed Effects model and 2SLS model will be statistically significant (Wooldridge, 2016). If the variable turns out to be exogenous, the estimates are similar (Wooldridge, 2016). The null hypothesis of this test is that there is no significant difference between the estimates of the Fixed Effects model and 2SLS model (Wooldridge, 2016). Testing the instrumental variable of sector average of board gender diversity, the results of the Durbin-Wu Hausman test show that the difference between the Fixed Effects and 2SLS estimates is statistically significant at a 1% significance level. Therefore, the null hypothesis is rejected and it is concluded that the variable gender diversity is endogenous. For this reason, this study proceeds with using the Fixed Effects model including the instrumental variable. Next, the strength of the proposed instrument needs to be tested. When the F statistic of this instrumental variable test is larger than 10, the instrumental variable is considered to be strong (Wooldridge, 2016). The F statistic of the conducted strength test is 225.01. Therefore, we conclude the used instrumental variable to be strong and proceed to use it in the Fixed Effects regression. This regression is similar to the previous Fixed Effects regression, but uses sector average board gender diversity to instrument board gender diversity;

$$Tobin's\ Q_{it} = B_0 + B_1 Industry\ average\ Gender\ diversity_{it} + B_2 Employees_{it} + B_3 Leverage_{it} + B_4 Board\ size_{it} + B_5 year\ dummies_t + \mathcal{E}_{it} + a_i$$

The fourth and final regression in this model takes a different approach to address endogeneity. In this regression, all explanatory variables are replaced with their one-year-lagged version. This method is also used by Liu et al. (2014), Kaczmarek, Kimino & Pye (2014) and Joecks et al. (2013) The reasoning behind this method is that female board directors (and the other control variables) need time to make an impact on firm performance. Moreover, while current firm performance might affect gender diversity in the same period, it is unlikely that current firm performance affects gender diversity in the previous period. Using lagged independent variables leads to the following regression;

$$Tobin's\ Q_{it} = B_0 + B_1 Gender\ diversity_{i,t-1} + B_2 Employees_{i,t-1} + B_3 Leverage_{i,t-1} + B_4 Board\ size_{i,t-1} + B_5 year\ dummies_t + \mathcal{E}_{it} + a_i$$

Model 2: Non-linear effect of board gender diversity on firm performance

As discussed in the section about the critical mass theory, there are reasons to believe that the relationship between board diversity and firm performance is non-linear. This led to the formation of Hypothesis 2, which states that when the share of females in boards is low, board diversity has a negative effect on firm performance, but that this effect will turn positive when a certain 'critical mass' is reached. Therefore, Model 2 repeats the regressions from Model 1, but includes a quadratic variable for gender diversity. In these regressions, the effect of gender diversity is calculated by taking *(coefficient of gender diversity + 2 * coefficient of gender diversity squared * the share of females in the board)*. Again, the Hausman test advices to use the Fixed Effects model and robust standard errors are used because of heteroskedasticity. Moreover, the third regression includes an instrumental variable for gender diversity squared, which is the squared sector average of board gender diversity. The Durbin-Wu Hausman test shows that both gender diversity and gender diversity squared are endogenous and that both used instruments are strong (F-statistic of 310.06 for the instrumental variable of squared sector average board gender diversity, 225.01 for the instrumental variable of sector average of board gender diversity). Including a quadratic variable for gender diversity in the model leads to the following regressions;

Regression 1:

$$Tobin's\ Q_{it} = B_0 + B_1 Gender\ diversity_{it} + B_2 Gender\ diversity\ squared_{it} + B_3 Employees_{it} + B_4 Leverage_{it} + B_5 Board\ size_{it} + B_6 year\ dummies_t + \mathcal{E}_{it}$$

Regression 2:

$$Tobin's\ Q_{it} = B_0 + B_1 Gender\ diversity_{it} + B_2 Gender\ diversity\ squared_{it} + B_3 Employees_{it} + B_4 Leverage_{it} + B_5 Board\ size_{it} + B_6 year\ dummies_t + \mathcal{E}_{it} + a_i$$

Regression 3:

$$Tobin's\ Q_{it} = B_0 + B_1 Industry\ average\ Gender\ diversity_{it} + B_2 Industry\ average\ gender\ diversity\ squared_{it} + B_3 Employees_{it} + B_4 Leverage_{it} + B_5 Board\ size_{it} + B_6 year\ dummies_t + \mathcal{E}_{it} + a_i$$

Regression 4:

$$Tobin's\ Q_{it} = B_0 + B_1 Gender\ diversity_{i,t-1} + B_2 Gender\ diversity\ squared_{i,t-1} + B_3 Employees_{i,t-1} + B_4 Leverage_{i,t-1} + B_5 Board\ size_{i,t-1} + B_6 year\ dummies_t + \mathcal{E}_{it} + a_i$$

Model 3: Effect of gender quotas on firm performance

Next, the effect of gender quotas on firm performance will be examined to answer Hypothesis 3. In Model 3, a difference-in-difference (DD) approach, as well as a triple-difference (DDD) approach will be taken to examine the effect of gender quotas on firm performance. The DD and DDD approach exploit a natural experiment in which an exogenous event, such as a policy change, affects a treatment group, but leaves a control group unaffected (Wooldridge, 2016). By making use of the natural experiment occurring due to the exogenous shock, this approach accounts for endogeneity. As became apparent in Section 2, most studies on gender quotas use the difference-in-difference approach to examine the effect of gender quotas on firm performance, including Matsa and Miller (2013), Yang et al. (2019), De Cabo et al. (2019), Comi et al. (2020) and Soare et al. (2021). In this approach, the control group can consist of either untreated firms within the country in which the quota was introduced, or firms from another country that would have been treated if the quota had applied to them. A triple-difference (DDD) approach, also used by Comi et al. (2017) and Matsa and Miller (2013), includes both groups of firms as a control group. This approach is especially useful when the parallel trends assumption is violated in the difference-in-difference approach (Wooldridge, 2016).

The gender quotas that will be studied are the French binding gender quota and the Spanish non-binding gender quota. For each gender quota, 3 regressions will be run; the first regression with untreated firms in the country of the gender quota as a control group; the second regression with Swiss firms that would have been treated had the studied quota applied to them as a control group; the third regression combining both control groups. All regressions are run with fixed effects and robust standard errors based on the Hausman test and detected heteroskedasticity respectively. The first two regressions are difference-in-difference (DD) regressions, the third regression is a triple-difference (DDD) regression.

A difference-in-difference approach compares the difference in the change in Tobin's Q in response to the announcement of the quota between the treatment group and the control group. Regressions 1 and 2 take the following form;

$$Tobin's\ Q_{it} = B_0 + B_1^{DD} Treated\ firms * Post\ quota_{it} + B_2 Treated\ firms_{it} + B_3 Post\ quota_{it} + B_4 Employees_{it} + B_5 Leverage_{it} + B_6 Board\ size_{it} + B_7 year\ dummies_t + \mathcal{E}_{it} + a_i$$

In this regression, 'Treated firms' is a dummy variable taking a value of 1 if a firm is affected by the quota and a value of 0 if it is unaffected by the quota. In the case of the French quota, a firm is treated if it is (1) a listed firm, or (2) an unlisted firm with more than 500 employees and more than 50 million euros of either yearly revenue or total assets. In the case of Spain, a firm is treated if at least 2 out of 3 conditions are met; (1) total assets are higher than 11.4 million euros, (2) annual revenue is higher than 22.8 million euros, (3) number of employees is greater than 250. 'Post quota' is a dummy variable taking a value of 1 if an observation is from a year after the announcement of the quota and taking a value of 0 if an observation is from a year prior to the announcement of the quota. In the case of France, the quota applies from 2011 onwards and in the case of Spain from 2007 onwards. An interaction term between these two dummy variables is included to determine the effect of the quota on firm performance.

A crucial assumption in the difference-in-difference model is the parallel trends assumption. This is the assumption that the dependent variable would trend at the same rate and direction between the control group and the treatment group in the absence of the treatment. Although it is impossible to know what the trend of the treatment group would have been like in the absence of treatment, the pre-treatment trends can be assessed. Firstly, a visual analysis can be conducted by comparing the trends in Tobin's Q of the treated and untreated firms prior to the announcement of the quota. Secondly, it can be tested whether the pre-treatment trends are parallel by performing the following regression;

$$Tobin's\ Q_{it} = B_0 + B_1^{DD} Treated\ firms * Trend_{it} + B_2 Trend_{it} + B_3 Treated_{it} + B_4 Employees_{it} + B_5 Leverage_{it} + B_6 Board\ size_{it} + B_7 year\ dummies_t + \mathcal{E}_{it} + a_i$$

In this regression, 'Trend' is a dummy variable taking a value of 1 if an observation is from a year prior to the announcement of the quota and taking a value of 0 if an observation is from a year after the announcement of the quota. If the coefficient of the interaction term between Treated firms and Trend is insignificant, there is no significant difference between the pre-treatment trends between the treatment group and the control group. If this is the case, it can be concluded that the parallel trends assumption holds.

The third regression, the triple-difference regression, takes the following form;

$$\begin{aligned} Tobin's\ Q_{it} = {} & B_0 + B_1^{DDD} Treated\ firms * Treated\ country \\ & * Post\ quota_{it} + B_2 Treated\ firms * Treated\ country_{it} \\ & + B_3\ Treated\ firms * Post\ quota_{it} + B_4 Treated\ country * Post\ quota_{it} \\ & + B_5 Treated\ firms_{it} + B_6 Treated\ country_{it} + B_7 Post\ quota_{it} \\ & + B_8 Employees_{it} + B_9 Leverage_{it} + B_{10} Board\ size_{it} + B_{11} year\ dummies_t + \mathcal{E}_{it} \\ & + a_i \end{aligned}$$

In this regression, 'Treated firms' is a dummy variable taking a value of 1 if a firm is treated or, in case a firm is from the control country, would have been treated if the quota had applied in the control country and taking a value of 0 if a firm is untreated or would have been untreated if the quota had applied in the control country. 'Treated country' is a dummy variable taking a value of 1 if a firm is from

the country in which the quota is introduced and taking a value of 0 if a firm is not from this country. 'Post quota' is a dummy variable taking a value of 1 if an observation is from a year after the quota was announced and taking a value of 0 if an observation is from a year before the quota was announced. Again, several interaction terms are included. The relevant interaction term is the interaction between Treated firms, Treated country and Post quota, as the coefficient of this interaction term will tell the effect of the quota on firm performance.

Again, it will be tested whether the parallel trends assumption holds by means of the following regression;

$$\begin{aligned} Tobin's\ Q_{it} = {} & B_0 + B_1^{DDD} Treated\ firms * treated\ country \\ & * Trend_{it} + B_2\ Treated\ firms * Trend_{it} + B_3 Treated\ country * Trend_{it} \\ & + B_4 Trend_{it} + B_5 Employees_{it} + B_6 Leverage_{it} \\ & + B_7 Board\ size_{it} + B_8 year\ dummies_t + \mathcal{E}_{it} + a_i \end{aligned}$$

Here, the parallel trends assumption holds if the interaction term between Treated firms, Treated country and Trend is statistically insignificant.

4. Empirical Results

This section displays the regression results of the models outlined in the previous section. Emphasis will be put on the coefficients that are relevant for answering the hypotheses.

Model 1: Effect of board gender diversity on firm performance

Table 6 shows the regression output of all four regressions of Model 1. Column (1) shows the results of the Pooled OLS regression of Tobin's Q on the share of female directors in boards and the control variables, including year dummies. The coefficient of gender diversity is positive but statistically insignificant. Board size does have a statistically significant negative impact on Tobin's Q.

Next, the Hausman Test was conducted to determine whether to use a Fixed Effects regression or a Random Effects regression. As discussed in the previous section, the Fixed Effects regression was opted for based on the results of the Hausman test. The results of the Fixed Effects regression are presented in Column (2) of Table 6. The Fixed Effects regression gives a positive but statistically insignificant coefficient for the variable of gender diversity. In fact, none of the coefficients in the Fixed Effects model are statistically significant, except for the constant.

The third regression uses the instrumental variable approach to control for endogeneity. As discussed in the previous section, endogeneity was detected and controlled for by using the sector average of board gender diversity as an instrumental variable. Column (3) of Table 6 displays the coefficients estimated by the Fixed Effects regression including the instrumental variable. The coefficient of board diversity (instrumented by the sector average board gender diversity) is relatively large compared to the estimates in the previous regressions, and significant at a 1% significance level. The coefficient of 2.705 means that a 1 percentage point increase in the share of females in the board increases Tobin's Q by 0.2705. Also the coefficient for the number of board members is found to be statistically significant at a 5% significance level, having a small, negative effect on Tobin's Q.

The fourth and final regression of Model 1 is the Fixed Effects regression that uses one-year-lagged versions of the independent variables to account for endogeneity. Except for the number of board directors, none of the lagged variables are found to have a significant effect on Tobin's Q, as displayed in Column (4) of Table 6. It should be noted that with this method all observations from the year 2000 were dropped; as 2000 is the first year from which data was available, no values could be taken from the year before as lagged values.

Table 6: Effect of board gender diversity on firm performance (Tobin's Q)

Dep. variable: Tobin's Q	(1) Pooled OLS	(2) FE	(3) FE with IV	(4) FE with lagged indep. variables
Gender diversity	0.0217	0.0923	2.705***	0.0293
	(0.0622)	(0.0684)	(0.429)	(0.0667)
Employees	-0.000000579	-0.000000102	-0.000000265	-8.31e-08
	(0.000000424)	(0.000000465)	(0.000000488)	(0.000000478)
Leverage/Equity	-0.00000139	-0.000000774	-0.000000124	-0.00000206
	(0.00000111)	(0.000000850)	(0.000000846)	(0.00000177)
Board size	-0.0123***	-0.00519	-0.00803**	-0.0102***
	(0.00281)	(0.00356)	(0.00390)	(0.00331)
Constant	2.365***	2.214***	2.190***	1.796***
	(0.0555)	(0.0590)	(0.0605)	(0.0455)
Year dummies	Yes	Yes	Yes	Yes
N	59497	59497	59497	50104
R^2		0.050		0.050
adj. R^2		0.049		0.049

Robust standard errors in parentheses
** p<0.10, ** p<0.05, *** p<0.010*

Model 2: Non-linear effect of board gender diversity on firm performance

Model 2 repeats the regressions of Model 1, but includes a quadratic term of the board gender diversity variable. Table 7 displays the results of all four regressions. In these regressions, the effect of gender diversity is found by calculating *(coefficient of gender diversity + 2 * coefficient of gender diversity squared * the share of females in the board)*. The pooled OLS regression, from which the results can be found in Column (1), finds a positive effect for gender diversity and a negative effect for the squared variable of gender diversity. For both variables, the coefficients are statistically insignificant.

The Fixed Effects regression, from which the results can be found in Column (2), provides no statistically significant coefficients for gender diversity and gender diversity squared. The Fixed Effects regression including IVs does provide statistically significant coefficients gender diversity and gender diversity squared, as can be seen in Column (3). The signs of the coefficients are the same as in the Pooled OLS regression, but the values are much larger. Calculating *(constant + coefficient of gender diversity + 2 * coefficient of gender diversity squared * the share of females in the board)* yields that the share of females in the board has a positive effect on Tobins's Q until the maximum value for Tobin's Q of 3.57 is reached when the share of female board directors is 34.06%. After this share is reached, board gender diversity has a negative effect on firm performance. When the share of females in the board exceeds 68.12%, Tobin's Q will be lower than when there are no women in the board.

Finally, Column (4) displays the results of the Fixed Effects regression using lagged independent variables. Except for the variable of number of board members, which is found to have a small negative effect on Tobin's Q, this regression did not yield any statistically significant results.

Table 7: Effect of board gender diversity on firm performance (Tobin's Q), including quadratic term of gender diversity

Dep. variable: Tobin's Q	(1) Pooled OLS	(2) FE	(3) FE with IV	(4) FE with lagged indep. variables
Gender diversity	0.189	0.167	7.888***	0.0662
	(0.147)	(0.147)	(1.120)	(0.152)
Gender diversity squared	-0.204	-0.172	-11.58***	-0.0872
	(0.281)	(0.282)	(1.974)	(0.316)
Employees	-7.92e-08	-9.94e-08	-0.000000112	-8.17e-08
	(0.000000457)	(0.000000465)	(0.000000549)	(0.000000478)
Leverage/Equity	-0.000000867	-0.000000766	0.000000472	-0.00000206
	(0.000000903)	(0.000000850)	(0.000000869)	(0.00000177)
Board size	-0.00532	-0.00541	-0.0230***	-0.0103***
	(0.00355)	(0.00357)	(0.00502)	(0.00332)
Constant	2.202***	2.215***	2.231***	1.797***
	(0.0586)	(0.0591)	(0.0637)	(0.0456)
Year dummies	Yes	Yes	Yes	Yes
N	59497	59497	59497	50104
R^2		0.050		0.050
adj. R^2		0.049		0.049

Robust standard errors in parentheses
** p<0.10, ** p<0.05, *** p<0.010*

Model 3a: Effect of French gender quota on firm performance

Model 3 tests the effect of the French and Spanish gender quotas on firm performance. For each gender quota, 3 regressions were performed; the first with untreated firms in the country of the gender quota as a control group; the second with firms from Switzerland that would have been treated if they had fallen under the studied quota as a control group; the third combining the two control groups. All regressions are run with fixed effects and robust standard errors based on the Hausman test and detected heteroskedasticity respectively.

Firstly, the results of the regressions of Model 3a studying the gender quota of France will be discussed. The first regression, from which the results are displayed in Column (1) of Table 8, uses French untreated firms as a control group. The coefficient of the interaction term between Treated and Post Quota has a value of 0.169 and is statistically significant at a 5% significance level. This means that Tobin's Q increased by 0.169 for treated firms due to the introduction of the gender quota. This confirms Hypothesis 3a stating that a binding gender quota positively affects firm performance. However, it should be noted that the parallel trends assumption does not hold; the coefficient of the interaction term between Treated and Trend in Table C1 in Appendix C is significant at a 5% significance level. This means that the trend in Tobin's Q prior to the introduction of the quota is not similar between the treated and untreated firms. Therefore, it cannot be assumed that the trend in Tobin's Q would have in similar after 2011 in case the gender quota had not been introduced. However, when

visually assessing the trends in Tobin's Q in Figure 2, the trends do look reasonably similar between the treated and untreated firms.

Since the parallel trends assumption did not hold when using French untreated firms as a control group, a second regression was performed using Swiss firms that would be treated firms if the French gender quota had applied to them as a control group. When using Swiss firms as a control group, the effect of the quota on firm performance is negative but insignificant, as can be seen from the coefficient for the interaction term between Treated and Post Quota in Column (2) in Table 8. Because of collinearity, the Treated variable was omitted from the regression. Table C1 in Appendix C shows the results of the test of the parallel trends assumption. For this regression, the coefficient of the interaction term between Trend and Treated is statistically insignificant, meaning the parallel trends assumption holds. Figure 4 shows parallel trends for Tobin's Q between the French and Swiss firms.

Table 8: Effect of French gender quota on firm performance (Tobin's Q) using a difference-in-differences approach

Dep. variable: Tobin's Q	(1) DD Control group: Untreated French firms	(2) DD Control group: Swiss firms
Treated	0.499*** (0.165)	0 (.)
Post Quota	-0.819*** (0.197)	-0.376** (0.189)
Treated*Post Quota	0.169** (0.0803)	-0.190 (0.123)
Employees	0.000000846 (0.00000104)	0.000000637 (0.00000101)
Leverage/Equity	-0.00000382 (0.00000550)	-0.00000457 (0.00000835)
Board size	-0.00940 (0.00683)	-0.00977 (0.00741)
Constant	1.816*** (0.0873)	2.180*** (0.178)
Year dummies	Yes	Yes
N	6266	7001
R^2	0.082	0.068
adj. R^2	0.078	0.064

Robust standard errors in parentheses
** p<0.10, ** p<0.05, *** p<0.010*

Thirdly, a triple-differences approach was used for the third regression, combining the two control groups from the two previous regressions; untreated French firms and Swiss firms. Table 9 displays the results from the DDD regression. The coefficient of the interaction term between Firms, Country and Quota captures the effect of the French gender quota on firm performance. Following the interpretation of the DDD estimation of Matsa and Miller (2013), this coefficient should be interpreted as the difference in how the difference in Tobin's Q between French treated and French untreated firms changed after the French quota was announced in 2011, compared to how the difference in Tobin's Q between Swiss 'treated' firms and Swiss 'untreated' firms changed after the French quota was announced in 2011. Put differently, the double difference in France is compared to the double difference in Switzerland. The coefficient of this interaction term is 0.160, meaning that the change in the difference in Tobin's Q between treated and untreated firms in France after the quota was announced in 2011 is 0.160 higher than the change in the difference in Tobin's Q between Swiss treated (had they fallen under the French quota) and Swiss untreated firms after the announcement of the quota in France. Table 9 shows that this coefficient is insignificant. Therefore, based on this triple-difference regression, we cannot conclude that the quota has a statistically significant impact on Tobin's Q. Table C2 in Appendix C shows that the parallel trends assumption does hold for the DDD estimation.

In summary, only the DD estimation using French untreated firms as a control group finds a statistically significant effect of the French gender quota on firm performance, namely a positive effect. Therefore, based on this first DD estimation, Hypothesis 3a stating the expectation that binding gender quotas positively affect firm performance is confirmed.

Table 9: Effect of French gender quota on firm performance (Tobin's Q) using a triple-difference approach

Dep variable: Tobin's Q	(1) DDD Control group: Both French untreated firms and Swiss firms
Firms*Country*Quota	0.160
	(0.234)
Firms*Country	-0.0472
	(0.300)
Firms*Quota	0.00554
	(0.217)
Country*Quota	-0.353*
	(0.201)
Firms	-0.135
	(0.183)
Country	0
	(.)
Quota	-0.390*
	(0.226)
Employees	0.000000818
	(0.000000987)
Leverage/Equity	-0.00000383
	(0.00000521)
Board size	-0.0145**
	(0.00690)
Constant	2.406***
	(0.198)
Year dummies	Yes
N	9047
R^2	0.080
adj. R^2	0.077

Robust standard errors in parentheses
** p<0.10, ** p<0.05, *** p<0.010*

Model 3b: Effect of Spanish gender quota on firm performance

Secondly, the results of Model 3b studying the Spanish board gender quota will be discussed. Table 10 shows the estimations of the DD regression. Column (1) displays the results of the regression using untreated Spanish firms as a control group and presents a positive coefficient that is statistically significant at a 10% significance level for the interaction term between Treated and Post Quota, indicating a positive effect of the Spanish gender quota on firm performance. Column (2) shows the results of the regression using Swiss 'treated' firms as a control group, not showing a statistically significant effect of the gender quota on Tobin's Q. In this regression, the variable Treated was omitted because of collinearity. Table C3 in Appendix C shows that the parallel trends test does not hold for the first regression, but does hold for the second regression. This finding slightly contradicts the visual analysis of pre-treatment parallel trends; Figure 6 shows somewhat similar trends between Spanish treated and untreated firms, while Figure 8 shows dissimilar trends for Swiss and Spanish firms.

Table 10: Effect of Spanish gender quota on firm performance (Tobin's Q) using a difference-in-differences approach

	(1)	(2)
Dep. variable: Tobin's Q	DD	DD
	Control group: untreated Spanish firms	Control group: Swiss firms
Treated	-0.179**	0
	(0.0857)	(.)
Post Quota	-0.536**	-0.358
	(0.232)	(0.250)
Treated*Post Quota	0.191*	-0.117
	(0.107)	(0.124)
Employees	0.000000498	-0.00000106
	(0.00000120)	(0.00000193)
Leverage/Equity	-9.96e-09	2.62e-08
	(0.000000322)	(0.000000143)
Board size	-0.00859	-0.0109
	(0.00799)	(0.00857)
Constant	1.905***	1.840***
	(0.205)	(0.272)
Year dummies	Yes	Yes
N	1861	1017
R^2	0.113	0.081
adj. R^2	0.100	0.056

Robust standard errors in parentheses
** p<0.10, ** p<0.05, *** p<0.010*

Finally, the DDD regression was run combining both control groups; untreated firms within Spain and firms in Switzerland. Table 11 displays the results of this regression, showing no statistically significant effect of the gender quota on Tobin's Q as the coefficient of the interaction term between Firms, Country and Quota is statistically insignificant. Table C4 in Appendix C shows that the parallel trends assumption holds for the DDD regression.

Table 11: Effect of Spanish gender quota on firm performance (Tobin's Q) using a triple-difference approach

	(1)
Dep variable: Tobin's Q	DDD Control group: Both Spanish untreated firms and Swiss firms
Firms*Country*Quota	0.142 (0.248)
Firms*Country	-0.219 (0.227)
Firms*Quota	0.0102 (0.224)
Country*Quota	-0.191 (0.199)
Firms	0.0268 (0.209)
Country	0 (.)
Quota	-0.223 (0.228)
Employees	0.000000776 (0.00000148)
Leverage/Equity	0.000000341 (0.000000302)
Board size	-0.0133 (0.00981)
Constant	2.143*** (0.199)
Year dummies	Yes
N	4460
R^2	0.077
adj. R^2	0.071

Robust standard errors in parentheses
** p<0.10, ** p<0.05, *** p<0.010*

In summary, only the DD approach using Spanish untreated firms as a control group finds a statistically significant effect of the Spanish gender quota on Tobin's Q, namely a positive effect. For this regression, the parallel trends assumption holds al well. For the other DD regression using Swiss firms as a control group and the DDD regression using both Spanish untreated firms and Swiss firms as a control group, the effect of the quota on Tobin's Q was found to be statistically insignificant. Therefore, based on the results of the first DD regression Hypothesis 3b stating that non-binding gender quotas have a positive effect on firm performance is confirmed.

Comparing the findings of Model 3a to the findings of Model 3b, it becomes apparent that both binding- and non-binding quotas have a positive effect on firm performance, but that this effect is slightly larger for non-binding quotas. However, it should be noted that the Spanish quota was introduced four years earlier than the French quota, making it harder to draw a comparison between the results of these two quotas.

5. Robustness check

As a robustness check, all regressions were repeated using Return on Assets instead of Tobin's Q as a measure of firm performance. For Model 1, only the Fixed Effects regression and the Fixed Effects regression with the instrumental variable yield statistically significant results for the variable of gender diversity; for both of these regressions, the coefficient for gender diversity is negative and statistically significant at a 1% significance level, as can be seen in Table 12. These results are inconsistent with the results of the regressions using Tobin's Q as a measure of firm performance. Also, the effect of gender diversity on Return on Assets is much stronger than on Tobin's Q. This can be explained by the fact that the variation in Return on Assets is larger than in Tobin's Q, as can be seen from Table 1.

Table 12: Effect of board gender diversity on firm performance (Return on Assets)

	(1)	(2)	(3)	(4)
Dep. variable: Return on Assets	Pooled OLS	FE	FE with IV	FE with lagged indep. variables
Gender diversity	0.594	-1.555**	-13.40***	-0.968
	(0.701)	(0.777)	(5.176)	(0.838)
Employees	0.00000227	-0.00000765**	-0.00000681**	-0.0000117***
	(0.00000231)	(0.00000312)	(0.00000324)	(0.00000346)
Leverage/Equity	0.00000166	-0.00000201	-0.00000484	0.0000348
	(0.0000214)	(0.0000227)	(0.0000227)	(0.0000462)
Board size	0.208***	-0.00744	0.00482	-0.184***
	(0.0277)	(0.0362)	(0.0370)	(0.0365)
Constant	-1.231***	3.017***	3.132***	3.077***
	(0.442)	(0.446)	(0.449)	(0.493)
Year dummies	Yes	Yes	Yes	Yes
N	59465	59465	59465	50055
R^2		0.018		0.020
adj. R^2		0.018		0.020

Robust standard errors in parentheses
** p<0.10, ** p<0.05, *** p<0.010*

For Model 2, which includes the quadratic term of gender diversity, the results are similar to the results of the regressions using Tobin's Q as the dependent variable; gender diversity has a positive but diminishing effect on firm performance. Table 13 shows that the Pooled OLS regression and the Fixed Effects regression with Instrumental Variables yield statistically significant results for both gender diversity and the quadratic term of gender diversity. Again, the magnitude of the coefficients is much larger than in the regressions using Tobin's Q as the dependent variable.

Table 13: Effect of board gender diversity on firm performance (Return on Assets), including quadratic term of gender diversity

Dep. variable: Return on Assets	(1) Pooled OLS	(2) FE	(3) FE with IV	(4) FE with lagged indep. variables
Board diversity	4.486***	0.925	20.06*	0.196
	(1.478)	(1.568)	(11.14)	(1.589)
Board diversity squared	-8.969***	-5.731**	-74.70***	-2.757
	(2.782)	(2.904)	(20.35)	(2.928)
Employees	0.00000237	-0.00000758**	-0.00000593	-0.0000117***
	(0.00000234)	(0.00000314)	(0.00000374)	(0.00000346)
Leverage/Equity	0.00000208	-0.00000173	-0.000000965	0.0000349
	(0.0000214)	(0.0000227)	(0.0000227)	(0.0000462)
Board size	0.197***	-0.0147	-0.0910**	-0.187***
	(0.0278)	(0.0363)	(0.0462)	(0.0366)
Constant	-1.199***	3.036***	3.375***	3.085***
	(0.442)	(0.446)	(0.462)	(0.494)
Year dummies	Yes	Yes	Yes	Yes
N	59465	59465	59465	50055
R^2		0.018		0.020
adj. R^2		0.018		0.020

Robust standard errors in parentheses
** p<0.10, ** p<0.05, *** p<0.010*

For Model 3a testing the effect of the French gender quota on firm performance, the results are slightly different when using Return on Assets as a measure of firm performance compared to when using Tobin's Q. Table 14 shows that when using Return on Assets as the dependent variable, the effect of the quota is found to be positive but insignificant for both regressions. This is different from the results of the regressions using Tobin's Q as the dependent variable, in which the first regression yields a statistically significant positive effect of the gender quota, and the second regression a negative but insignificant result. Table D1 in Appendix D shows that the parallel trends assumption holds for both regressions when using Return on Assets as the dependent variable.

Table 15 shows the results of the DDD regression, finding a positive yet statistically insignificant effect of the quota on firm performance. This is consistent with the findings of the same regression using Tobin's Q as a measure of firm performance. Table D2 in Appendix D shows that the parallel trends assumption holds.

Table 14: Effect of French gender quota on firm performance (Return on Assets) using a difference-in-differences approach

	(1)	(2)
Dep. variable:	DD	DD
Return on Assets	Control group: Untreated French firms	Control group: Swiss firms
Treated	-1.393***	0
	(0.419)	(.)
Post Quota	-3.356**	-2.240**
	(1.597)	(1.005)
Treated*Post Quota	1.278	0.716
	(0.872)	(0.627)
Employees	-0.00000361	-0.00000418
	(0.00000847)	(0.00000802)
Leverage/Equity	0.0000434	0.0000808
	(0.0000941)	(0.000113)
Board size	-0.0732	-0.0901
	(0.0597)	(0.0591)
Constant	5.089***	4.513***
	(0.640)	(0.765)
Year dummies	Yes	Yes
N	6270	7010
R^2	0.036	0.035
adj. R^2	0.032	0.031

Robust standard errors in parentheses
** p<0.10, ** p<0.05, *** p<0.010*

Table 15: Effect of French gender quota on firm performance (Return on Assets) using a triple-differences approach

Dep variable: Return on Assets	(1) DDD Control group: both French untreated firms and Swiss firms
Firms*Country* Quota	1.577 (1.613)
Firms*Country	0.808 (1.336)
Firms*Quota	0.0572 (1.386)
Country*Quota	-0.865 (1.496)
Firms	-1.518 (1.241)
Country	0 (.)
Quota	-1.918 (1.527)
Employees	-0.00000364 (0.00000777)
Leverage/Equity	0.0000196 (0.0000970)
Board size	-0.0671 (0.0530)
Constant	5.114*** (0.779)
Year dummies	Yes
N	9043
R^2	0.038
adj. R^2	0.035

Robust standard errors in parentheses
** p<0.10, ** p<0.05, *** p<0.010*

Repeating Model 3b with Return on Assets as the dependent variable, the found effect on firm performance in the difference-in-difference approach is the same as when using Tobin's Q as the measure for firm performance; when using Spanish untreated firms as the control group the effect is positive, while when using Swiss firms as the control group, the effect is negative. Table 16 shows that this effect is statistically significant for both regressions. When using Tobin's Q as the dependent variable, only the first regression found the quota to have a significant effect on firm performance. Table D3 in Appendix D shows that the parallel trends assumption does not hold for both regressions when using Return on Assets as the dependent variable.

For the DDD model, Table 17 shows that the effect of the quota is positive yet insignificant, which was also the case when using Tobin's Q as a measure of firm performance. The parallel trends assumption does hold for the DDD model, as shown in Table D4 in Appendix D.

Table 16: Effect of Spanish gender quota on firm performance (Return on Assets) using a difference-in-differences approach

	(1)	(2)
Dep. variable: Return on Assets	DD Control group: untreated Spanish firms	DD Control group: Swiss firms
Treated	-2.360**	0
	(0.911)	(.)
Post Quota	-5.204***	-1.451
	(1.461)	(1.079)
Treated*Post Quota	2.978***	-1.831**
	(1.094)	(0.879)
Employees	0.0000153**	0.00000655
	(0.00000649)	(0.0000108)
Leverage/Equity	-0.0000289***	-0.0000418***
	(0.00000546)	(0.00000419)
Board size	0.116	-0.0536
	(0.127)	(0.0562)
Constant	5.901***	5.741***
	(1.614)	(1.128)
Year dummies	Yes	Yes
N	1857	1015
R^2	0.076	0.125
adj. R^2	0.063	0.102

Robust standard errors in parentheses
** p<0.10, ** p<0.05, *** p<0.010*

Table 17: Effect of Spanish gender quota on firm performance (Return on Assets) using a triple-differences approach

	(1)
Dep variable:	DDD
Return on Assets	Control group: both Spanish untreated firms and Swiss firms
Firms*Country*Quota	1.547
	(1.530)
Firms*Country	-2.713*
	(1.504)
Firms*Quota	1.404
	(1.082)
Country*Quota	-2.831**
	(1.229)
Firms	0.279
	(1.183)
Country	0
	(.)
Quota	-1.793*
	(1.040)
Employees	0.00000880
	(0.00000811)
Leverage/Equity	-0.0000370***
	(0.00000647)
Board size	0.0569
	(0.0923)
Constant	5.409***
	(1.089)
Year dummies	Yes
N	4446
R^2	0.055
adj. R^2	0.049

Robust standard errors in parentheses
** p<0.10, ** p<0.05, *** p<0.010*

6. Conclusion

In conclusion, this thesis studied the effect of board gender diversity and gender quotas on firm performance in Europe. Extant literature is inconclusive about the effect of gender diversity on firm performance, with some studies finding a positive effect, while other studies finding a negative effect or no effect. While existing literature usually studies one particular country or industry, this thesis studied a large sample consisting of data on European firms from a large variety of industries, thereby providing new evidence on the effect of gender diversity on firm performance. In order to examine this effect, an OLS regression and Fixed Effects regression were conducted. An instrumental variable approach and lagged variable approach were used to control for endogeneity and reverse causality. The results of this the Fixed Effects model with the sector average of board gender diversity as an instrument for board gender diversity indicate a positive effect of board gender diversity on firm performance. Following the human capital theory, resource dependence theory and agency theory, this positive effect might be the result of increased heterogeneity of human capital, broader perspectives and reduced agency costs. The found result is in line with the first hypothesis. Also, this finding is in line with the findings of among others Liu et al. (2014), Song et al. (2020), Brahma et al. (2021), Campbell and Mínguez-Vera (2008) and Carter et al. (2003).

Furthermore, this study contributes to the scarce literature on the non-linear effect of gender diversity on firm performance. A positive but diminishing effect of board gender diversity on firm performance was found when including a quadratic term for gender diversity into the Fixed Effects regression with instrumental variables. This finding is contradictory to the second hypothesis and the critical mass theory, which predict a negative but increasing effect. Also it contradicts the findings of Joecks et al. (2013), who found a U-shaped relationship between gender diversity and firm performance.

Finally, the effect of gender quotas on firm performance was examined by means of difference-in-difference models and triple-difference models. Whereas most previous studies examine only one particular quota, this study examined and compared the effect of the binding French binding quota and the Spanish non-binding quota on firm performance. To the best of this thesis' knowledge, this study is the first to examine to what extent the effect of gender quotas on firm performance differs between binding- and non-binding quotas. For both studied quotas, only the difference-in-difference regression using untreated domestic firms as a control group finds the quotas to have a statistically significant effect on firm performance. For both quotas, this effect was found to be positive. This confirms the second hypothesis of this thesis. Also, the found positive effect of the French gender quota is in line with the findings of Maghin (2022). The difference-in-difference regressions using Swiss firms as a control group, as well as the triple-difference regressions, did not yield statistically significant results. Comparing the found effects of both quotas on firm performance, it can be concluded that non-binding gender quotas have a slightly larger positive effect on firm performance than binding gender quotas. As mentioned by Ahern and Dittmar (2012) and Terjesen et al. (2015), forced replacement of board directors might distort the optimal composition of the board. Since forced replacement only occurs in the case of binding gender quotas, this might explain why the positive effect on firm performance is slightly higher for the studied non-binding quota than for the binding quota.

In all, the research question of this thesis, being "*What is the effect of board gender diversity and gender quotas on firm performance?"* can be answered with that board gender diversity and both binding- and non-binding gender quotas have a positive effect on firm performance. Therefore, increasing board gender diversity is not only desirable because of moral and equity reasons, but also because of financial reasons. Moreover, gender quotas have a positive effect on firm performance and do not seem to distort the positive effect of gender diversity on firm performance. Based on the

studied gender quotas, a non-binding quota should be slightly preferred over a binding quota when solely regarding firm performance.

There are a number of limitations to this research. The first limitation concerns the used sample; with over 40% of all observations the United Kingdom is overrepresented in the sample. Furthermore, the robustness check using Return on Assets as a measure of firm performance does not fully corroborate the findings of the regressions using Tobin's Q as a measure of firm performance. Moreover, the parallel trends assumption does not hold for all difference-in-difference regressions and triple-difference regressions. This makes it uncertain whether the effects found in these regressions truly represent the effects of the quota or whether these results are partly driven by trend differences between the treatment group and the control group. One final limitation concerns the comparability of the studied gender quotas. This thesis studies the French and Spanish gender quota to be able to compare how the effect on firm performance differs between binding- and non-binding gender quotas. However, it should be noted that the Spanish quota was introduced four years earlier than the French quota, making it harder to draw a comparison between the results of these two quotas.

Several recommendations can be made for future research. First of all, this thesis makes suggestions about what factors cause board gender diversity to have a positive effect on firm performance, such as increased heterogeneity of human capital, increased linkages to external resources and reduced agency costs. Future research could focus on the exact channels through which board gender diversity affects firm performance. Similarly, it can be further examined why the positive effect of gender diversity on firm performance turns negative as gender diversity increases. Furthermore, this thesis aimed to compare the effect on firm performance between binding gender quotas and non-binding gender quotas. One binding gender quota and one non-binding gender quota were studied to be able to make this comparison. However, it should be noted that the findings of the studied cases of binding- and non-binding quotas do not necessarily extrapolate to every case of binding- and non-binding gender quotas. To get a better idea of whether the findings of the cases studied in this thesis are representative to binding- and non-binding gender quotas in general, further research could study additional cases of gender quotas.

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8. Appendix

8.1 Appendix A: Gender quotas

Table A1: Overview of gender quotas in Europe

Country	Type of quota	Applicable to which firms	Sanctions	References	Legislation	%	Passage date	Compliance date	Notes
Norway	Binding	Public limited and SOEs	Fines in case of non-compliance under special circumstances, dissolvement of firm in case of continued non-compliance	Comi et al., 2017	Norwegian Gender Balance Law	40%	2003	2006	
Spain	Non-binding	Firms that satisfy at least 2 out of 3 conditions; (1) (1) total assets higher than 11.4 million euros, (2) annual revenue higher than 22.8 million euros, (3) number of employees greater than 250	No	Comi et al., 2020; European Commission, 2012; Palá-Laguna & Esteban-Salvador, 2016	Law 3/2007 of 22 March 2007 on effective equality between men and women	40%	March 2007	2015	Gender diversity taken into account for provision of public subsidies and state contracts by state
France	Binding	Publicly listed and unlisted companies with 500+ employees and 50 million+ Euros revenue or total assets per year over previous three years	Suspension of director benefits, annulment of nominations	Comi et al., 2020; European Commission, 2012; République Française Légifrance, 2011	Copé-Zimmerman law (LOI n° 2011-103 du 27 janvier 2011 relative à la représentation équilibrée des femmes et des hommes au sein des conseils d'administration et de surveillance et à l'égalité professionnelle)	40% (20% ad interim quota of 20% from 2014 onwards for listed firms)	January 2011	2017	

Belgium	Binding	Publicly listed and SOEs	In case of non-compliance, any new director has to be of the minority gender. After 1 year all board member compensation and benefits are lost	Comi et al., 2017; European Commission, 2012	Act of 28 July 2011 (Quota Law)	33%	September 2011	2017 for publicly listed firms, 2012 for state owned enterprises, 2019 for small listed firms	
Germany	Non-binding	Top 100 publicly traded companies	NO	Comi et al., 2017	Act on Equal Participation of Women and Men regarding Leadership Positions within the Sectors of Private Economy and Public Service	30% until 2018, 50% since 2018	March 2015	January 2016	If quota is not met, firms are required to either appoint women for vacant positions, or leave them empty
Italy	Binding	Publicly listed and SOEs	Fines after 4 months of non-compliance, annulment of board after 7 months of non-compliance	Comi et al., 2020 ; Pastore, 2019 ; Magnanelli et al., 2020 ; European Commission, 2012	*Italian Legislative Decree n. 120/2011*, i.e. Golfo-Mosca law	33% (20% ad interim quota from April 2013 until 2015)	June 2011	2015	Expires in 2022
Nether-lands	Non-binding	Large private and public limited companies (€17.5 million+ assets, net turnover €35 million+ and 250+ employees)	No	European Commission, 2012	Civil Code	30%	May 2011	2016	Explanation of non-compliance required in annual report
Iceland	Non-binding	Publicly traded firms + SOEs, both with 50+ employees	No	Terjesen, Aguilera & Lorenz, 2015	Amendment to Act No. 13/2010 and No. 2/1995	40%	March 2010	September 2013	

Review of most studied European gender quotas

Norway

As Norway was the first country to implement a binding gender quota, the Norwegian gender quota is a popular study case. Norway introduced a binding gender quota for all publicly listed firms, requiring these firms to reach a share of 40% women directors within two years (Matsa & Miller, 2013). Using a difference-in-differences approach, Yang et al. (2019) find the Norwegian gender quota to have a negative impact on firm risk, return on assets and Tobin's Q. However, Yang et al. (2019) do note that it is ambiguous whether the reduced firm risk is beneficial to the firm performance in the long run. Because of this, they conclude that from an economic perspective, the causal effect of the gender quota remains ambiguous.

Ahern an Dittmar (2012) also study the Norwegian case and find a negative effect of the quota on firm performance. At impact of the announcement of the quota they find the quota to cause a significant drop in stock prices. In the long run, they find a decline in Tobin's Q. The paper notes that this result is in line with the idea that boards are chosen in such a way that shareholder value is maximized and that quotas disturb this optimal board composition if firms are forced to change their board composition by including more women (Ahern & Dittmar, 2012). Matsa and Miller (2013) also studied the Norwegian gender quota by comparing Norwegian firms that were affected by the quota to Nordic firms that were not affected. They find that the introduction of the Norwegian quota caused an increase in labor costs, resulting short-run corporate profitability to decline (Matsa & Miller, 2013). Bøhren and Staubo (2016) also find a negative impact of the quota on firm performance and ascribe this to the fact that the quota greatly increased the share of independent directors. Bøhren and Staubo (2016) note that board independence on the one hand increases value through increased monitoring (as predicted by the agency theory) but on the other hand decreases value as it reduces the advice given by dependent inside directors. Bøhren and Staubo (2016) conclude that the shock to board independence caused by the quota distorts this tradeoff, resulting in a negative impact on firm performance.

Italy

In 2012, Italy introduced the *Italian Legislative Decree n. 120/2011*, which states that from 2015 onwards 33% of the board directors needs to be female (Magnanelli, Nasta & Raoili, 2020). The quota was introduced gradually; from August 2012 onwards, 20% of the board had to consist of the underrepresented gender (Pastore, 2019). The law applies to public companies since August 2012 and to state-owned enterprises since February 2013 (Pastore, 2019).

Magnanelli et al. (2020) studied the Italian market's response to the gender quota using a dummy variable approach and difference-in-difference approach with random effects and find empirical evidence that the quota had a positive impact on firm performance, especially for family-owned companies. Comi et al. (2020) find that board gender quota in Italy had a positive effect on productivity, but do not find a significant effect on firm performance. Ferrari, Ferraro, Profeta and Pronzato (2016) conduct an event study and find that the quota positively affected the stock market.

Belgium

In 2011, Belgium introduced the '*Act of 28 July 2011*' which states that firm's boards needs to consist of at least 33% of both genders (European Commission, 2012). State owned enterprises had to comply from 2012 onwards, large listed companies from 2017 onwards and all other listed firms from 2019 onwards (European Commission, 2012). In case of non-compliance, any new director has to be of the

minority gender (Comi et al., 2020). After 1 year of non-compliance all board member compensation and benefits are lost (Comi et al., 2020).

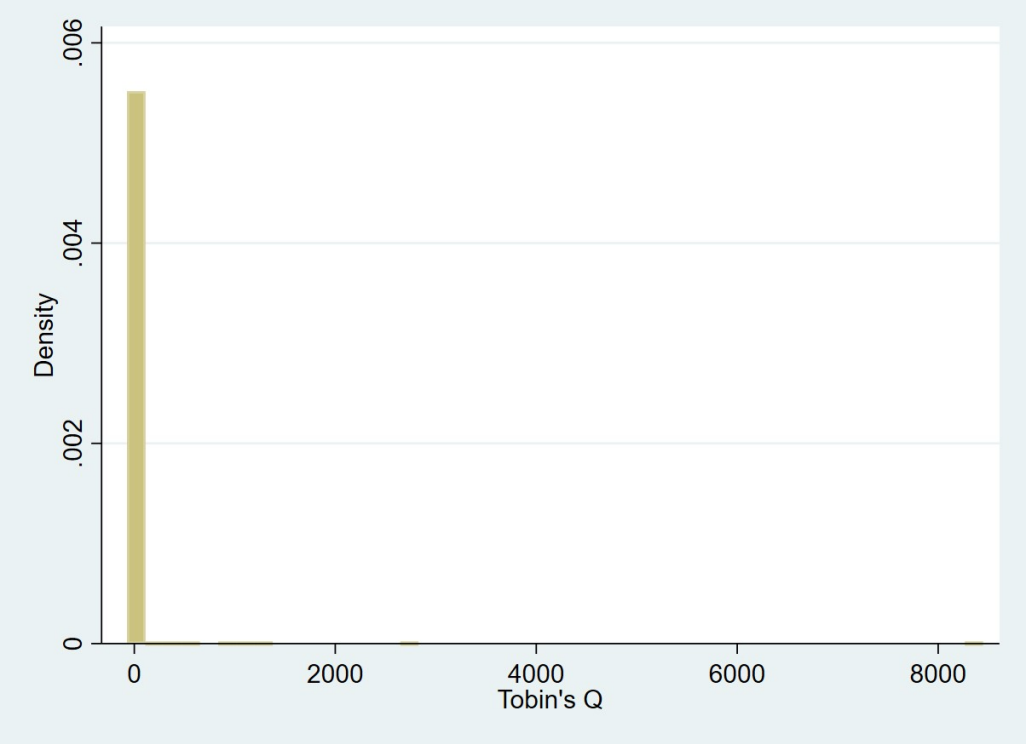
Soare, Detilleux & Deschacht (2021) estimated the effect of the Belgian gender quota. A difference-in-difference approach was used to compare the change in firm performance between the treated listed firms and the untreated unlisted firms. Soare et al. (2021) find a statistically negative causal effect of the gender quota on various indicators of firm performance.

8.2 Appendix B: Data and Methodology

Table B1: Description and sources of variables

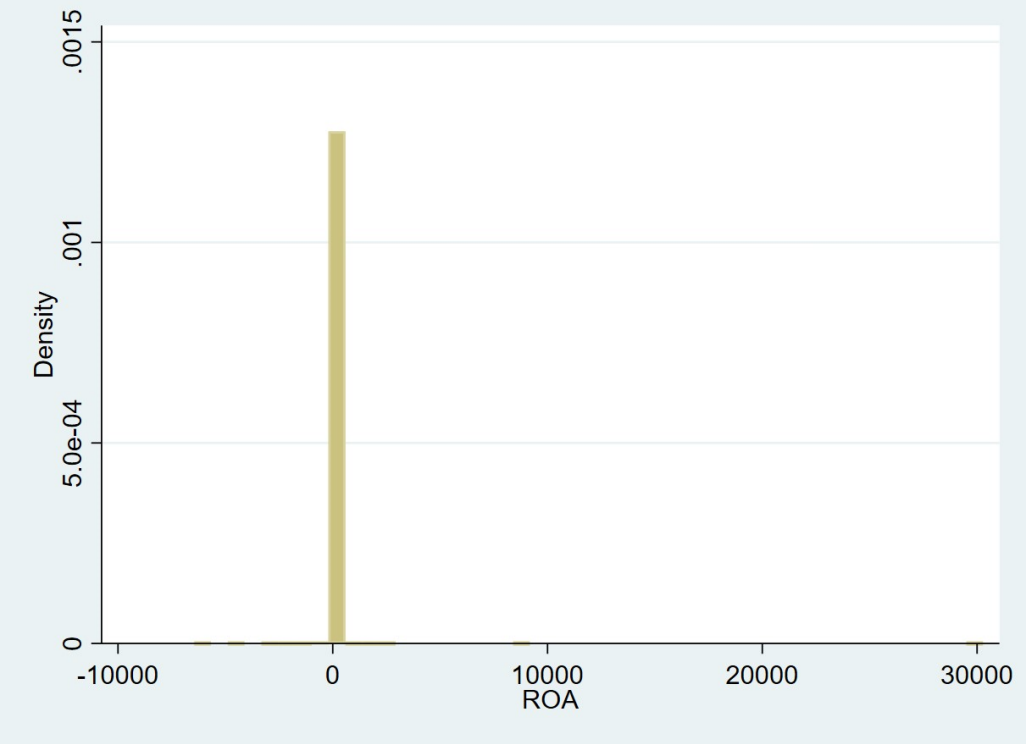
Variable	Definition	Source
Tobin's Q	(Equity Market Value + Liabilities Book Value) / (Equity Book Value + Liabilities Book Value)	Refinitiv
Return on Assets	(Net income + (interest expense on debt – interest*(1 – tax rate)) / total assets)	Refinitiv
Gender diversity	Proportion of female directors on the board of directors	Boardex
Employees	Number of both full time and part time employees in the company	Refinitiv
Leverage/Equity ratio	((Long Term Debt + Short Term Debt & Current Portion of Long Term Debt) / Common Equity * 100)	Refinitiv
Board size	Number of directors on the board	Boardex
Year	Dummy for each year	
Total assets	Sum of total current assets, long term receivables, investment in unconsolidated subsidiaries, other investments, net property plant and equipment and other assets	Refinitiv
Revenue	Gross sales and other operating revenue less discounts, returns and allowances	Refinitiv
Sector	Reports the sector in which a firm is active	Boardex
Listing status	Listing status of a firm, being either listed or delisted	Orbis

Figure B1: Distribution of Tobin's Q before truncating data



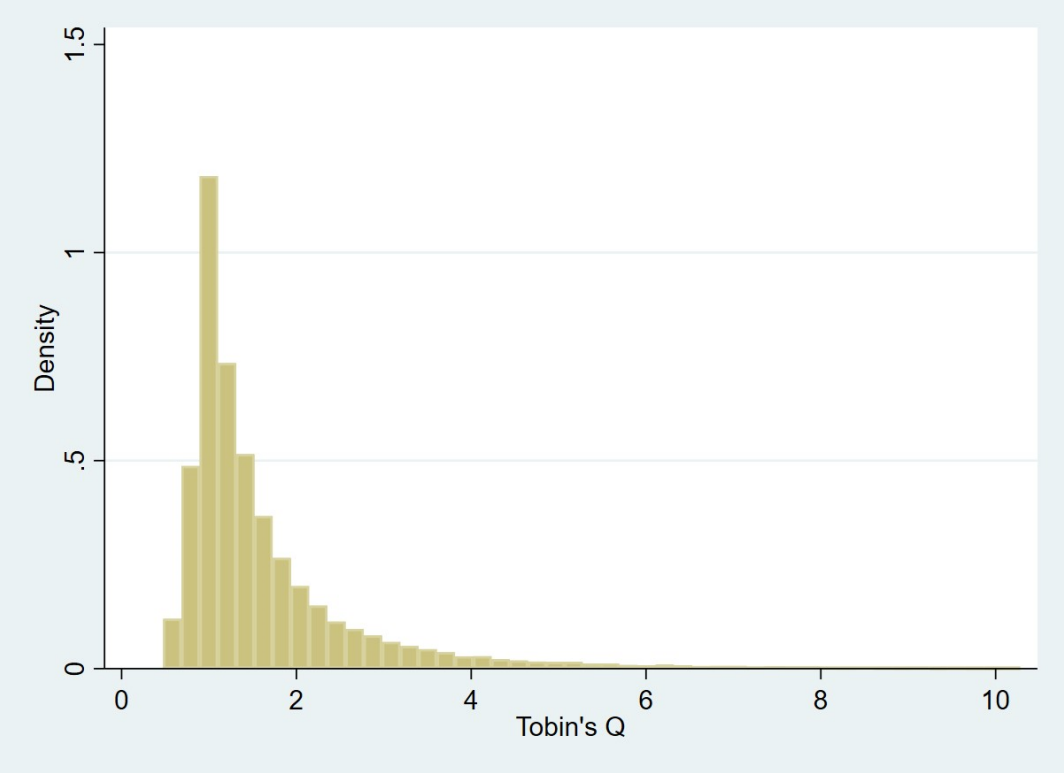
Data source: Refinitiv

Figure B2: Distribution of Return on Assets before truncating data



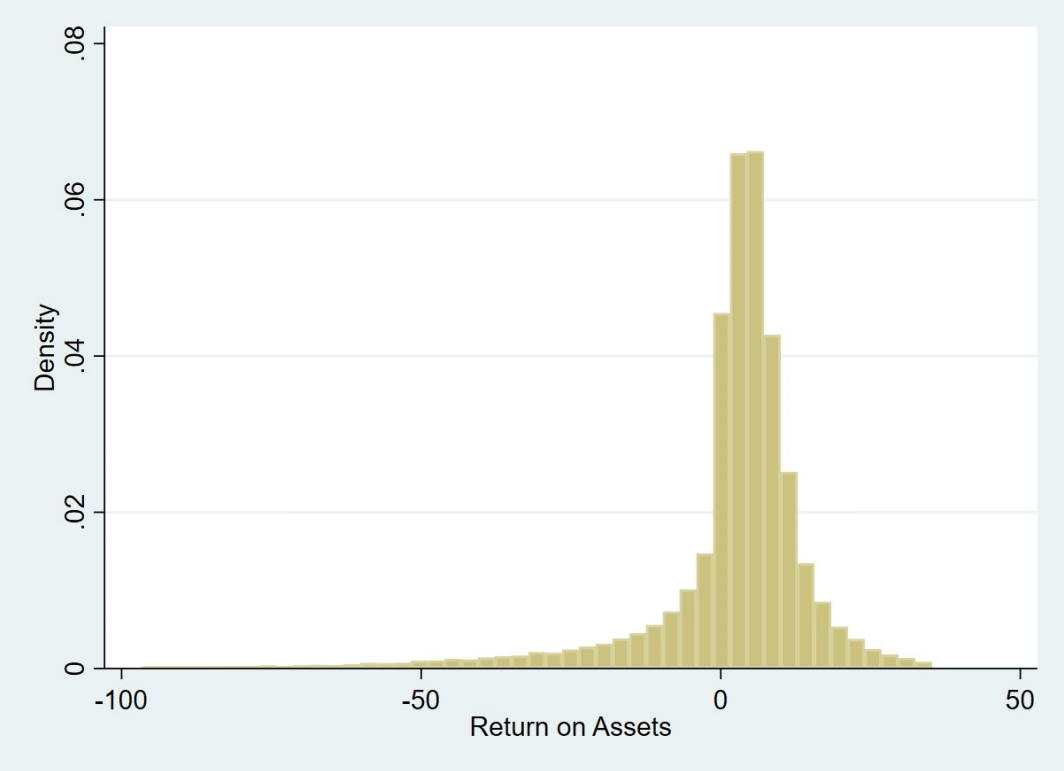
Data source: Refinitiv

Figure B3: Distribution of Tobin's Q



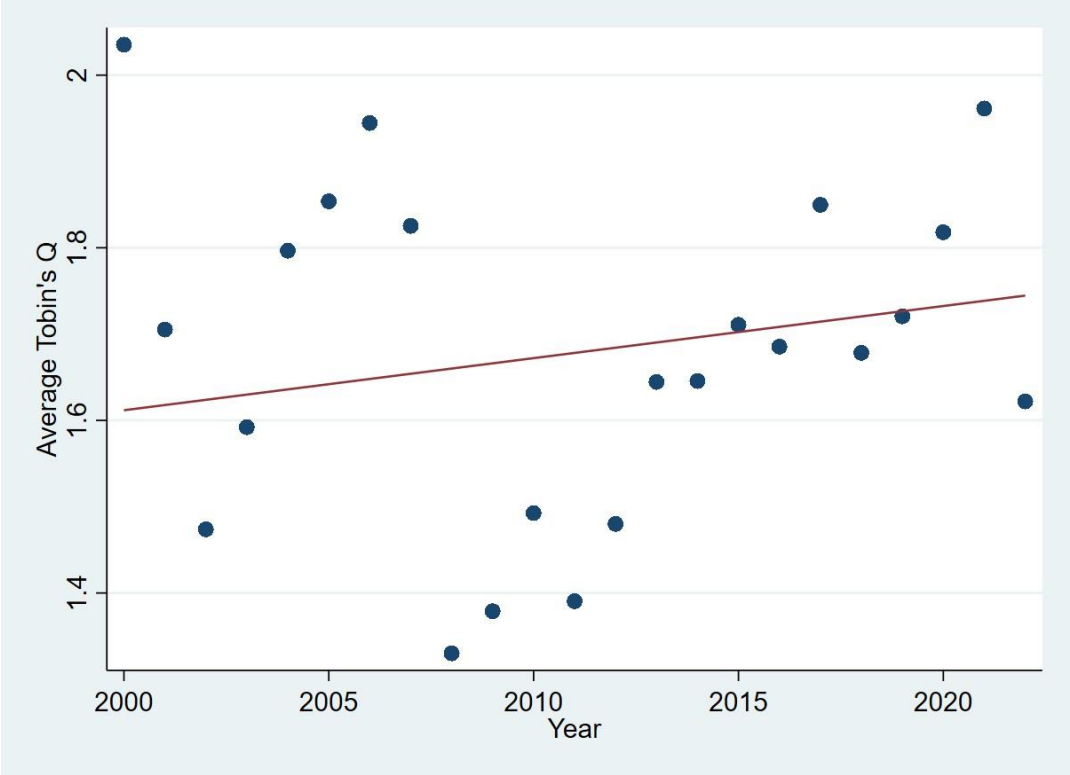
Data source: Refinitiv

Figure B4: Distribution of Return on Assets



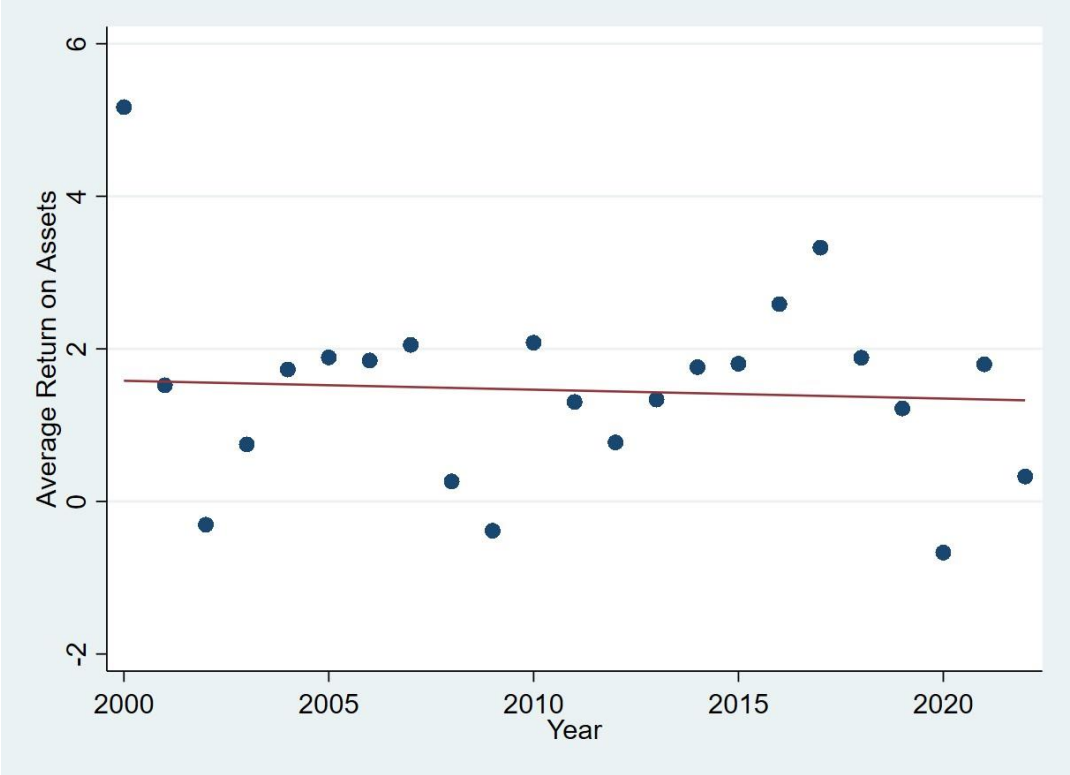
Data source: Refinitiv

Figure B5: Development of Tobin's Q over time



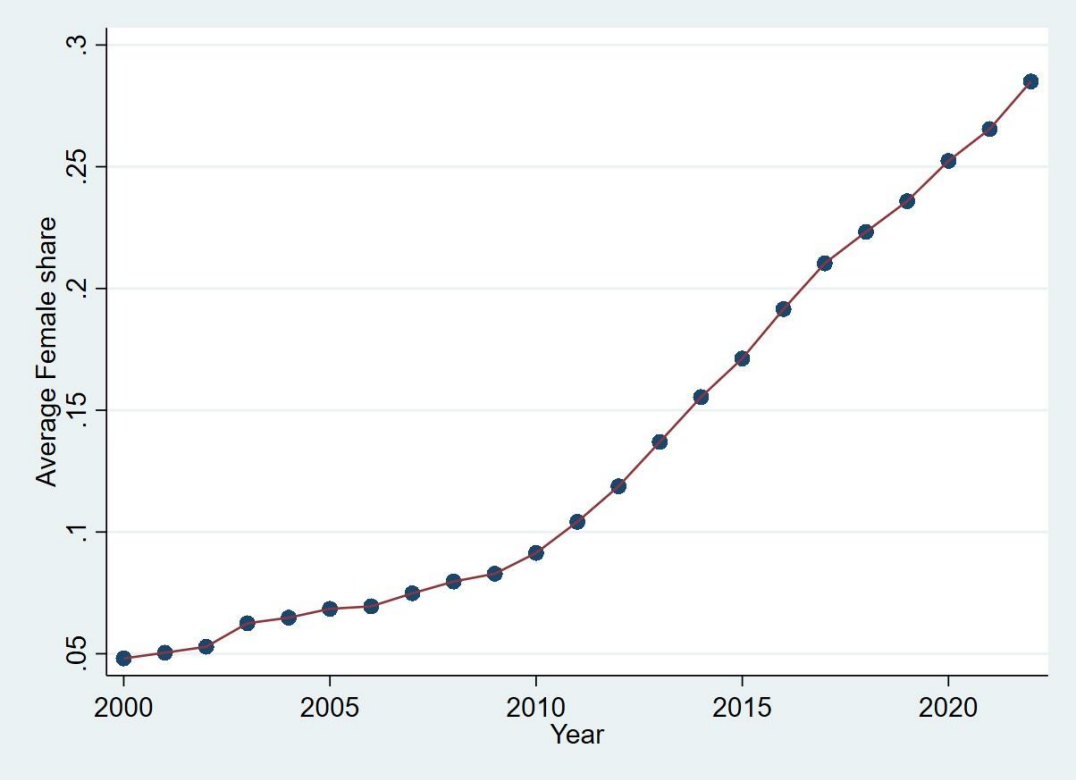
Data source: Refinitiv

Figure B6: Development of Return on Assets over time



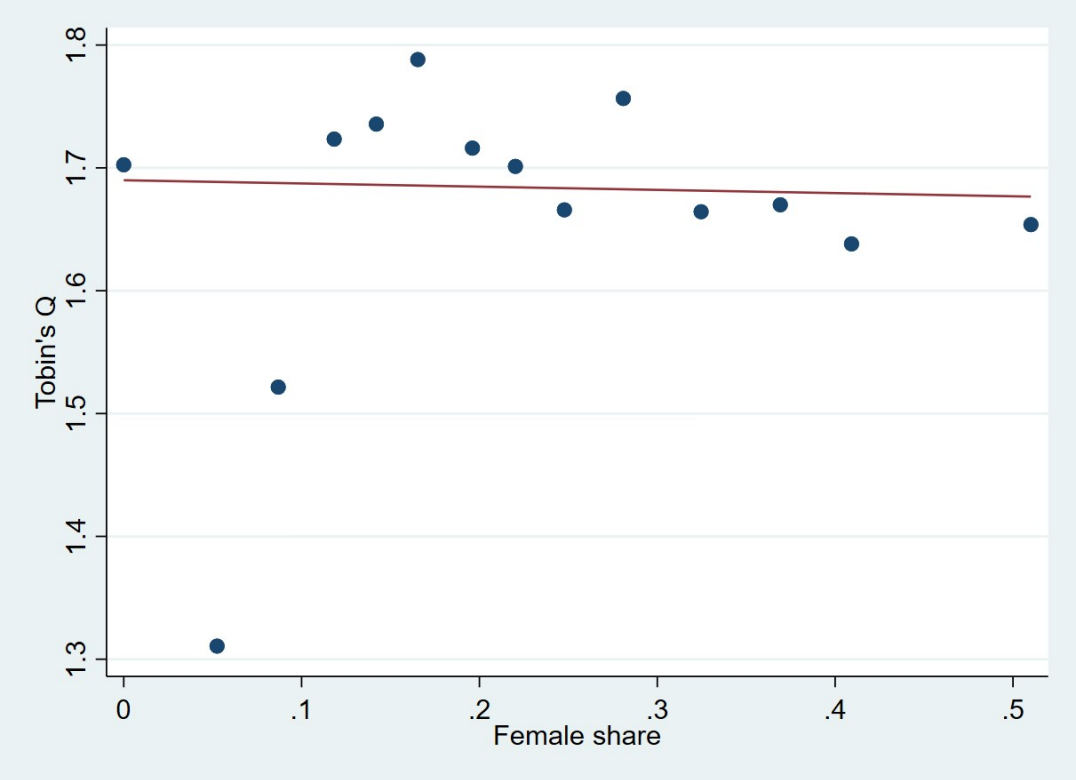
Data source: Refinitiv

Figure B7: Development of the share of females in boards



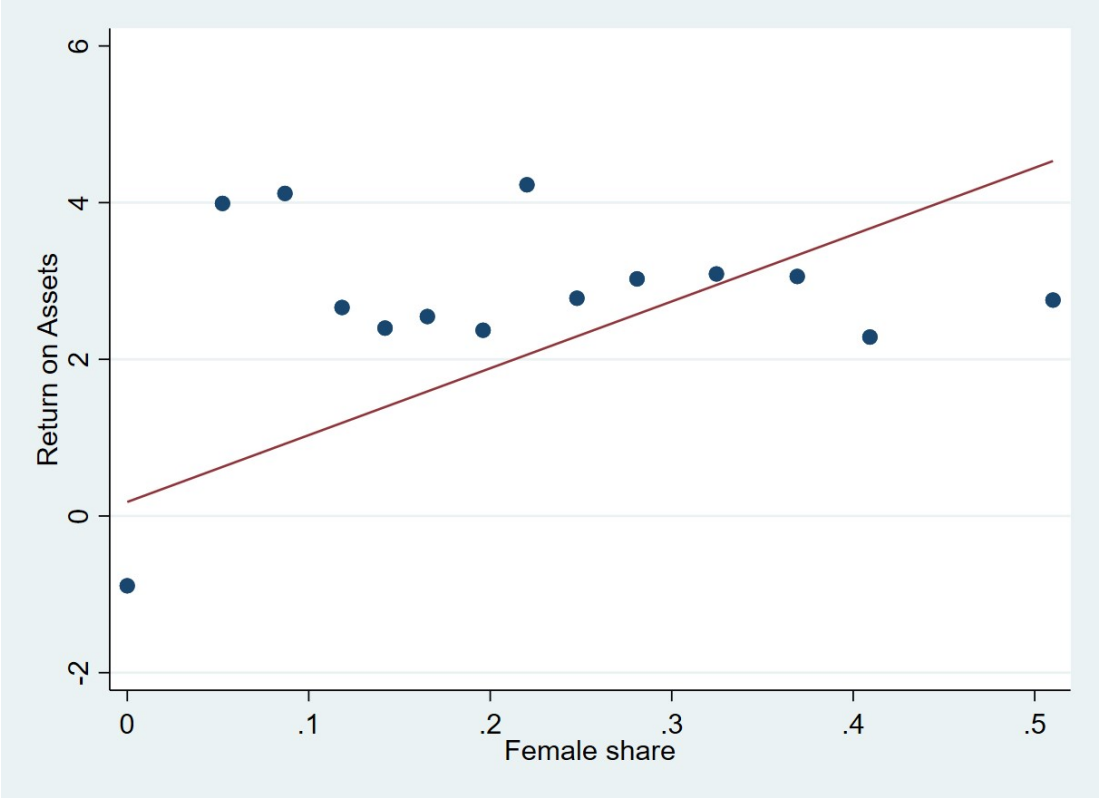
Data source: Boardex

Figure B8: Relationship between the share of female board directors and Tobin's Q



Data sources: Refinitiv and Boardex

Figure B9: Relationship between the share of female board directors and Return on Assets



Data sources: Refinitiv and Boardex

Correlations

To examine the relationship among all relevant variables, a correlations matrix was computed. The correlations matrix in Table B2 shows that the highest correlation is between Female and Female Squared, taking a value of 0.930. This is unsurprising, as Female Squared is the squared version of the Female variable. The only other noteworthy correlation is between board size and the number of employees. Multicollinearity arises when the relationship between two independent variables is very large (Wooldridge, 2016). The Variance Inflation Factor (VIF) is used to test whether there exists multicollinearity among the variables. Table 6 shows the Variance Inflation Factor for each variable. As a rule of thumb, multicollinearity is concluded when the Variance Inflation Factor is larger than 10 (Wooldridge, 2016). From Table B3 it can be seen that the VIF is lower than 10 for each variable. Therefore, it is concluded that there is no multicollinearity in the models using these variables.

Table B2: Correlations Matrix

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)
(1) Tobin's Q	1.000						
(2) Return on Assets	-0.071	1.000					
(3) Gender diversity	-0.003	0.087	1.000				
(4) Gender diversity sq	-0.005	0.057	0.930	1.000			
(5) Employees	-0.048	0.069	0.074	0.044	1.000		
(6) Leverage/Equity	-0.017	0.002	-0.000	-0.000	0.010	1.000	
(7) Board size	-0.102	0.130	0.088	0.012	0.392	0.018	1.000

Table B3: Variance Inflation Factor

	VIF	1/VIF
Gender diversity	7.776	.129
Gender diversity sq	7.716	.13
Board size	1.226	.816
Employees	1.184	.845
Leverage/Equity	1	1
Mean VIF	3.78	.

Heteroskedasticity

All regressions in this thesis were tested for the presence of heteroskedasticity using the Breusch–Pagan/Cook–Weisberg test for heteroskedasticity. The null hypothesis of this test is that the errors in the regression have constant variance conditional, i.e. homoskedasticity (Wooldridge, 2016). For all regressions, the Breusch–Pagan/Cook–Weisberg test gives a highly significant p-value for the chi2, hence we reject the null hypothesis of homoskedasticity at the 1% significance level. Therefore we conclude that there exists heteroskedasticity in the regressions, i.e. the variance in the error term is not constant (Wooldridge, 2016). For this reason, all regressions will use robust standard errors.

Table B4: Distribution of observations over countries

Countries	Freq.	Percent	Cum.
Austria	708	1.19	1.19
Belgium	1453	2.44	3.63
Bulgaria	2	0.00	3.63
Croatia	35	0.06	3.69
Cyprus	128	0.21	3.91
Czech Republic	66	0.11	4.02
Denmark	829	1.39	5.41
Estonia	8	0.01	5.42
Faroe Islands	25	0.04	5.46
Finland	1088	1.83	7.29
France	6452	10.84	18.13
Georgia	1	0.00	18.13
Germany	5569	9.35	27.48
Gibraltar	30	0.05	27.53
Greece	589	0.99	28.52
Guernsey	500	0.84	29.36
Hungary	89	0.15	29.51
Iceland	93	0.16	29.67
Isle Of Man	217	0.36	30.03
Italy	2288	3.84	33.87
Jersey	419	0.70	34.58
Liechtenstein	44	0.07	34.65
Lithuania	13	0.02	34.67
Luxembourg	545	0.92	35.59
Malta	47	0.08	35.67
Monaco	48	0.08	35.75
Netherlands	1789	3.00	38.75
Norway	1774	2.98	41.73
Poland	465	0.78	42.51
Portugal	463	0.78	43.29
Republic Of Ireland	1353	2.27	45.56
Romania	45	0.08	45.64
Russian Federation	388	0.65	46.29
Slovakia	6	0.01	46.30
Slovenia	23	0.04	46.34
Spain	1857	3.12	49.46
Sweden	3039	5.10	54.56
Switzerland	2598	4.36	58.92
Turkey	423	0.71	59.63
Ukraine	19	0.03	59.66
United Kingdom - England	22476	37.75	97.41
United Kingdom - Northern Ireland	95	0.16	97.57
United Kingdom - Scotland	1163	1.95	99.52
United Kingdom - Wales	284	0.48	100.00
Total	59546	100.00	

8.3 Appendix C: Results

Table C1: Parallel Trends test France DD models

	(1)	(2)
Dep. variable:	DD	DD
Tobin's Q	Control group: Untreated French firms	Control group: Swiss firms
Treated*Trend	-0.169**	0.190
	(0.0803)	(0.123)
Treated	0.669***	0
	(0.180)	(.)
Trend	0.819***	0.376**
	(0.197)	(0.189)
Employees	0.000000846	0.000000637
	(0.00000104)	(0.00000101)
Leverage/Equity	-0.00000382	-0.00000457
	(0.00000550)	(0.00000835)
Board size	-0.00940	-0.00977
	(0.00683)	(0.00741)
Constant	0.997***	1.670***
	(0.163)	(0.0998)
Year dummies	Yes	Yes
N	6266	7001
R^2	0.082	0.068
adj. R^2	0.078	0.064

Robust standard errors in parentheses
** p<0.10, ** p<0.05, *** p<0.010*

Table C2: DDD parallel trends test France

	(1)
Dep. variable: Tobin's Q	DDD Control group: Untreated French firms and Swiss firms
Country*Firms*Trend	-0.143
	(0.224)
Country*Trend	0.340*
	(0.196)
Firms*Trend	-0.0236
	(0.206)
Trend	0.406*
	(0.221)
Employees	0.000000814
	(0.000000987)
Leverage/Equity	-0.00000383
	(0.00000521)
Board size	-0.0145**
	(0.00690)
Constant	1.726***
	(0.0921)
Year dummies	Yes
N	9047
R^2	0.080
adj. R^2	0.077

Robust standard errors in parentheses
** p<0.10, ** p<0.05, *** p<0.010*

Table C3: DD parallel trends test Spain

	(1)	(2)
Dep. variable: Tobin's Q	DD Control group: Spanish Untreated firms	DD Control group: Swiss firms
Treated	0.0116	0
	(0.104)	(.)
Trend	0.536**	0.358
	(0.232)	(0.250)
Treated*Trend	-0.191*	0.117
	(0.107)	(0.124)
Employees	0.000000498	-0.00000106
	(0.00000120)	(0.00000193)
Leverage/Equity	-9.96e-09	2.62e-08
	(0.000000322)	(0.000000143)
Board size	-0.00859	-0.0109
	(0.00799)	(0.00857)
Constant	1.369***	1.428***
	(0.148)	(0.152)
Year dummies	Yes	Yes
N	1861	1017
R^2	0.113	0.081
adj. R^2	0.100	0.056

Robust standard errors in parentheses
** p<0.10, ** p<0.05, *** p<0.010*

Table C4: DDD parallel trends test Spain

Dep. variable: Tobin's Q	(1) DDD Control group: Spanish untreated firms and Swiss firms
Country*Firms*Trend	-0.238
	(0.151)
Country*Trend	0.350***
	(0.134)
Firms*Trend	0.157
	(0.140)
Trend	0.136
	(0.193)
Employees	0.000000930
	(0.00000135)
Leverage/Equity	0.000000321
	(0.000000370)
Board size	-0.0172*
	(0.00957)
Constant	1.862***
	(0.106)
Year dummies	Yes
N	4460
R^2	0.084
adj. R^2	0.078

Robust standard errors in parentheses
** p<0.10, ** p<0.05, *** p<0.010*

8.4 Appendix D: Robustness check

Table D1: Parallel Trends test France DD models with Return on Assets as dependent variable

Dep. variable: Return on Assets	(1) DD Control group: Untreated French firms	(2) DD Control group: Swiss firms
Treated*Trend	-1.278	-0.716
	(0.872)	(0.627)
Treated	-0.115	0
	(0.928)	(.)
Trend	3.356**	2.240**
	(1.597)	(1.005)
Employees	-0.00000361	-0.00000418
	(0.00000847)	(0.00000802)
Leverage/Equity	0.0000434	0.0000808
	(0.0000941)	(0.000113)
Board size	-0.0732	-0.0901
	(0.0597)	(0.0591)
Constant	1.734	2.778***
	(1.529)	(0.871)
Year dummies	Yes	Yes
N	6270	7010
R^2	0.036	0.035
adj. R^2	0.032	0.031

Robust standard errors in parentheses
** p<0.10, ** p<0.05, *** p<0.010*

Table D2: DDD parallel trends test France using Return on Assets as dependent variable

	(1)
Dep. variable: Return on Assets	DDD Control group: untreated French firms and Swiss firms
Country*Firms*Trend	-1.349
	(1.533)
Country*Trend	0.684
	(1.436)
Firms*Trend	-0.266
	(1.297)
Trend	2.073
	(1.478)
Employees	-0.00000362
	(0.00000778)
Leverage/Equity	0.0000196
	(0.0000970)
Board size	-0.0677
	(0.0530)
Constant	2.758***
	(0.853)
Year dummies	Yes
N	9043
R^2	0.038
adj. R^2	0.035

Robust standard errors in parentheses
** p<0.10, ** p<0.05, *** p<0.010*

Table D3: DD parallel trends test Spain using Return on Assets as dependent variable

Dep. variable: Return on Assets	(1) DD Control group: Spanish untreated firms	(2) DD Control group: Swiss firms
Treated	0.619	0
	(1.158)	(.)
Trend	5.204***	1.451
	(1.461)	(1.079)
Treated*Trend	-2.978***	1.831**
	(1.094)	(0.879)
Employees	0.0000153**	0.00000655
	(0.00000649)	(0.0000108)
Leverage/Equity	-0.0000289***	-0.0000418***
	(0.00000546)	(0.00000419)
Board size	0.116	-0.0536
	(0.127)	(0.0562)
Constant	0.697	3.454***
	(1.717)	(1.002)
Year dummies	Yes	Yes
N	1857	1015
R^2	0.076	0.125
adj. R^2	0.063	0.102

Robust standard errors in parentheses
** p<0.10, ** p<0.05, *** p<0.010*

Table D4: DDD parallel trends test Spain using Return on Assets as dependent variable

	(1)
Dep. variable: Return on Assets	DDD Control group: Spanish untreated firms and Swiss firms
Country*Firms* Trend	-0.773
	(1.077)
Country*Trend	1.376
	(0.944)
Firms*Trend	-0.203
	(0.822)
Trend	1.663*
	(0.919)
Employees	0.0000106
	(0.00000839)
Leverage/Equity	-0.0000389***
	(0.00000661)
Board size	0.0610
	(0.0952)
Constant	2.747**
	(1.098)
Year dummies	Yes
N	4446
R^2	0.051
adj. R^2	0.045

Robust standard errors in parentheses
** p<0.10, ** p<0.05, *** p<0.010*