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The effect of gender diversity on the performance and risk of firms

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Abstract
Geschlechtervielfalt in den Führungsetagen ist heutzutage ein wichtiges und relevantes Thema. Frauen sind immer noch unterbezahlt und in Führungspositionen unterrepräsentiert. Statistische Belege für diese Ungleichheit haben dazu geführt, dass immer mehr Vorschriften erlassen werden, die Geschlechterquoten in den Vorständen von Unternehmen vorschreiben. Die Wirksamkeit dieser Vorschriften ist ein diskutiertes Thema, und es gibt eine wachsende Zahl von Studien, die die Auswirkungen der Geschlechterdiversität auf die Leistung und das Risiko von Unternehmen untersuchen. Die Ergebnisse der bisherigen Forschung sind jedoch sehr uneinheitlich und betonen den umfeldspezifischen Charakter der Beziehung. Diese Studie soll einen Beitrag zur bestehenden Literatur leisten, indem sie die Beziehung zwischen der Geschlechtervielfalt in deutschen Aufsichtsräten und der Unternehmensleistung, dem Investitionsverhalten, dem Risiko und den Eigenschaften der Aufsichtsräte analysiert. Es wird ein 2SLS-Ansatz, kombiniert mit einer Differenzen-von-Differenzen-Methode, verwendet, bei dem die deutsche FüPoG I-Verordnung von 2015 instrumentalisiert wird, um Endogenitätsbedenken auszuräumen und die Kausalität der Ergebnisse zu ermöglichen. Unsere Ergebnisse werden außerdem durch mehrere Robustheitstests gestützt. Wir finden einen signifikant positiven Effekt auf die Unternehmensleistung und den Verschuldungsgrad sowie einen signifikanten Einfluss auf die Zusammensetzung des Aufsichtsrats. Wir stellen außerdem fest, dass dieser Effekt stark sektorspezifisch ist.

Abstract
Gender diversity in boardrooms is an important and relevant topic today. Women are still underpaid and underrepresented in leadership positions. Statistical evidence of this inequality has given rise to increasing regulatory requirements, stipulating gender quotas on boards of firms. The effectiveness of these legislations is a strongly debated subject with a growing body of literature examining the effect of gender diversity on firm performance and risk. However, previous research is highly heterogeneous in their findings and emphasizes the environment-specific nature of the relationship. This study aims to contribute to existing literature by analysing the relationship between gender diversity on German supervisory boards and firm performance, investment behavior, risk and board characteristics. We employ a two stage least squares and a difference-in-difference approach, instrumentalising the German FüPoG I regulation in 2015, to deal with endogeneity concerns and enable causality of results. Our findings are further supported by multiple robustness tests. We find a positive effect on firm performance and leverage, as well as a significant influence on the board composition. We further find that this effect is highly sector specific.

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1 Introduction

In today's fierce business environments, companies experience ever-growing competition and thus pressure to perform well. The effects that influence the success of firms are multiple, intricate, and change and adjust to the economic environment as well as the current society. In the last decade, justice and equality have become one of the leading movements, ranging from the environment and biodiversity to social justice. Racial equality, gender equality and diverse representation in firms have been seen as core pillars of a just society.

Gender diversity in companies has been heavily discussed in the press and in research. Still, there is not enough female representation in leadership positions in politics, academia and business (Madsen et al., 2017). The "Women in Leadership Report" (LinkedIn Economic Graph., 2023) shows that female underrepresentation in both management and leadership positions still exists. This trend is particularly strong in traditionally male-dominated industries (LinkedIn Economic Graph., 2023). Figure 1 represents a graph of gender equality in leadership positions across different countries. As one can observe, Austria, Germany, and Switzerland belong to countries with the highest gender inequality.

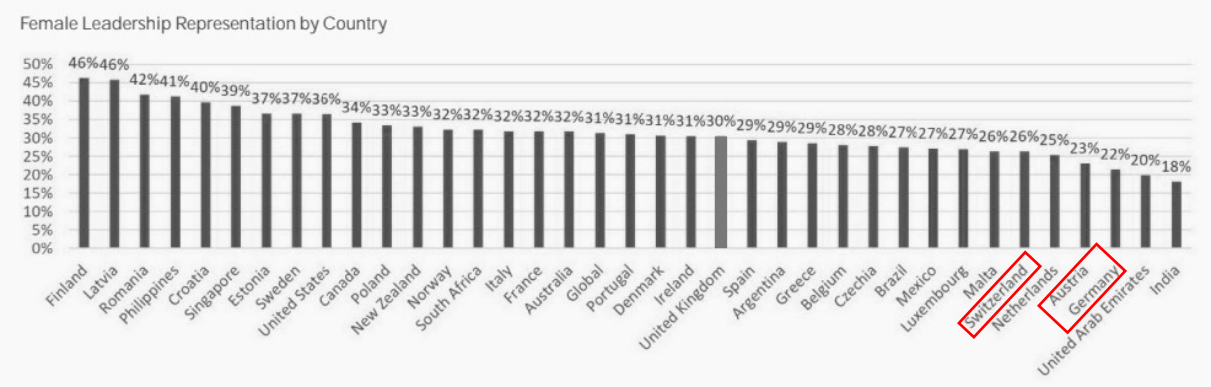

Figure 1 - Gender Equality in % across countries (LinkedIn Economic Graph., 2023)

Women make up to 51 % of the European population. Out of all graduates, 56 % in Austria, 50.2 % in Germany, and 52 % in Switzerland were women in 2021 (Erudera et al., 2022; Swiss Universities, 2021). In the European Union, still, only 69 % of the female working population is employed compared to 80 % of the male working population (Eurostat, 2024). The gender pay gap, defined as the difference between wages of men and women, in 2022 in the EU was 12.7 % on average (Eurostat, 2024). For Germany and its surrounding countries, these numbers are even more alarming - Germany at 17.7 %, Austria at 18.4 %, and Switzerland at 17.9 % (Eurostat, 2024).

With that, there has been pressure to reform governance in companies by legislating gender representation quotas. These reforms often focus on the boards of the firms, since these are determining the decision and thus steering the business. The effectiveness of such quotas, however, is disputed.

Germany's first gender quota law was passed in 2015, and then amplified in 2021. We exploit Germany's gender diversity legislation of 2015 (FüPoG I) to study the relationship between gender diversity on boards and firm performance and risk. We additionally look at the effect on investment behavior and other board characteristics. This research should then provide answers about the effectiveness of gender equality legislation and an argument for meritocratic considerations.

Prior research on the topic of gender diversity on boards suggests a significant influence on firms. Studies looking at the impact on the performance of firms find mixed effects. Similarly, the effect on riskiness seems to still be inconclusive. Furthermore, authors point out the importance of contexts for this field of research.

Despite countless measures taken to raise awareness of this issue, work environments still seem to be lacking in gender diversity. If the argument of social justice is not enough to provide equal opportunities for both genders, profitability and performance might convince decision-makers in the economy to prioritize this issue. As the activist and author Jesse Jackson said, **"Inclusion is not a matter of political correctness. It is the key to growth."**

Our study poses the following question to examine the effect of gender diversity on firms:

“Does gender diversity on supervisory boards influence the performance and riskiness of firms?”

The objective of this study is to investigate the relationship between gender diversity on boards, firm performance, and risk. In a first step, a thorough literature review is conducted to pin down theoretical concepts underlying this issue and to identify research gaps. The second part uses robust empirical methods to examine the causality of this research question. The empirical part of this study is set up to focus on a specific economic environment - the countries of the DACH region (i.e., Germany, Austria, and Switzerland) and its listed firms. The data has been gathered for years between 2012 and 2018. We simultaneously examine risk, investment, and performance variables, as well as board characteristics, to get a comprehensive perspective on the effect of gender-diverse boards.
Women continue to be underrepresented in board positions. The purpose of this study is thus also to convince the reader that equal representation of genders is crucial for social justice and the economy. Previous literature has shown heterogeneous and often conflicting results regarding this topic. Many papers and well-cited studies find that the relationship is intricately detailed and determined by various contexts (Zhang et al. (2020), Reddy et al. (2019)). Additionally, most studies focus on risk and performance separately, overlooking the interrelatedness of the two. To our knowledge, the gender quota regulation of 2015 in Germany (FüPoG I) has thus far never been exploited in a 2SLS setting, even though this exogenous shock (i.e., the regulation) provides a suitable instrumental variable to conduct this type of research. Furthermore, previous papers in this field often consider difference-in-difference methods to examine this research question. This can lead to omitted variable bias and endogeneity concerns (Callaway et al., 2021) (see chapter "Endogeneity"). To deal with these issues, the methodology of this study combines a difference-in-difference approach, using time series and fixed effects, with a two-stage least squares (2SLS) approach. Thus, our study additionally contributes with the uniqueness of its research design.
The specificity of economic, regulatory, and market landscapes, which vary across countries and sectors, calls for further investigation, zeroing in on individual environments. Our research offers nuanced insights underscoring its relevance and critical contribution to understanding these complex dynamics.

1. Literature Review

1.2 “The Boards" and Governance

In this study, we focus on board characteristics to examine the relationship between gender diversity and firm risk and performance. The governance structure in Germany follows a so-called "two-tier board system". The mandatory two-tier structure consists of two governing bodies within the company - the management board and the supervisory board (Block et al., 2016). The management board consists of executive directors who decide on the firm’s objectives and operate it to reach the desired goals (Block et al., 2016). The supervisory board, with its non-executive directors, oversees the management board, appoints executive directors, and acts in the interest of other stakeholders (Block et al., 2016). Overall, "the boards" are responsible for the success or failure of the firm. This system inevitably and purposefully leads to the separation of control and ownership, which should lead to efficient monitoring (Fama, E. F. & Jensen, M. C., 1983).
Previous literature has focused primarily on boards to examine the effect of gender diversity, as it is assumed that top management should be the closest representation of the companies' stakeholders, especially its workforce (Li et al., 2022; Yang et al., 2019). The upper echelon theory provides support for this approach. The theory builds on bounded rationality principles, emphasizing that strategic situations are complex; hence perfect rationality in decision-making is not possible (Abatecola et al., 2020). The upper echelon theory is based on the notion that the top management (senior-level executives) has the strongest influence on firm performance. Their characteristics, such as age, gender, skill, and education, affect their decision-making in strategic situations and in turn the organisation’s performance. Thus, focusing on the gender composition of boards, as the representation of the firm as a whole, is in line with this theory.

Former research has supported the argument that boards strongly influence the financial performance and governance of firms. Characteristics, such as diversity (including gender, nationality, and age), size of board, qualification, and tenure seem to be the main determinants (e.g., Muller et al., 2014; Adams et al., 2019). Muller et al. (2014) find a positive relationship between firm performance (measured by ROA) and the independence of directors, as well as the proportion of foreign directors. Adams et al. (2009) find that, for a sample of US companies, female directors have better board attendance than male directors, and more women on boards increase monitoring efficiency, making governance sounder. Furthermore, executive turnover seems to be more aligned with stock performance with gender-diversified boards, and equity-based compensation is preferred (Adams et al., 2009).

1.3 Gender diversity

Diversity as a socio-political concept has been defined as differences and similarities that could lead to advantages or discrimination in certain contexts (Gardenswartz et al., 2003). Diversity includes, but is not exclusive to, racial or ethnic classifications, age, gender, religion, philosophy, politics, physical abilities, socioeconomic background, sexual orientation, gender identity, intelligence, physical health, mental health, genetic attributes, personality, behavior, or attractiveness (Roberson, Q. M., 2019). Diversity also encompasses gender. In the context of this research, gender diversity ought to be understood as the equal representation and treatment of men and women in firms. The female gender continues to be underrepresented in today's economy, even though conditions for equal involvement seem to be met. Women make up around 51 % of the European population. Out of all graduates, 56 % in Austria, 50.2 % in Germany, and 52 % in Switzerland were women in 2021 (Erudera et al., 2022; SwissUniversities, 2021). In the European Union, only 69 % of the female working population is employed compared to 80 % of the male working population (Eurostat, 2024). The gender pay gap, defined as the difference between wages of men and women, in 2022 in the EU was 12.7 % on average (Eurostat, 2022). For Germany and surrounding countries, these numbers are even more alarming - Germany 17.7 %, and for example Austria 18.4 %, Switzerland 17.9 % (Eurostat, 2022). Even with the same qualification, women are valued less in the working environment. For example, female graduates of the Banking and Finance Master's Program at the University of Vienna earn 9 % less than male graduates, with 9 % fewer female graduates being employed three years after graduation (UniVienna, 2023).

As a solution to this persisting issue, gender quotas in firms are often proposed.

This, however, has not been without criticism. Skeptics argue that requiring a fixed quota does not align with the principle of meritocracy. Meritocratic principles build on the notion that everybody has the same opportunities, regardless of gender, nationality, class, or race, and thus can succeed only based on skill and commitment to working hard (Powell et al., 2016). This further translates into the concept of objective evaluation. Hence, if different levels of performance are observed, the option that this is caused by discrimination would be ruled out. However, studies suggest that the conditions for an objective assessment of performance are not provided in our society, and perceptions of merit are shaped by gendered norms (Powell et al., 2016).

In the context of gender diversity literature, tokenism, introduced by Kanter et al. in 1977, is another relevant concept. Tokenism explores the effect of different proportions of groups of a social type on the interactions within organizations (Kanter et al., 1977). It is closely related to gender diversity research in the sense that it often focuses on the underrepresentation of women. Kanter et al. focus on unequally represented genders within groups, particularly a high proportion of men relative to few women – female members being the "tokens" in this context. In such environments, structural issues stifle the potential of women in the workforce. Due to their minority, women tend to experience heightened visibility, which causes performance pressure. Furthermore, they feel isolated by the majority and are expected to comply with stereotypical gender roles (Kanter et al.,1977).

Another important theory to consider is "Unconscious Gender Bias". Unconscious gender bias occurs when a "person consciously rejects gender "stereotypes but still unconsciously makes evaluations based on stereotypes" (Madsen et al., 2018). Madsen quotes Ely et al. (2011), who defined unconscious gender bias as one of "the powerful yet often invisible barriers to women's advancement that arise from cultural beliefs about gender, as well as workplace structures, practices, and patterns of interaction that inadvertently favor men". This theory is often proposed as an explanation for the

career hindrance of women (Madsen et al., 2018). This leads to female candidates for top-level positions being overlooked, as assumptions about their preference for motherhood over a career are made without considering their personal views.
An important aspect to consider when talking about gender representation in firms is the decision between the so-called "mommy track" or "career track". "Mommy track" is defined as a career path that allows for more flexible and reduced working hours but also blocks or slows advancement (Merriam Webster, 2023). The effect can mainly be measured in wage trajectories. Wilde et al. (2010) find that wage trajectories change drastically after childbearing age for high-skill women, with marginal change for low-skill women. Their results show that the lifetime costs of childbearing are particularly substantial for highly skilled women (Wilde et al., 2010). Taking these differential costs into account, high-skill women tend to delay or avoid childbearing to be able to advance in their careers (Wilde et al., 2010).
Child penalties, as a related concept, have often been quoted in recent literature. They are defined as "the effects of parenthood on women relative to men" and are considered one of the most influential forces for gender inequality in the labor market (Kleven et al., 2019). Kleven et al. (2019) find a significant increase in child penalties for women relative to men in European countries.
Stereotypes about women, whether positive or negative, undermine efforts to promote gender equality in leadership positions (Adams et al., 2016). Adams et al. (2016) name negative stereotypes, like female inherent risk aversion, to be one potential reason for under-representation. What is more, positive stereotypes, such as the virtuous performance-boosting ability of women, put unnecessary pressure on female leaders, further underscoring the issue of tokenism (Adams et al., 2016).
The multitude of theories explaining the under-representation of women in the labor market often emphasize the injustice of this inequality.

1.4 Regulation

There has been increasing pressure to reform governance in companies by legislating gender representation quotas. The article, "Women's Presence on Corporate Boards: Addressing Director Selection Participation and Gender Bias," explores the under-representation of women on corporate boards, despite the increasing number of qualified women (Young et al., 2022). The authors indicate that quotas and incentives have been considered in various countries to promote gender diversity on boards, but without enforced quotas, little change is observed (Young et al., 2022.). Thus, while regulation plays an important role in promoting gender diversity, hard quota law seems to be more efficient (Young et al., 2022.)
Norway was one of the first countries to legislate gender quotas of 40 % in the boardroom by 2008, followed by Spain in 2015 and other European countries (e.g., France, Italy, Germany, Austria or Switzerland). Since the focus of this study is the DACH region, this section provides details on the gender regulation in Germany, Austria, and Switzerland.
Prior to 2015, Germany focused solely on voluntary commitment to gender equality. Gender equality was stipulated in federal laws in Germany only more recently. Germany introduced the first gender diversity regulation in 2015, effective from 2016 - the FüPoG I (Führungspositionengesetz). This law included measures to promote women in executive positions in business and public service, including a commitment to a gender quota of at least 30 % for boards of publicly traded and fully codetermined companies as well as an obligation to set target sizes for supervisory boards, executive boards, and top management levels (BMFSFJ, 2023). According to the Codetermination Act of 1976, German listed companies with more than 2000 employees must be fully codetermined, which implies that at least one half of the supervisory board must be composed of the employees' representatives (Hoffman et al., 1976). Sanctions for non-compliance with this regulation primarily target reputational damage. Nonconforming companies were required to publicly disclose not meeting the legislated targets, which potentially subjected them to shareholder and public scrutiny (BMFSFJ, 2023). However, more stringent financial sanctions were introduced only later with FüPoG II (BMFSFJ, 2023).
FüPoG I was extended in 2021 to bridge discovered gaps and make the regulation more effective. FüPoG II for the private sector required that listed firms in Germany and those with equal co-determination must additionally have at least one woman on their executive boards if they have more than three members (BMFSFJ, 2023). This increased the scope of effect by 66 companies, out of

which 21 companies before the regulation had no women on their boards (BMFSFJ, 2023). Furthermore, companies must report target percentages to increase gender inclusion in companies and will be faced with stricter penalties (including financial fees) if they fail to comply (BMFSFJ, 2023).
In Austria, equal treatment of men and women was added to the constitution in 2009. In 2011, gender quotas were imposed for corporate boards of directors if the company is majority-owned by the state (Austria Gender Equality, 2022). These companies were required to have 25 % women on boards by 2013 and 35 % by 2018 (Austria Gender Equality, 2022). Announced in 2017 and effective from the beginning of 2018, the Law on Equality for Women and Men as Non-Executive Directors on Company Boards was introduced. This law requires companies listed on the Austrian stock exchange and firms with more than 1000 employees to have at least 30 % of their boards being of the underrepresented gender (Austria Gender Equality, 2022). Not affected, however, are companies with less than 20 % of total employees of the relevant gender (Austria Gender Equality, 2022).
Switzerland also introduced early measures to increase awareness about gender diversity. The first regulation focused on equal pay for women and men in the Federal Constitution since 1981, which was further substantiated by the Gender Equality Act in 1996 (Deloitte, 2023). This regulation has been then revised and newly introduced, effective from 2021, with the ultimo in 2032 (Deloitte, 2023). This law requires affected companies to perform an analysis of equal pay, to verify this analysis by an authorized independent body, and to communicate the results to the companies' stakeholders (Deloitte, 2023). The analysis must be repeated at least every 4 years, or until equal pay has been achieved and the results verified (Deloitte, 2023). Excluded are companies under inspection with relation to equal pay and companies that already achieved gender equality (Deloitte, 2023).

2. Hypothesis Development

2.2 Gender diversity Regulation

Reddy et al.'s (2019) broad-scope literature review of gender diversity on boards also uses gender regulation as the main determinant for their study. They use gender quota legislation in different companies as instrumental variables, assuming a significant impact on the gender composition of boards (Reddy et al., 2019).
Young et al. (2022) explore the under-representation of women on corporate boards, despite the increasing number of qualified women. Their study indicates that quotas and incentives have been considered in various countries to promote gender diversity on boards, but without enforced quotas, little change is observed (Young et al., 2022).
Guiso et al. (2024) study the spillover effects on related firms stemming from the 2011 Italian law mandating gender quotas. They confirm the effectiveness of gender quota regulation on directly targeted firms and even extend its cogency towards connected companies.
Furthermore, following the approach of a popular study conducted in Norway (Yang et al., 2019), a significant effect provides the basis for the soundness of the chosen methodology.
Due to the findings in research about quota regulation, a certain effectiveness is assumed. This is supported also by the fact that non-compliance with regulation, used as the instrument of this study, is sanctioned.

Hypothesis 1: Gender diversity increased after the introduction of the FüPoG I regulation in 2015 in Germany.

2.3 Firm Performance, Investment Behavior, and Risk

Diversity is related to the concept of heterogeneous groups. Since most of the work in corporate contexts occurs in teams, researchers in the last century already recognized the need to examine the potential effects of working in diverse groups on effectiveness and problem-solving. Knouse et al. (1999) argue that diversity should theoretically increase effectiveness in group settings. Diverse groups should benefit from the different backgrounds of their members, causing broader perspectives. This should lead to a larger number of potential solutions for problems, as well as a higher level of innovativeness. Furthermore, since different perspectives can widen the scope of perceptions, diversity should create greater synergy. Similarly, heterogeneity in the diversity-sense is expected to bring forward more variation in network contacts. On the other hand, there are potential negatives from

having more diversity in group dynamics. Due to a potential perceived lack of similarity, cohesion might be difficult to achieve. Furthermore, if subgroups are created and intra-group conflict arises, open bias and dis-inclusion might inhibit effective teamwork (Knouse et al., 1999).
Knouse et al. (1999) subsequently cite Harrison et al. (1998), who emphasize the temporal component as a crucial determinant of the success of heterogeneous groups. This study found that, with increasing time, group members understood each other and managed to align incentives and expectations. Consequently, the effectiveness of heterogeneous groups surpasses that of homogeneous groups in problem-solving and innovation (Harrison et al., 1998).
Knouse et al. (1999) themselves examined the relationship between different percentages in diversity categories within work groups (gender, minority, and persons with disabilities) and the effectiveness of group work. They find that gender-diverse and minority groups performed more effectively at the 11-30 % level of diversity. Interestingly, in terms of gender, the optimal diversity level is up to 50 %, indicating that equal representation of genders increases the performance of groups (Knouse et al., 1999).
Another important theory to consider is the critical mass theory. Critical mass theory is defined as "a threshold number (or percentage) of women in a legislature necessary for transforming the legislative context from one in which women-friendly policy is unlikely to one in which the opportunities for women's policy success are increased" (Dahlerup et al., 2006). It implies the question of whether a certain percentage of women on boards acts as a threshold, causing positive effects of gender diversity on the company. Subsequent studies have found that the benefits of gender-diversified boards arrive in a U-shape (Joecks et al., 2013). When the proportion of female directors hits 30 %, there are positive effects on the firms in question (Joecks et al., 2013). Combining these findings with Knouse et al. (1999), we may derive potential implications for our study. Since we exploit a gender quota regulation that mandates a 30 % female representation, we assume that it will have significant impacts.
When constructing assumptions about the effects of gender diversity in the context of firms, upper echelon theory and agency theory are also relevant. Especially when considering governance structures, it is important to take agency problems into consideration.
In Shapiro's (2005) agency theory (also called principal-agent theory) one party, the agent, acts on behalf of another party, the principal. In the context of firms, the principals are shareholders (even stakeholders in a broader sense), and the agents are executive managers. Such a relationship often leads to asymmetric information, which is a classical agency problem. Since only the agent has perfect information about her or his own capabilities and intentions, the principal experiences uncertainty. This can result in adverse selection, leading to situations where the principal attracts under-qualified agents. Proper governance controls and a wide pool of potential candidates are necessary to deal with such agency problems. Relating it to gender diversity and the topic of meritocracy, a more diverse pool of applicants would make adverse selection potentially less pronounced (Shapiro, 2005).
Connecting agency theory literature further to this research topic, interesting takeaways can be found. The article, "Women's Presence on Corporate Boards: Addressing Director Selection Participation and Gender Bias", explores the under-representation of women on corporate boards, despite the increasing number of qualified women (Young et al., 2022). This research discusses how gender bias in director selection and board member participation needs deeper understanding. It indicates that quotas and incentives have been considered in various countries to promote gender diversity on boards, but without enforced quotas, little change is observed (Young et al., 2022). For a better understanding of women's presence on boards, the study emphasizes that a direct focus on gender bias in director selection and participation is crucial (Young et al., 2022). In the context of our research, this article provides insights into the challenges and biases that may affect female board representation in firms. It suggests that merely increasing the number of women on boards may not be sufficient; understanding and addressing the underlying gender biases in selection and participation are crucial. This aligns with the inquiry into the impact of female board representation on decision-making and financial performance metrics, as it implies that the effectiveness of gender diversity is tied to the deeper integration and equitable participation of women in board activities, beyond their mere presence (Young et al., 2022).
To sum up, agency theory emphasizes that especially supervisory board directors reduce agency costs by monitoring agents. This in turn leads to more efficient governance, which is related to better performance and lower risk (Fama et al., 1983).

Upper echelon theory relates to performance and risk through the cognitive framing of directors that impacts firm performance and risk (Li et al., 2022). Regarding risk, studies have found that women tend to have lower overconfidence bias, as well as seeking expert opinion more often (Li et al., 2022). This combination of factors then provides a better risk oversight, decreasing the overall riskiness of firms (Li et al., 2022). This extends to greater firm performance since these attributes allow for better identification and assessment of investment opportunities, leading to higher returns (Li et al., 2022). Concluding from these theories, we hypothesize that gender diversity significantly influences firms.

Hypothesis 2: Increased gender diversity significantly impacted the performance of firms in the sample.
Hypothesis 3: Increased gender diversity significantly impacted the risk of firms in the sample.
Hypothesis 4: Increased gender diversity significantly impacted the investment behavior of firms in the sample.

The implications of these theories are supported by previous literature on gender diversity in firms. While some studies find no significant relationship (e.g., Fernandez & Temprano, 2020), the larger portion of research in this field suggests a considerable impact.
Even though Ciavarella et al. (2017) do not find a significant relationship on the overall leadership level, they report that focusing only on executive directors, firms with a higher proportion of foreign female directors have higher performance (Ciavarella et al., 2017).
The Goncalves et al. (2022) paper delves into the European context, specifically examining the impact of women in executive and non-executive roles on firm value in public companies. The positive association between firms with women CFOs and higher values, along with the intriguing influence of women chairs, provides further depth to the understanding of how gender diversity shapes firm values and market expectations. This study also builds on the notion of the importance of gender-diversified boards for firm performance (Goncalves et al., 2022).
Adams et al. (2009) find an overall significant, but negative, effect on performance for a sample of US companies, which is driven by fewer takeover defences in gender-diversified boards.
The Chatterjee et al. (2023) study, focusing on top Indian companies, examines the relationship between gender diversity on corporate boards and financial performance. The findings suggest that the mere presence of women directors does not significantly impact financial performance. However, positive influences emerge when female members actively contribute and constitute a substantial part of boards (Chatterjee et al., 2023).
Zhang et al. (2020) investigate an institutional approach to gender diversity and find that there is significant variation in the relationship between gender diversity and firm performance based on institutional contexts of different countries and sectors. They emphasize that the relationship is positive the more gender diversity is normatively accepted in the specific context (Zhang et al., 2020).
A highly cited study by Joecks et al. (2013) connects gender diversity on boards with "critical mass theory" (see chapter “Gender diversity”). The authors try to find out whether the relationship between gender diversity and performance has a U-shaped structure. A U-shaped structure would indicate that a small percentage of the underrepresented gender would have negative effects on performance, which would turn positive once the proportion increases to a certain level. The results report an initial negative relationship, but once the 30 % "critical mass" threshold has been reached, this effect becomes positive (Joecks et al., 2013).
Like firm performance, a large number of previous literatures find that gender diversity has a significant influence on firm risk. Sahay et al. (2018) emphasize the global underrepresentation of women in the financial system and argue for increased inclusion to address gender inequality and enhance stability in the banking system. The research suggests that having more women in financial decision-making positions can combat gender inequality, stabilize banking, and lead to economic advantages such as higher business investment and increased spending on education (Sahay et al., 2018).
Building on this foundation, Tashfeen et al. (2023) explore the ways in which women on boards of banks employ investment and financial techniques to decrease risk and enhance firm value. This research reveals that women on boards play a strategic role in value creation, actively mitigating stock volatility and bankruptcy risks. The emphasis on the proactive risk management facilitated by women

in advisory roles reinforces the idea that gender diversity can be a key factor in navigating the intricate landscape of risk within banks (Tashfeen et al., 2023).
Yang et al. (2019) also examine the causality of the relationship between gender diversity on boards and riskiness. Using a difference-in-difference approach, with a focus on systematic as well as idiosyncratic risk, they find a negative relationship. Hence, increasing the proportion of female directors decreases systemic and idiosyncratic risk of firms, which positively impacts investor valuation of firms. These results support the argument of increased financial stability of firms with more female board members (Yang et al., 2019).
Li et al. (2022) study the effect of board diversity on firm risk. They find a significantly positive relation between the proportion of female directors on the board and the standard deviation of monthly stock return as a firm risk proxy (Li et al., 2022).
Risk is also an important determinant of the prosperity of a firm and can be connected to investment behavior. Most studies find a positive relationship between firm riskiness and return (Nguyen et al., 2015). Due to more aggressive financial and investment policies, firms increase their profitability and value (Nguyen et al., 2015). Filippin et al. (2016) show that there is a consensus in the literature about women being more risk-averse than men. This commonly used stereotype implies that having more women on the board negatively impacts firm value (Filippin et al., 2016).
Adams et al. (2016) emphasize the influence of stereotypes on women, which often heightens pressure to perform and undermines their capabilities. A common stereotype for women is that they are risk-averse, thus lowering the risk, but also the performance of firms (Adams et al., 2016). This notion has been challenged in literature, emphasizing that, while decreasing overall risk, women tend to be more innovative and take "good risks", increasing the firms' profitability (Nadeem et al., 2019). Nadeem et al. (2019) challenge this stereotype and find a negative relationship between board gender diversity and firm risk but a positive impact between the number of women on board and firm risk on profitability (Nadeem et al., 2019). Furthermore, they find a positive effect on firm leverage, invalidating the above-explained misconception of female risk aversion (Nadeem et al., 2019). This in turn provides the argument that women tend to take “good” risks, i.e., risks that lead to higher profits (Nadeem et al., 2019).
Bernile et al. (2018) find a significant relationship between board gender diversity and decision-making, specifically the level of R&D investment. They find that more diverse firms have less volatile financial policies. Particularly, they have a lower debt ratio and maintain more dividend payouts. However, even though financial decisions are less risky, having more female directors on the board increases the aggressiveness of investment policies, mainly into research and development. Thus, even though one could assume that the risk of the firm would decrease its profitability, this effect is counteracted by increased innovativeness of a more gender-diversified board. This provides evidence of correct risk-taking of women, which indirectly might increase profitability while keeping the business financially stable (Bernile et al., 2018).

2.2 Firm Board Characteristics

Prior literature shares the view that quotas affecting individual board characteristics tend to change hiring practices and thus improve overall board quality in more than the targeted aspect (Guiso et al., 2024). Furthermore, the theory of heterogeneous groups also argues that improving one branch of diversity might have positive effects on the overall performance of the group (Knouse et al., 1999). In line with this literature, it is assumed that the change in diversity supports a change in overall board characteristics (i.e., H5).

Hypothesis 5: Increased gender diversity significantly impacted other board characteristics (i.e., tenure, average qualifications, network size, and nationality mix) of firms in the sample.

2.3 Sector Analysis

Gender diversity (and thus female representation) differs across sectors and industries (LinkedIn Economic Graph, 2023). Some regulations target specific industries, but most gender quota laws are cross-sectoral.

Since for the FüPoG I regulation used in this study, all sectors will be affected to the same degree, traditionally male-dominated sectors will inevitably be more exposed to the effects of such quotas. These sectors will have to increase their gender diversity more to comply with the generic regulation. The World Economic Forum published a report on female representation in different industries. This report reveals that healthcare and care services (64.7 %) is the most female-dominated field. Female employees outnumber men workers, in education (54.0 %) and consumer services (51.8 %). Industries with an underrepresentation of women are retail (48.7 %), real estate (44.7 %) and financial services (42.4 %). The lowest participation of women is in sectors like oil, gas and mining (22.7 %) and infrastructure (22.3 %) (World Economic Forum., 2023).
Additional evidence is provided by the "Women in Leadership Report" (LinkedIn Economic Graph, 2023).

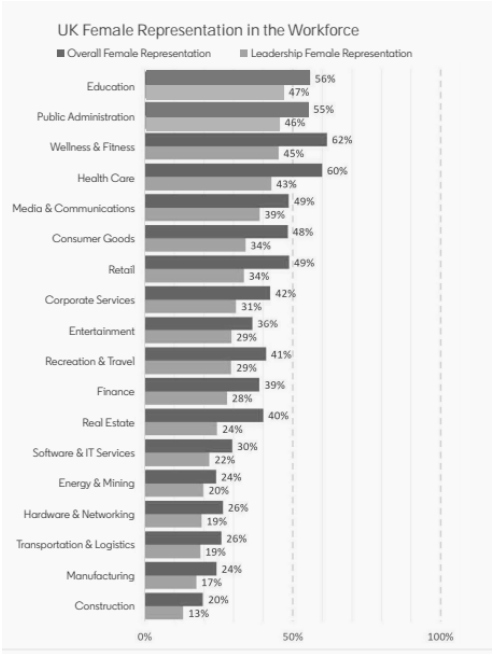

Figure 2 - Women in Leadership by Industry (source: LinkedIn Economic Graph, 2023)

Figure 2 reports that the highest gender inequality prevails in traditionally male-dominated sectors such as construction, manufacturing, finance and IT. We consider all these industries in our sample and expect that the impact of the regulation will be more pronounced.
We therefore hypothesize that the regulation affected sectors differently and that this difference is also present in their performance, investment behavior, risk, and board characteristics:

Hypothesis 6: The effects are dependent on sectoral changes in gender ratios.

2.4 Overview of Hypotheses

Taking the reviewed literature into account, the following hypotheses have been developed.

H1	*Gender diversity increased after the introduction of the FüPoG I regulation in 2015 in Germany.*
H2	*Increased gender diversity significantly impacted performance of firms in the sample.*
H3	*Increased gender diversity significantly impacted risk of firms in the sample*
H4	*Increased gender diversity significantly impacted investment behavior of firms in the sample.*
H5	*Increased gender diversity significantly impacted other board characteristics (i.e., tenure, average qualifications, network size and nationality mix) of firms in the sample.*
H6	*The effects is dependent on sectoral changes in gender ratios.*

Table 1 - Overview of Hypotheses

3. Data and Methodology

3.2 Data and Sample

We analyze the effect of gender-diversified boards on the performance and risk of firms, using data about their board members as well as financial data. Governance data, such as individual board members' characteristics, their gender, age, tenure, nationality, qualifications, time in the company, network size, and the companies' board size, was provided by BoardEx. Balance sheet data is taken from Compustat (Capital IQ) and Refinitiv (Eikon). Data has been gathered on an individual director basis and subsequently merged by ISIN, company name, and year. Missing data was hand-collected from annual reports or imputed using predictive mean matching. Furthermore, to deal with outliers, data has been winsorized at 1 % and 99 % levels (Yang et al., 2019; Matsa et al., 2013). Additionally, we take the logarithm of the variables in our analysis to operate with more normally distributed values. We consider data on annual frequency from 2012 until 2018. Years prior to 2012 have been excluded because of the potential effects of the 2008 financial crisis as well as limited data availability. For the analysis, the timeframe has been cut to 2018 because of the introduction of the Austrian Gender Quota Regulation. This would have shifted the definition of treatment and control group, making the proposed research design of this study imprecise. The timeframe of our study could be considered relatively stable (European Commission, 2014).

The sample consists of German, Austrian, and Swiss companies listed on the stock exchange. The firms are of various sectors, sizes, and ages to achieve a representative sample. Only companies with complete information have been considered, and firms in financial distress have been excluded.

The treatment group for the analysis is defined as German companies affected by the gender quota of 2015 (FüPoG I), i.e., German listed and fully codetermined companies. German listed firms with more than 2000 employees must have equal codetermination (Hoffman et al., 1976). The control group consists of all companies in the sample not affected by the German gender quota regulation (i.e., German companies with less than 2000 employees, Austrian firms, and Swiss firms). The total sample amounts to 275 companies, with the treatment sample size equal to 40 companies, with total observations of 1925.

We choose to include Austrian, and Swiss companies in the control group to provide a comparable and representative sample. Only using German companies not affected by the regulation as the control group would leave us with only relatively small companies (i.e., companies with less than 2000 employees). Analyzing DACH region firms with a relatively large sample size allows examining cross-border relationships but within a similar economic context. The DACH countries possess similarities in terms of their economic development, cultural and historic ties, political structures, and legal frameworks, which makes them suitable for this analysis (Bandelow, N. C., Sager, F., & Biegelbauer, P., 2013).

3.3 Methodology

The methodology of this study combines a difference-in-difference approach, using time series panel data and fixed effects, with a two-stage least squares (2SLS) estimation. This provides a robust method that validates the findings across different methodological frameworks and increases the credibility of our results.

A 2SLS approach is often used to deal with potential endogeneity of explanatory variables (i.e., gender ratio). The FüPoG I gender quota regulation serves as an instrumental variable (IV). This IV is modeled as a dummy from a difference-in-difference setting. Due to its exogenous nature, it presumably influences gender diversity within the affected firms (first-stage) and not directly firms' performance or risk (second-stage). Furthermore, it is highly correlated with gender ratio, which confirms its quality as an instrument. In this way, the impact of gender diversity is isolated from confounding factors.

In the first-stage, Gender Ratio (i.e., the percentage of male directors on boards) is explained by the dummy variable "DID" (i.e., the instrument). We predict the potentially endogenous variable (i.e., gender ratio) using the instrumental variable. The results of the first-stage analysis are then fitted (i.e., predicted) and used in the second-stage, where dependent variables for performance, investment

behavior, risk, and board characteristics are explained by these fitted values. For the 2SLS model, we include all control variables as well as fixed effects.
Many studies only include firm and industry fixed effects and do not control for time-fixed effects (Yang et al., 2019; Matsa et al., 2013). In our study, we include time and firm fixed effects and dummies (factors) for sector and country effects. A Wu-Hausman test was performed to confirm that fixed effects are a better fit for our model than random effects.

3.4 Variables

3.4.1 Dependent Variables (DV)

For the first-stage of our 2SLS analysis, the main dependent variable is "Gender Ratio", which equals 1 if the supervisory board consists of 100 % of men. We choose to continue with this scaling to stay consistent with the data providers and to point towards the gendered nature of data (see "Discussion and Implications").
We use a combination of market and accounting data to calculate our primary performance variables. Accounting data represents past performance of companies and thus is often considered backward-looking (Yang et al., 2019). Market data reflects the investors' views and thus can be seen as forward-looking (Yang et al., 2019).
As performance variables, we include Tobin's Q, Market to Book Ratio (MTBR), and Return on Assets (ROA). Tobin's Q indicates firm effectiveness from the perspective of investors (Wolfe et al., 2003). It is a ratio between the market value of total assets and its replacement value (Wolfe et al., 2003). Similarly, MTBR is also an indicator of firm value but only includes equity instead of total assets and divides the market value of equity by its book value (Yang et al., 2019). Tobin's Q is thus supposed to provide a more comprehensive insight into firm performance. For the sake of completeness, we consider both variables.
Since **Tobin's Q** and **Market to Book Ratio (MTBR)** were not readily available from data providers, we calculate them using the following formulas:

Tobin's Q = Market Value Total Assets / Replacement Value
= Total Assets + (Common Shares Outstanding * Price Close - Fiscal) - Total Common/Ordinary Equity - Total) / Total Assets

Market to Book Ratio = Market Value Total / Book Value per Share
= (Common Shares Outstanding) * (Price per Share) / (Common Equity * Common Shares Outstanding)

As an additional performance proxy, **Return on Assets (ROA)** has been used, which is calculated as:

ROA = Earnings before Interest and Tax (EBIT) / Total Assets.

The variables **Capital Expenditure (CapEx)** and **Research and Development (R&D)** are used to investigate the investment behavior of the firm. These might also be seen as secondary indicators for the channel of potential effects on risk and performance (Nadeem et al., 2019).
R&D expenditure has been provided by Compustat and capital expenditure is calculated as:

CapEx = Ending PP&E - Beginning PP&E + Depreciation

In terms of firm risk, we follow Yang et al. (2019) and Li et al. (2022) and use market data, particularly daily returns. Since Compustat does not provide this directly, we use the following formula to calculate daily stock returns:

Daily stock return = (((Closing Price of the stock *Adjustment factor for stock splits and dividends / Dividend adjustment factor) [current period]) / ((Closing Price of the stock *Adjustment factor for stock splits and dividends / Dividend adjustment factor) [previous time period]) -1) * 100

Subsequently, we calculate the **standard deviation of daily returns (SD returns)** and use it as a proxy for total risk - i.e., idiosyncratic and market risk. Using this variable to investigate risk has been well established in the literature (e.g., Perryman et al., 2016; Li et al., 2022; Sila et al., 2016).
Another firm-risk-related indicator is **Debt to Equity Ratio (DTE Ratio)**. This ratio can be interpreted as the company's ability to meet outstanding debt obligations (Nukala et al., 2021). In this sense, we use it as a secondary variable to investigate whether gender diversity influences the propensity to leverage. In combination with the risk proxy, this could deliver a more comprehensive finding.

3.4.2 Independent Variables (IV)

Since the focus of this study is gender diversity, we use **Gender Ratio** as the main independent variable. The data is provided by BoardEx and is calculated as the percentage of male directors on boards. Consequently, Gender Ratio is equal to 1 if the board consists of 100 % male directors and 0 if the board is purely female. This is used as a predicted value in the second-stage analysis of our 2SLS.
"DID" is a dummy variable representing firms that are affected by the FüPoG I gender quota regulation of 2015 in Germany. It is used as the instrument for our analysis. It takes values of 1 if the firm is affected by the gender quota regulation (i.e., belongs to the treatment group). If the firms fall into the control group category, this dummy variable takes values of 0.

3.4.3 Control Variables (CV)

We include several controls ranging from accounting to governance variables.
In terms of accounting variables, **total assets** are often used to control for firm size (Asad et al., 2023). Some studies use the number of directors as a proxy for firm size (Yang et al., 2019). However, due to multicollinearity concerns, we choose to exclude the number of directors as a control variable and use only total assets instead. To isolate the causal effect of gender diversity, we control for other possible (and available) governance influences. Individual board member characteristics include **nationality, number of qualifications, time on board, and network size** (Yang et al., 2019; Li et al., 2022; Asad et al., 2023). To avoid multicollinearity, time in company is excluded, as it nearly perfectly positively correlates with time on board. The number of qualifications is provided as a numeric variable and can be interpreted as the average number of qualifications at the undergraduate level and above for all directors in the sample (IE Business School., n.d.). The nationality mix of the board describes the percentage of directors from different countries (IE Business School., n.d.). BoardEx defines network size as the "number of overlaps through employment, other activities, and education" (IE Business School., n.d.).
Table 2 classifies and describes all variables that have been used.

Classification	Variable	Description
DV	Tobin's Q	Market Value Total Assets / Replacement Value
DV	MTB Ratio	Market Value / Book Value
DV	ROA	EBIT / Total Assets
DV	SD returns	Standard Deviation of Daily Stock Returns
DV	DTE Ratio	Total Liabilities / Total Equity
DV	CapEx	PP&E end - PP&E start + Depreciation
DV	R&D	Research and Development Expenses
DV / IV	Gender Ratio	%age of male directors (1 = 100% male)
IV	DID	Dummy variable for companies affected by FüPoG I regulation
CV	Total Assets	Firm size proxy
CV	Nationality Mix	%age of nationalities of directors different from home country of company
CV	Number of Qualifications	Average number of qualifications at undergraduate level and above
CV	Time on Board	Years spent in role as director
CV	Network Size	Number of potential connections that the company could benefit the company

Table 2 - Overview of Variables

3.4.4 Regression Models

A panel data regression from 2012 until 2018 is used. For the first-stage of our 2SLS approach, the following regression model has been applied:

$$\begin{aligned}&\log(\boldsymbol{GenderRatio})_{it}\\&= \boldsymbol{\beta_0} + \boldsymbol{\beta_1 DID_{it}} + \boldsymbol{\beta_2}\, \boldsymbol{Qualifications_{it}} + \boldsymbol{\beta_3}\, \boldsymbol{TimeOnBoard_{it}}\\&+ \boldsymbol{\beta_4 NationalityMix_{it}} + \boldsymbol{\beta_5 NetworkSize_{it}} + \boldsymbol{\beta_6 TotalAssets_{it}}\\&+ \sum \boldsymbol{j}\, \boldsymbol{\beta_{7j} Country_{ij}} + \sum \boldsymbol{k} \boldsymbol{\beta_{8k} Sector_{ik}} + \boldsymbol{\mu_i} + \boldsymbol{\lambda_t} + \boldsymbol{\epsilon_{it}}\end{aligned}$$

Here, Gender Ratio is explained by the dummy variable „DID“, which equals 1 if the company is in the treatment group and 0 if the firm is classified as the control group. The variable “GenderRatio” has been log-ed to operate with normally distributed values. We include multiple board characteristics as controls, such as average number of qualifications (i.e., „Qualifications”), time on board (i.e., „TimeOnBoard“), nationality mix (i.e., „NationalityMix“) and network size (i.e., „NetworkSize“). Additionally, we control for size of the firm with „TotalAssets“. We primarily use firm and time fixed effects in this regression (μi + λt). Furthermore, we factor (i.e., $\sum j$ and $\sum k$) “Country” and “Sector” to control for country and sector fixed effects as well.
We subsequently fit the result of the first-stage regression and use these values in the second-stage as the main explanatory variable for our independent variables.
The regression model for our second-stage is as follows:

$$\begin{aligned}\log(\boldsymbol{Y})_{it} = \boldsymbol{\beta_0} + \boldsymbol{\beta_1 fitted\_GenderRatio_{it}} + \boldsymbol{\beta_2}\, \boldsymbol{Qualifications_{it}} + \boldsymbol{\beta_3}\, \boldsymbol{TimeOnBoard_{it}}\\+ \boldsymbol{\beta_4 NationalityMix_{it}} + \boldsymbol{\beta_5 NetworkSize_{it}} + \boldsymbol{\beta_6 TotalAssets_{it}}\\+ \sum \boldsymbol{j}\, \boldsymbol{\beta_{7j} Country_{ij}} + \sum \boldsymbol{k} \boldsymbol{\beta_{8k} Sector_{ik}} + \boldsymbol{\mu_i} + \boldsymbol{\lambda_t} + \boldsymbol{\epsilon_{it}}\end{aligned}$$

In the second-stage regression model, we use the same controls and fixed effects as in the first-stage. Y indicates all dependent variables of interest. These include:

1. Performance Variables: Tobin’s Q, Market to Book Ratio, Return on Assets
2. Investment Behavior Variables: Capital Expenditure, Research & Development
3. Risk Variables: Standard Deviation of Daily Returns, Debt to Equity Ratio
4. Board Characteristics Variables: Number of Qualifications, Time on Board, Nationality Mix, Network Size.

3.4.5 Endogeneity

Gender quota regulation has grown increasingly popular in many developed countries (Li et al., 2022). Its efficiency can only be confirmed or denied by literature reporting robust results. The topic of gender equality being as sensitive as it is, it is important to find the most fitting method to ensure the possibility of a strong argument.

Not many studies that focused on gender diversity on boards have considered a methodology that properly handles endogeneity concerns (Yang et al., 2019). Adams et al. (2016) emphasize that transforming correlation into causality by dealing with endogeneity is imperative for gender diversity research. However, if not appropriately addressed, endogeneity might cause substantial problems and can throw a negative light on related literature (Sila et al., 2016; Kilic et al., 2016; Adams et al., 2016). Sources of endogeneity in gender diversity literature are mainly due to omitted variable bias and selection bias. Omitted variable bias occurs when one does not control for a factor that affects the treatment variable, outcome variable and/or both (Yang et al., 2019). Examples of variables that are prone to being omitted are director ability and time-invariant firm characteristics (Yang et al., 2019). In this particular case, we are mostly concerned about gender ratio (Adams et al., 2016). Selection bias is also relevant to consider when discussing gender diversity literature. In this context it can refer to a situation where female directors with different core values systematically choose director positions (Yang et al., 2019). In this sense, women that select themselves into male-dominated positions present with male characteristics, because otherwise they would not be able to reach such placements (Yang et al., 2019).

We use two different types of analyses to deal with the highlighted issues of endogeneity. First, a difference-in-difference analysis is used. A difference-in-difference analysis is often suitable for experiments where an exogenous variable, such as a quota regulation, affects a subgroup of the sample and does not affect the rest of the sample (Callaway et al., 2021).

Therefore, one can test for the significant differences between the affected treatment group and the non-affected control group before and after the exogenous shock (i.e., the reform) (Callaway et al., 2021; Yang et al., 2019; Matsa et al., 2013).

We integrate this into a two-stage least square regression (instrumental variable approach) to deal with reverse causality and omitted variable bias (Kilic et al., 2016; Sila et al., 2016). To choose a suitable instrumental variable (IV), it must fulfil the following conditions: an IV has to be associated with the treatment; it should not have any direct association with the final outcome, only through the treatment; and there should not be any association with the measured confounders (Aso et al., 2020). Furthermore, a strong instrumental variable should be highly correlated with the endogenous variable. Former studies on gender diversity have used board gender quota reforms as IVs (Li et al., 2022). For this study, the German board gender quota reform of 2015 - the FüPoG I - offers itself as an appropriate IV, due to its exogenous nature as well as the high correlation with gender ratio.

4. Analysis and Results

4.2 Summary Statistics

In this section, summary statistics, the correlation matrix, t-tests and F-tests as well as the distribution of sectors are reported.

	Treatment	Germany (control)	Austria	Switzerland
treated	1	0	0	0
TobinsQ				
mean	2,02918956	2,506809907	1,554684883	2,805524946
SD	1,797085905	2,771001487	1,204994791	2,866832699
min	0,539301882	0,279861861	0,48093889	0,48093889
max	15,8522123	15,8522123	15,58998107	15,58998107
SD of returns				
mean	13,64474834	8,584359528	7,699330468	12,25822868
SD	34,37846463	24,70435368	20,84425951	29,57874888
min	0,347281391	0,347281391	0,353670976	0,353670976
max	234,2099242	234,2099242	201,3578455	201,3578455
TotalAssets				
mean	125608,759	5748,178476	13614,28151	14463,35979
SD	295628,4661	13946,85305	37812,51798	54547,72597
min	78,265	52,73854	8,47	8,47
max	1595342,42	102898,3	435826	463636
Market_to_Book_Ratio				
mean	4,267653114	3,906566417	2,818784144	4,430041824
SD	4,35279345	4,583076908	3,797362556	5,374865509
min	0,177474411	0,177474411	0,172521772	0,172521772
max	21,70167768	22,89751551	28,76731375	28,76731375
ROA				
mean	0,045589722	0,049912897	0,041177395	0,04500227
SD	0,059984302	0,066807537	0,060502064	0,078617204
min	-0,241553953	-0,241553953	-0,334448792	-0,334448792
max	0,243050088	0,243050088	0,243804291	0,243804291
Debt_to_Equity_Ratio				
mean	6,697003429	1,403014523	2,883118813	2,201299015
SD	10,04052616	2,078602484	3,883660589	3,704886258
min	-0,616051311	-0,616051311	0,000238224	0,000238224
max	49,59947696	18,50974026	24,69901738	24,69901738
GenderRatio				
mean	0,777587814	0,891944724	0,855015915	0,875669268
SD	0,088143351	0,150238168	0,108495807	0,12463415
min	0,571	0,4	0,509	0,509
max	1	1	1	1
NationalityMix				
mean	0,316487455	0,14120603	0,254376658	0,344297719
SD	0,181561549	0,22565405	0,251354197	0,282301596
min	0	0	0	0
max	0,8	0,8	0,8	0,8
NoQuals				
mean	1,726067136	1,565556486	1,627902505	2,191565409
SD	0,429301607	0,613632829	0,418124092	0,579064121
min	0,5	0,461666667	0,5	0,5
max	2,878194444	2,878194444	3	3,4
TimeBrd				
mean	6,286224249	6,53637143	6,682876433	7,047956402
SD	2,121297334	3,085949853	2,507613191	3,435384137
min	0,868416667	0,868416667	0,706666667	0,706666667
max	13,075	15,5922	17,41583333	17,41583333
NetworkSize				
mean	1008,143214	507,2424957	472,5969939	937,6771393
SD	647,2071817	473,7847775	394,2409164	702,8683146
min	17,6875	18,71428571	56,09090909	34,2
max	2968,881253	2717,857143	3280,688017	3280,688017
CapEx				

mean	1072,316685	-40,57428643	293,8623793	150,3295924
SD	5606,629626	1032,24817	2107,667394	1881,54905
min	-16111,211	-7491,9	-8266,46	-8266,46
max	21489,16	5519,807	13336,52	13336,52
Observations	279	199	377	1666

Table 3 – Summary Statistics

In table 3, summary statistics of the main variables of interest are displayed. The treatment group, the German control group, Austrian and Swiss firms are shown separately. The total number of observations is 1925 on a yearly basis, with 279 stemming from the treatment group. The most observations come from companies based in Switzerland. This is simply due to data availability.
The mean value for Tobin's Q is comparable across the treatment and control group with values around 2.0. The mean of total assets is higher for the treatment group, while the average firm size proxy for the control group moves towards treatment group levels after including Austrian and Swiss firms. The values for the Market to Book Ratio are comparable for all groups in the sample, and mean Return on Assets is around 0.4. The gender ratio for the treatment group is lower (with 77%) than for the control groups, where the mean values range between 0.86 and 0.89. This suggests that the treatment group has, on average, the highest representation of women on their supervisory boards. The average nationality mix for the treatment group is 0.31, for German control firms and Austrian firms slightly below this level. The average number of qualifications moves between 1.67 and 2.2, with the maximum qualifications being 3.4. Firms in our treatment group have the highest mean network size with around 1008 connections.
These statistics show that the control group has been appropriately chosen as it includes comparable values across variables.

	t-test	F-test
log(TobinsQ)		
mean	**0.000685**	
SD		**0.0000551**
log(SD of returns)		
mean	**0.0822**	
SD		**0.0971**
log(TotalAssets)		
mean	**1.13e-47**	
SD		**0.0567**
log(Market_to_Book_Ratio)		
mean	0.124	
SD		0.350
log(ROA)		
mean	**0.0983**	
SD		**5.35e-10**
log(Debt_to_Equity_Ratio)		
mean	**2.98e-26**	
SD		0.974
log(GenderRatio)		
mean	**6.73e-40**	
SD		**4.44e-12**
log(NationalityMix)		
mean	0.693	
SD		**0.00247**
log(NoQuals)		
mean	**9.28e-14**	
SD		**0.00000218**
log(TimeBrd)		
mean	**0.0401**	
SD		**0.0000145**
log(NetworkSize)		
mean	**0.00000570**	
SD		0.829
log(CapEx)		
mean	**0.0144**	
SD		**1.50e-93**

Table 4 - t-test and F-test

We combine basic summary statistics with F-tests and t-tests in table 4. Since we used a logarithm of the variables, a t-test is an appropriate measure to test the differences between the means of the variables of treatment and control groups. The F-test is a standard measure used for testing differences in standard deviations of normally distributed data. Our analysis shows significance for almost all reported variables. Even though Market to Book Ratio is only marginally significant, we choose to include it in our analysis to get a representative insight (Yang et al., 2019).

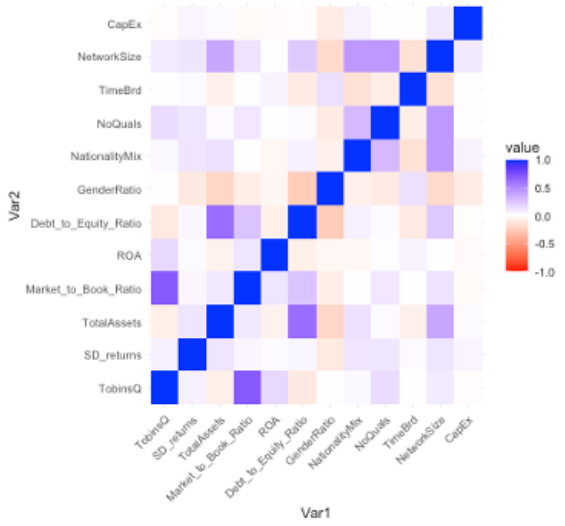

Figure 3 - Correlation Matrix

Figure 3 explores the correlation between the variables of interest. We can observe that Tobin's Q, Market to Book Ratio and Return on Assets are correlated at around 0.5, which is to be expected as they are all proxies for performance. We choose to keep all performance proxies to get a comprehensive picture of the effect. Debt to Equity Ratio is further correlated with total assets, which has been confirmed in previous literature (Marsh et al., 1982; Hovakimian et al., 2001).

	Treatment	Germany (control)	Austria	Switzerland
Sectors	**share**	**share**	**share**	**share**
Aerospace & Defence	0.00%	0.00%	1.06%	0.00%
Automobiles & Parts	9.68%	4.52%	2.39%	0.54%
Banks	6.45%	0.50%	14.32%	9.78%
Beverages	0.00%	4.52%	0.00%	0.00%
Business Services	0.00%	4.52%	0.00%	2.70%
Chemicals	12.90%	0.00%	2.39%	3.78%
Clothing & Personal Products	6.45%	0.00%	0.00%	1.62%
Construction & Building Materials	3.58%	4.02%	7.16%	3.24%
Containers & Packaging	0.00%	0.00%	0.00%	1.08%
Diversified Industrials	3.23%	0.00%	7.16%	4.32%
Electricity	3.23%	0.00%	0.00%	1.08%
Electronic & Electrical Equipment	6.45%	4.52%	4.77%	5.94%
Engineering & Machinery	6.09%	0.50%	4.77%	10.98%
Food & Drug Retailers	0.00%	9.05%	2.39%	1.08%
Food Producers & Processors	0.00%	0.00%	0.00%	4.86%
Forestry & Paper	0.00%	0.00%	2.39%	0.00%
General Retailers	0.00%	0.00%	0.00%	1.68%
Health	3.23%	9.05%	0.00%	4.32%
Information Technology Hardware	6.45%	0.00%	4.77%	2.16%
Insurance	3.23%	0.00%	4.77%	2.16%
Investment Companies	6.45%	0.00%	0.00%	0.54%
Leisure & Hotels	0.00%	0.00%	2.39%	1.62%
Life Assurance	0.00%	0.00%	0.00%	0.54%
Media & Entertainment	0.00%	0.00%	0.00%	1.08%
Oil & Gas	0.00%	0.00%	4.77%	0.00%
Pharmaceuticals and Biotechnology	3.23%	4.52%	0.00%	8.64%
Private Equity	0.00%	9.05%	0.00%	2.70%
Publishing	0.00%	0.00%	0.00%	0.54%
Real Estate	3.23%	4.52%	9.55%	9.18%
Renewable Energy	0.00%	9.05%	0.00%	1.08%
Software & Computer Services	3.23%	4.52%	0.00%	1.62%
Speciality & Other Finance	3.23%	22.61%	3.45%	7.74%
Steel & Other Metals	0.00%	4.52%	4.77%	1.62%
Telecommunication Services	3.23%	0.00%	4.77%	0.54%
Transport	3.23%	0.00%	4.77%	1.20%
Utilities - Other	3.23%	0.00%	0.00%	0.00%

Table 5 – Sectoral Composition

Table 5 shows the sectoral composition of each group and country. We consider 36 sectors, excluding tobacco and alcohol (Matsa et al., 2013). The most sectors are represented in Switzerland, as this is where most of the firms in our control group are based. The highest share of sectors in the treatment group is the “Chemicals” industry, followed by “Information Technology”, “Investment Companies”, “Clothing & Personal Products”, and “Engineering & Machinery”. In the control group, most German

companies are in the “Specialty Finance” sector, Austrian firms in the “Banks” sector, and in our Swiss sample, “Engineering & Machinery” has the highest representation.

4.3 Plotting Gender Ratio Across Time

We start the analysis by plotting the average yearly gender ratio against time. A decrease in gender ratio would suggest an increase in the presentation of female directors on supervisory boards for the studied companies. This plot provides the basis for our analysis.
Figure 4 shows the graphic of the evolution of the average gender ratio over the timeframe of this analysis. The blue line shows the average gender ratio for all companies within the treatment group. The red line, on the other hand, displays this variable for our control group. Until 2014, the groups, on average, followed an approximately parallel trend. We can observe a clear difference in the evolution rate in gender ratio after 2015 between the treatment group and the control group. From 2015 onward, the treatment group experienced a sharper increase in gender diversity relative to the control group. The downward trend suggests an increase in the participation of women on the boards overall.
In figure 5 a more granular, country level, approach is displayed to see the evolution within individual countries. German non-treated companies have the highest gender ratio (i.e., the lowest participation of women) across nearly the whole timeframe, Switzerland being in the middle and Austria having the highest proportion of female directors of the whole control group. The treatment group shows the highest female participation over every year, with a strong decline after 2015.

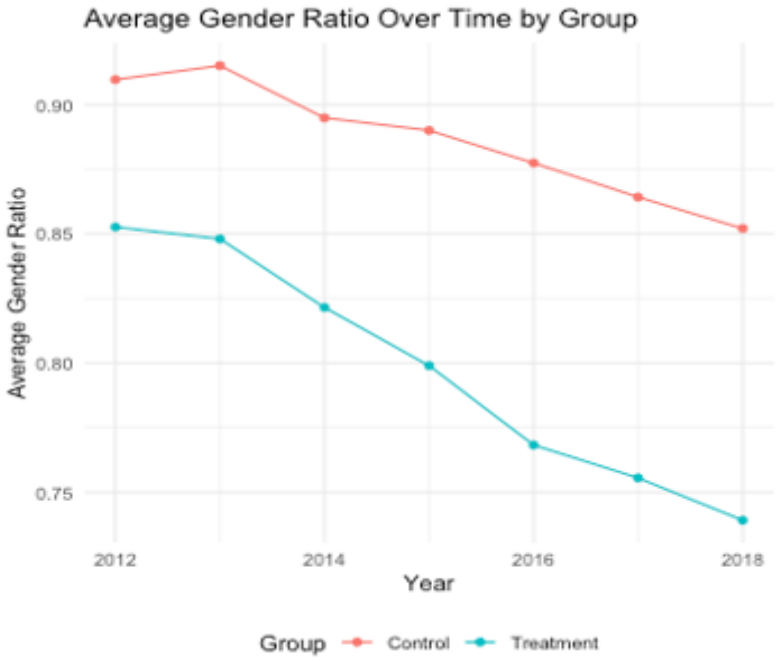

Figure 4 – Plot of Gender Ratio over Time

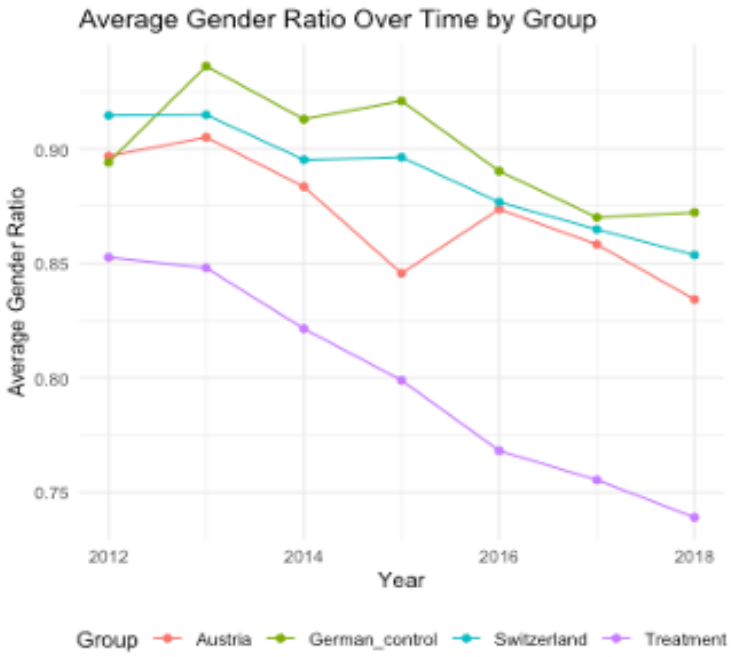

Figure 5 - Gender Ratio over Time (countries)

One can also observe that the gender ratio did not decrease to 70 % (i.e., the legislated 30 % gender quota) immediately after the FüPoG I regulation became effective, nor did the companies reach the stipulated level before the end of our observation period. There are two potential reasons for this. First, a gradual adjustment is to be expected as it requires time to recompose supervisory boards due to contract periods and termination clauses, as well as governance considerations. Second, FüPoG I could be categorized as a "soft hard law". While the stipulated quota of 30 % was mandatory, the sanctions "only" included reputation damage. Even though this can have a large impact on firm profitability and even solvency, financial sanctions tend to have a more immediate effect (Iacobucci et al., 2014). FüPoG II was introduced in 2021 in Germany to strengthen FüPoG I. This translated into widening the scope of applicability, but also, importantly, by introducing financial sanctions (for more details, please refer to chapter “Regulation”). It would be interesting to conduct an analysis beyond the introduction of FüPoG II to observe potential differences in the effectiveness of financial vs. reputational sanctions (see chapter “Discussion and Implications”).

4.4 Results

In this section, we report the results of our 2SLS analysis. In the first part, we discuss the first-stage difference-in-difference analysis of the change in gender ratio after the FüPoG I regulation in 2015. In the second part, we analyze the results of the second-stage analysis, including performance, risk, investment, and board variables.

4.4.1 First-stage

Table 6 reports the first-stage results of our 2SLS analysis. Here, gender ratio is explained by the chosen instrument in a difference-in-difference regression with fixed effects and control variables. The instrument ("DID") is an interaction term of years post-2015 with German companies that had more than 2000 employees post 2015. We use time and firm fixed effects and control for sectors and country effects. We further control for the size of the company and other board member characteristics (i.e., tenure, qualifications, nationality, and network size).

	log(Gender Ratio)
Main Explanatory Variable DID (Germany * Employees > 2000 * post 2015)	**-0.017** (0.006)**
NoQuals	0.001 (0.003)
TimeBrd	**0.003*** (0.006)**
NationalityMix	0.005 (0.000)
NetworkSize	**-0.000* (0.000)**
TotalAssets	**-0.000** (0.000)**
Number of Observations	1925
Firm FE	Yes
Sector FE	Yes (factor)
Time FE	Yes
Country FE	Yes (factor)
R-squared	0.048

Table 6 - First-stage

The results show a negative, statistically significant (p = 0.01) coefficient, which indicates that the treatment group (in this case, firms in Germany with more than 2000 employees after 2015) experienced, on average, a decrease of 1.79% in the dependent variable compared to the control group. This is a clear indication of the effectiveness of FüPoG I.
The results of our analysis *confirm hypothesis H1: Gender diversity increased after the introduction of the FüPoG I regulation in 2015 in Germany.*

4.4.2 Second-stage

In the second-stage, we fit the values of the first-stage and use this to explain dependent variables.

4.4.2.1 Performance

	log(Tobin's Q)	log(MTB Ratio)	log(ROA)
Fitted Gender Ratio (1 = 100% male)	**-2.632. (1.550)**	**-4.476. (2.481)**	**-6.495* (2.752)**
NoQuals	**0.096*** (0.016)**	**0.062* (0.026)**	**0.048. (0.029)**
TimeBrd	**0.012* (0.005)**	0.015 (0.009)	**0.034** (0.011)**
NationalityMix	0.020 (0.036)	-0.069 (0.058)	**1.425* (0.064)**
NetworkSize	0.000 (0.000)	0.000 (0.000)	-0.000 (0.000)
TotalAssets	**-0.000** (0.000)**	**0.000* (0.000)**	**-0.000** (0.000)**
Number of Observations	1925	1925	1925
Firm FE	Yes	Yes	Yes
Sector FE	Yes (factor)	Yes (factor)	Yes (factor)
Time FE	Yes	Yes	Yes
Country FE	Yes (factor)	Yes (factor)	Yes (factor)
R-squared	0.035	0.035	0.019

Table 7 - Second-stage (Performance)

Table 7 shows the results of our second-stage analysis with performance as the dependent variable. We consider firm, time, country, and sectors fixed effects as well as all control variables. The results suggest a significantly negative relationship between the fitted values of the gender ratio and all three chosen performance proxies (i.e., Tobin's Q, Market to Book Ratio and Return on Assets).
As for Tobin's Q, increasing the share of female directors by 1 % (i.e., decreasing gender ratio) is associated with a significant increase in Tobin's Q (β= - 2.632; p = 0.08). A similar, but stronger result is found for MTB Ratio, where the coefficient is -4.476 (p = 0.07). For Return on Assets and coefficient is also negative with a coefficient of -6.495 (p = 0.01).
This indicates that a higher female representation on supervisory boards is associated with a significant increase in the performance of firms. These findings are in line with previous literature

(Joecks et al., 2013; Chatterjee et al., 2023; Zhang et al., 2020) and support the diversity argument even further.
Concluding, we *confirm hypothesis 2: Increased gender diversity significantly impacted the performance of firms in the sample.*

4.4.2.2 Investment Behavior

	log(CapEx)	**log(R&D)**
Fitted Gender Ratio (1 = 100% male)	-9.952 (0.000)	-0.416 (4.455)
NoQuals	-0.019 (0.015)	0.029 (0.046)
TimeBrd	0.492 (0.562)	-0.007 (0.017)
NationalityMix	0.019 (0.034)	0.108 (0.103)
NetworkSize	0.153 (0.188)	0.000 (0.000)
TotalAssets	**-0.006*** (0.002)**	-0.000 (0.000)
Number of Observations	1925	1925
Firm FE	Yes	Yes
Sector FE	Yes (factor)	Yes (factor)
Time FE	Yes	Yes
Country FE	Yes (factor)	Yes (factor)
R-squared	0.035	0.002

Table 8 - Second-stage (Investment Behavior)

Table 8 represents the results of the second-stage analysis for investment variables. Here, capital expenditure as well as research and development expenses have been chosen as proxies for the investment behavior of companies.
The results suggest negative, albeit non-significant (p = 0.49 for CapEx; p = 0.95 for R&D), relationships.
We thus cannot reject the null hypothesis. We *reject hypothesis 3: Increased gender diversity significantly impacted the investment behavior of firms in the sample.*

4.4.2.3 Risk

	log(DTE Ratio)	**log(SD of returns)**
Fitted Gender Ratio (1 = 100% male)	**-8.264* (3.591)**	2.066 (1.177)
NoQuals	**-0.0852* (0.037)**	0.008 (0.031)
TimeBrd	0.011 (0.013)	0.008 (0.011)
NationalityMix	-0.029 (0.083)	**0.208** (0.069)**
NetworkSize	**0.000* (000)**	0.000 (0.000)
TotalAssets	**0.000*** (0.000)**	0.000 (0.000)
Number of Observations	1925	1925
Firm FE	Yes	Yes
Sector FE	Yes (factor)	Yes (factor)
Time FE	Yes	Yes
Country FE	Yes (factor)	Yes (factor)
R-squared	0.062	0.013

Table 9 - Second-stage (Risk)

Table 9 represents the results of our second-stage analysis for risk. The main risk variable is the standard deviation of returns (Li et al., 2022; Yang et al., 2019). Here, a positive, albeit non-significant, result has been found. Significance would suggest that a higher participation of female directors decreases risk for our sample. A positive relation would be in line with previous literature (Nadeem et al., 2019; Nguyen et al., 2015). Furthermore, this would also be supported by the upper-echelon and agency theory, which suggest that higher diversity in the top-management level increases monitoring and thus decreases agency costs and risk. However, we cannot come to such conclusions

due to the non-significance of the results. Thus, *hypothesis 4: increased gender diversity significantly impacted the risk of firms in the sample is (marginally) denied.*
We further look at leverage (Debt to Equity Ratio). Here, we find a significant and negative relationship (p = 0.02). This suggests that a higher female representation increases the Debt to Equity Ratio. According to our previous findings, this does not translate into an increase in overall risk.

4.4.2.4 Board Characteristics

	log(Qualifications)	**log(Time on Board)**	**log(Nationality Mix)**	**log(Network Size)**
Main Explanatory Variable DID (Germany * Employees > 2000 * post 2015)	**4.330*** (0.591)**	**0.167*** (0.301)**	**9.460*** (1.038)**	**-0.212*** (1.083)**
NoQuals	/	**-0.036*** (0.007)**	**0.013 (0.011)**	**0.271*** (0.012)**
TimeBrd	**-0.016*** (0.002)**	/	**-0.039*** (0.004)**	**0.066*** (0.004)**
NationalityMix	**0.027. (0.014)**	**-0.121*** (0.015)**	/	**0.408*** (0.028)**
NetworkSize	**0.000*** (0.000)**	**0.000*** (0.000)**	**0.000*** (0.000)**	/
TotalAssets	**0.000* (0.000)**	**0.000*** (0.000)**	**0.000*** (0.000)**	**-0.000*** (0.000)**
Number of Observations	1925	1925	1925	1925
Firm FE	Yes	Yes	Yes	Yes
Sector FE	Yes (factor)	Yes (factor)	Yes (factor)	Yes (factor)
Time FE	Yes	Yes	Yes	Yes
Country FE	Yes (factor)	Yes (factor)	Yes (factor)	Yes (factor)
R-squared	0.184	0.661	0.149	0.420

Table 10 - Second-stage (Board Characteristics)

The results in table 10 suggest a significant relationship for all four chosen board characteristics. Coefficients for average qualifications, tenure, and nationality mix are positive, indicating that increased gender diversity decreases the values of these board characteristics. A decrease in average time on board after bringing in new directors for replacement is to be expected (Yang et al., 2019). Network size increases with female participation. All in all, we can *confirm hypothesis 5: Increased gender diversity significantly impacted other board characteristics (i.e., tenure, average qualifications, network size, and nationality mix) of firms in the sample.*

4.4.3 Sector Analysis

Sectors play an important role in gender diversity research. It is essential to consider the differences between individual sectors to try to understand what is driving the significant results in our analysis. The idea behind this more granular approach is the fact that not every sector in our sample must adjust the board composition after the regulation to the same degree. Some sectors had to increase gender diversity by a significant amount to reach the stipulated target of 30 % of female directors, while other sectors were not far from this threshold even prior to the reform.
To investigate this, we first calculate the deviations of gender ratios post-2015 from gender ratios prior to 2015 for each sector. Subsequently, we arrange the sectors by strength of deviation.
We then conduct a new difference-in-difference analysis (first-stage), where we interact the instrument dummy ("DID") with the calculated deviation.

	log(Gender Ratio)
Main Explanatory Variable DID (Germany * Employees > 2000 * post 2015)	0.004 (0.011)
NoQuals	0.002 (0.003)
TimeBrd	**0.003*** (0.000)**
NationalityMix	0.006 (0.007)
NetworkSize	**0.000* (0.000)**
TotalAssets	**0.000** (0.000)**
DID*Deviation	**0.310* (0.121)**
Number of Observations	1925
Firm FE	Yes
Sector FE	Yes (factor)
Time FE	Yes
Country FE	Yes (factor)
R-squared	0.049

Table 11 - Deviation in Gender Ratio for Sectors

Table 11 shows the results of this interaction analysis. The positive coefficient of "DID*Deviation" suggests that the greater the disparity within the industry, the larger the difference between control and treatment before and after the change. This indicates that the results depend on the magnitude of the change of gender ratio in the sectors. The greater the change in gender ratios within the companies' sectors, the more the difference in gender ratio change before and after the reform between control and treatment is determined by the change in the sector.
Establishing the importance of sectoral changes in gender ratio, we proceed by grouping the 50 % of sectors with the highest deviation and performing the 2SLS analysis again. These sectors include Information Technology, Chemicals, Electronics, Pharmaceuticals and Biotechnology, Electricity, Business Services, Insurance, Utilities, Transport, Real Estate, Food Producers & Processors, Engineering & Machinery, Automobiles & Parts, and Diversified Industrials.
The 50 %, and not less, are chosen to provide a large enough sample size, such that representative results are possible. The sample size in the sector analysis amounts to 1085 observations.

50% largest change	log(Gender Ratio)
Main Explanatory Variable DID (Germany * Employees > 2000 * post 2015)	**-0.028*** (0.008)**
NoQuals	0.004 (0.004)
TimeBrd	**0.003*** (0.000)**
NationalityMix	-0.004 (0.008)
NetworkSize	-0.000 (0.000)
TotalAssets	**-0.000** (0.000)**
Number of Observations	1085
Firm FE	Yes
Sector FE	Yes
Time FE	Yes
Country FE	Yes
R-squared	0.058

Table 12 - First-stage (Sectors)

Table 12 shows the result of the first-stage difference-in-difference analysis of the grouped sectors, which indicates a negative and significant relationship. Even though the sample size decreased, the p-level is smaller, suggesting stronger significance. The coefficient is also larger in absolute terms, suggesting a larger effect.

	log(Tobin's Q)	log(MTB Ratio)	log(ROA)
Fitted Gender Ratio (1 = 100% male)	**-2.307. (1.306)**	**-4.175* (2.109)**	-1.706 (2.359)
NoQuals	**0.082*** (0.023)**	**0.066. (0.037)**	0.058 (0.042)
TimeBrd	0.008 (0.005)	0.011 (0.009)	**0.024* (0.010)**
NationalityMix	0.000 (0.045)	-0.084 (0.073)	0.024 (0.083)
NetworkSize	**0.000** (0.000)**	0.000 (0.000)	-0.000 (0.000)
TotalAssets	**-0.000** (0.000)**	**0.000* (0.000)**	**-0.000** (0.000)**
Number of Observations	1085	1085	1085
Firm FE	Yes	Yes	Yes
Sector FE	Yes	Yes	Yes
Time FE	Yes	Yes	Yes
Country FE	Yes	Yes	Yes
R-squared	0.059	0.035	0.019

Table 13 - Second-stage (Sectors) (Performance)

	log(CapEx)	log(R&D)
Fitted Gender Ratio (1 = 100% male)	-6.387 (1.170)	-0.789 (3.820)
NoQuals	-0.225 (0.025)	0.069 (0.067)
TimeBrd	0.033 (0.048)	-0.002 (0.002)
NationalityMix	-0.043 (0.041)	-0.007 (0.132)
NetworkSize	**0.043* (0.210)**	0.000 (0.000)
TotalAssets	**-0.005** (0.002)**	-0.000 (0.000)
Number of Observations	1085	1085
Firm FE	Yes	Yes
Sector FE	Yes	Yes
Time FE	Yes	Yes
Country FE	Yes	Yes
R-squared	0.015	0.002

Table 14 - Second-stage (Sectors) (Investment Behavior)

	log(SD of returns)	log(DTE Ratio)
Fitted Gender Ratio (1 = 100% male)	0.280 (2.652)	**-8.264* (3.591)**
NoQuals	0.045 (0.047)	**-0.0852* (0.037)**
TimeBrd	0.016 (0.011)	0.011 (0.013)
NationalityMix	**0.181* (0.092)**	-0.029 (0.083)
NetworkSize	0.000 (0.000)	**0.000* (000)**
TotalAssets	**0.000* (0.000)**	**0.000*** (0.000)**
Number of Observations	1085	1085
Firm FE	Yes	Yes
Sector FE	Yes	Yes (factor)
Time FE	Yes	Yes
Country FE	Yes	Yes (factor)
R-squared	0.018	0.062

Table 15 - Second-stage (Sectors) (Risk)

Table 13 reports the findings of the second-stage analysis for performance, table 14 on investment behavior, and table 15 on risk within the sector analysis. We can observe that the performance variables Tobin's Q and Market to Book Ratio as well as Debt to Equity Ratio are significant. The p-

levels suggest stronger significance levels. Return on Assets decreased in effect as well as to only a marginally significant level.
These results suggest that for sectors that had to undertake the largest re-composition of their supervisory boards, performance, as measured by Tobin's Q and Market to Book Ratio, increased significantly.

	log(Qualifications)	log(Time on Board)	log(Nationality Mix)	log(Network Size)
Fitted Gender Ratio (1 = 100% male)	**4.907*** (0.415)**	**0.137*** (0.467)**	**-3.390*** (0.943)**	**-7.939*** (1.073)**
NoQuals	/	**-0.104*** (0.012)**	0.023 (0.017)	**0.291*** (0.017)**
TimeBrd	**-0.018*** (0.0012)**	/	-0.003 (0.004)	**0.022*** (0.004)**
NationalityMix	0.025 (0.016)	-0.021 (0.025)	/	**0.276*** (0.038)**
NetworkSize	**0.000*** (0.000)**	**0.000*** (0.000)**	**0.000*** (0.000)**	/
TotalAssets	**0.000*** (0.000)**	**0.000*** (0.000)**	**-0.000** (0.000)**	0.000 (0.000)
Number of Observations	1085	1085	1085	1085
Firm FE	Yes	Yes	Yes	Yes
Sector FE	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes
R-squared	0.294	0.504	0.114	0.325

Table 16 - Second-stage (Sectors) (Board Characteristics)

Table 16 shows the results of the analysis of board characteristics within companies of sectors with the largest change in gender ratio after regulation. The positive coefficients stayed approximately at the same level of strength, albeit decreasing in p-levels marginally. A decrease in average time on board after bringing in new directors to replace other ones is to be expected. Interestingly, the relationship between board diversity and nationality mix turns negative when focusing on sectors. Network size is also negatively associated with the fitted gender ratio.
To further test the difference between the most affected sectors and the least affected sectors, we also perform the same analyses for the 50% of sectors with the smallest deviations. We subsequently do a Wald test to test the difference between the results of these two groups of sectors. In the following table 17, the main results are reported.

	First-stage	log(Tobin's Q)	log(MTB Ratio)	log(ROA)	log(CapEx)	log(R&D)	log(DTE Ratio)	log(SD of returns)	log(Qualifications)	log(Time on Board)	log(Nationality Mix)	log(Network Size)
p-Value	**0.037***	0.818	0.166	**0.004***	0.368	0.274	0.402	**0.007***	**0.000***	**0.000***	**0.000***	**0.000***
Wald Statistic	4.359	0.053	1.197	8.257	0.809	1.195	0.526	7.249	47.091	106.732	3519.826	242.050

Table 17 - Wald Test (Sectors)

As one can observe, the differences in the regression results are significant for the first-stage, ROA, SD of returns, as well as all the chosen board characteristics.
All in all, these results *confirm hypothesis 6: The effects are dependent on sector changes in gender ratios.*

4.5 Robustness

4.5.1 Placebo Test - Year

PLACEBO (time = 2013)	First-stage
Main Explanatory Variable (Gender Ratio) DiD (Germany * Employees > 2000 * post 2012)	-0.014 (0.009)
NoQuals	0.001 (0.003)
TimeBrd	**0.003*** (0.000)**
NationalityMix	0.005 (0.006)
NetworkSize	**-0.000* (0.000)**
TotalAssets	**-0.000** (0.000)**
Number of Observations	1925
Firm FE	Yes
Sector FE	Yes
Time FE	Yes
Country FE	Yes
R-squared	0.045

Table 18 - Placebo Test (Year)

To support the robustness of our findings, we employ a number of placebo tests. In the first test, the year 2013 is used as the treatment year instead of 2015. This year is close enough to detect any potential trends but far enough from the original treatment year to not be affected by the regulation of 2015. Table 18 reports the results of this placebo test. We find that the first-stage of the analysis reports non-significant results. This supports our first hypothesis (i.e., H1: Gender diversity increased after the introduction of the FüPoG I regulation in 2015 in Germany) about the effectiveness of the regulation even further. No subsequent second-stage tests have been performed because the chosen methodology builds on the significance of the first-stage regression, which in this case has been ruled out.

4.5.2 Placebo Test – Number of Employees

The second condition for the application of the FüPoG I law was that the number of employees surpassed 2000. We thus further test the results of our analysis on this assumption. Three different cut-off points are chosen, and the 2SLS analysis is performed.
As the first cut-off point, we choose that the number of employees must be lower than 1700; the second one equals 1500 employees, and the last is 1000. The reason for choosing lower numbers of employees is to test the effect of firm size on the results. The following table represents the results of the first-stage analysis. We find no significant results in the first-stage analysis, which inhibits further second-stage analyses. This in turn confirms that only companies that were truly affected by the regulation increased their gender ratio significantly compared to the chosen control group.

PLACEBO (Number of employees)	First-stage		
	Employees < 1700	**Employees < 1500**	**Employees < 1000**
Main Explanatory Variable Gender Ratio) DiD (Germany * Employees > 2000 * post 2012)	0.005 (0.007)	0.005 (0.008)	0.005 (0.007)
NoQuals	0.002 (0.003)	0.002 (0.003)	0.001 (0.003)
TimeBrd	**0.003*** (0.000)**	**0.004*** (0.000)**	**0.004*** (0.000)**
NationalityMix	0.005 (0.006)	0.005 (0.006)	0.005 (0.006)
NetworkSize	**-0.000* (0.000)**	**-0.000* (0.000)**	**-0.000* (0.000)**
TotalAssets	**-0.000** (0.000)**	**-0.000** (0.000)**	**-0.000** (0.000)**
Number of Observations	1925	1925	1925
Fixed Effects	Yes	Yes	Yes
R-squared	0.044	0.044	0.43

Table 19 - Placebo Test (Employees)

4.5.3 Conjecture Manipulation Test

A further concern that theoretically could impact the robustness of our results is conjecture manipulation. In this sense, companies that anticipated that they would be affected by the regulation starting in the beginning of 2016 would decrease the number of employees to avoid having to comply with the stipulated quota. To provide evidence against these concerns, we perform a sample selection bandwidth test to see whether significant changes in the number of employees were made before the introduction of the FüPoG I regulation. First, we sample out companies that lay within three chosen bandwidths (i.e., 300, 500, and 1000) around the stipulated 2000 employee boundary. Then we examine the individual granular samples to see whether there was a significant change in the number of employees a year prior to the introduction of the legislated quota. The following table 20 summarizes the results.

Sample selection Bandwidth			
Bandwith (Employees)	500	300	1000
Intercept	3.187 (1.642)	0.012 (0.035)	-3.457 (2.346)
Year	0.000 (0.008)	0.001 (0.002)	0.002. (0.001)
post_2015	1.646 (1.935)	0.035 (0.046)	1.123 (0.9877)
Year*post_2015	-0.000 (0.01)	-0.001 (0.002)	-0.001 (0.000)
Firm FE	Yes	Yes	Yes
Time FE	Yes	Yes	Yes
Controls	Yes	Yes	Yes
R-Squared	0.042	0.077	0.011

Table 20 - Bandwidth Test

We find no significant results in either of the chosen bandwidths, which indicates that for the examined sample, there is no evidence that the number of employees was manipulated to avoid being affected by the FüPoG I regulation.

5. Discussion and Conclusion

5.2 Key Findings

We find that the hard quota regulation in Germany, which stipulated a 30 % female representation on supervisory boards, significantly increased gender diversity in affected German firms. Furthermore, we find that this significantly increased performance. We find no significance in terms of risk, even though the Debt to Equity Ratio increases considerably. We further do not find any effect on investment behavior as measured by capital expenditure and research and development expenses. In terms of board composition and characteristics, we find that average qualifications, average tenure, and nationality mix decrease. A decrease in average tenure is to be expected because of the directors' replacements. Network size increases with gender diversity. We perform several placebo tests, and the combined results of them support the robustness of the findings.

We subsequently investigate a more granular sample, focusing on sectors that experienced the largest change in gender ratios after the regulation (i.e., traditionally male-dominated sectors). Here, we understandably find a stronger decrease in gender ratio. This is combined with stronger and more significant increases in performance. The Debt to Equity Ratio further also increases in the absolute coefficient and significance, while investment and risk variables stay insignificant. In terms of gender ratio, we find a negative relationship for average qualifications and average tenure. The effect on network size stays positive, but nationality mix turns positive after focusing on male-dominated sectors.

5.3 Discussion and Implications

There is consensus in the literature that information shapes opinions about gender equality (Muriaas, R. L., & Peters, Y., 2024). We support the growing gender equality literature by providing further evidence about its effect on companies.

Our findings thus have important implications for practice and literature. First, gender diversity does not only align with a socially just society but might also contribute to the prosperity of the economy. Our results clearly show that increasing gender diversity benefits the companies in our sample in terms of performance. This can be used as a further argument for increasing gender equality in leadership positions. Our results do not find any significance in terms of risk. However, we find a significant increase in Debt to Equity Ratio. Combined, we can speculate that, while increasing leverage, the company did not become riskier after the increase in diversity. Board composition and its average characteristics change significantly with the increase in female participation. This indicates that gender diversity does have a significant spillover effect into other characteristics.

Second, our study demonstrates that the gender quota regulation has been highly effective in increasing gender diversity on supervisory boards in Germany. This indicates that legally mandated quotas (i.e., hard quotas) are a particularly effective approach to promoting greater workplace equality. Consequently, regulators have powerful tools at their disposal to achieve this objective. However, it is important to point out that enforcing gender quotas by law and sanctioning any non-compliance is only temporary a solution. Muriaas and Peters (2024) find that opinions change if increased gender equality is supported by information about females' skills and qualifications rather than because of legislated quotas. This implies that, even though quota regulation is an effective push measure to increase diversity as of right now, it is of the essence that we move towards a more pull approach. Equal representation should be reached by realizing potential and skill regardless of gender. This is done by acknowledging that increasing diversity does not mean lowering the bar on competence, but rather provides benefits for all stakeholders.

As briefly discussed in the section "Analysis and Results", Germany strengthened its FüPoG I regulation in 2021 by introducing FüPoG II. This new legislation broadened the scope of applicability and introduced financial sanctions, rather than the previously stipulated reputational damage. Young et al. (2022) argue for the effectiveness of binding quotas with sanctions if enforceability is possible. This would be an interesting further point of research, as a direct comparison between the effect of reputation and financial sanctions in a staggered introduction setting could be examined.

Our sector analysis also has important implications, especially for further research. We have concluded that the effect of gender diversity depends on sector-specific factors. It is found that sectors that were male-dominated before the introduction of the quota benefited more from increasing

diversity with an increase in performance. Discovering these broader results leaves a door open for further investigation of individual sectors and the effect of gender diversity. Particularly, it would be interesting to study traditionally patriarchal industries (such as IT, banking, finance, automobiles, etc.) in detail.
Overall, we find results that differ from some studies focusing on specific samples outside the scope of our analysis (e.g., Yang et al., 2019), which indicates that the findings are highly specific to economic environments and time periods.
Another important point to discuss is indirect and spillover effects. This is because the success of gender diversity regulation is determined by whether its effects grow beyond the treated companies or sectors to have an impact on a broader group (Guiso et al., 2024). Guiso et al. (2024) provide one of the first studies that investigates such effects. They investigate the horizontal spillover effects of the Italian gender quota regulation in 2011. Horizontal spillover effects are defined as "the effects on firms non directly targeted by the quotas" (Guiso et al., 2024). Directors of companies targeted by this regulation that also sat on boards of non-targeted firms were exploited in this study to examine the indirect effects of the Italian gender quota law. The authors find that the increase in gender diversity in non-targeted firms is twice as large if the directors simultaneously participate in boards of targeted companies. In line with this innovative literature, it would be interesting to look at the spillover effects in the context of the DACH region. Even though Austria and Switzerland were not affected by the FüPoG I regulation, the countries are economically and politically connected. This means that the companies in the control group might have been indirectly affected through supply chains, connections, and other factors. In this case, our findings would not reflect the effect versus non-effect of gender diversity but rather the distinction between direct and indirect effects. This, in turn, could be interpreted as an externality. Consequently, it could be seen as another important and interesting topic for further research, particularly the spillover effects of gender diversity regulation.

5.4 Limitations

The first limitation of this study concerns the high specificity of the scenario – i.e., the gender quota regulation in Germany as well as the regional context of the DACH countries. Even though this is the basis of our methodology and allows us to report robust results, it might cause non-generalizability to other countries' gender quota regulations and the effect on performance and risk. The DACH region is additionally a very particular environment, which implies that these results might not be applicable to other countries and regions. Furthermore, FüPoG I was announced in the middle of 2015 and became effective in 2016, requiring affected firms to make rather large changes within a short time span. We thus cannot rule out that a certain time lag of this change.
Additionally, the relatively small sample size of this study must be acknowledged. While we focus on listed large companies, which should offer a representative sample, it may not fully capture effects that are generalizable to all companies within these countries. Another limitation of the small sample size is the inability to conduct a more detailed sector-specific analysis.
Furthermore, the backward-looking nature of this study, along with the time period analyzed, may limit its relevance for understanding current dynamics. A more recent analysis could provide a clearer and more illustrative perspective on the present situation.
Even though we are including multiple control variables to prevent omitted variable bias, ability, as such, is difficult to account for. While we control for education and experience, unobserved ability (such as intelligence) might have also an effect on our model (Gould, E. D. (2005)).
Last, technical limitations of coding must be mentioned. The technical capabilities of the used version of R did not allow for the inclusion of both stages of the 2SLS into one equation, which might have led to overly optimistic estimations of the fitted gender ratio with biased standard errors.

5.5 Conclusion

Despite our limitation, we hope that this study provides interesting results that can contribute to existing literature, as well as a fertile ground for further research. We also hope to convince the reader that gender diversity is not only a question of social justice but also an important contributor to economic welfare.

6. References

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