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# Board Gender Diversity and Firm Financial Performance: The Role of Innovation

*Is there a relationship between board gender diversity and subsequent firm financial performance, and does innovation affect it?*

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**Abstract**

This quantitative study investigates the inter-relationship between board gender diversity, innovation, and subsequent firm financial performance. We use two multivariate OLS regression models on an unbalanced panel dataset with firm-year observations for listed companies headquartered in the U.S. between 2012-2019. In contrast to most previous research, our study fails to find significant statistical evidence in support of a positive relationship between board gender diversity and firm financial performance. Further, neither innovation intensity in companies, nor relative innovation importance in industries, respectively, can be concluded to have an impact on said relationship. While we cannot find support for our hypotheses, our study further discusses the difficulty in measuring the interaction effect between innovation and board gender diversity on subsequent firm financial performance - ultimately contributing to the disentanglement of a vastly ambiguous field of research.

**Tutor**: Milda Tylaite

**Keywords**: Board Gender Diversity, Innovation, Financial Performance, U.S. Firms, Interaction Term

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# 1. Introduction

The case for increased gender diversity in the boardroom has been a topic of increased scrutiny in corporate governance and managerial performance research in the past decades. While both research and its contemporary corporate implications continuously progress, more male directors were named James, William, Robert, or John than there were female board members in S&P 1500 companies as recently as in 2014, according to the EY Center for Board Matters Database (2022). Although male directors still hold a majority of seats on corporate boards in the U.S., the general trend is heading towards higher diversity where; for instance, according to Bloomberg (2021), female representation on boards of directors reached 30% across the S&P 500 in 2020 compared to 18% five years prior. This development is evident across the globe, where scholars are increasingly investigating the so-called "business case" for female directorship, emphasising the financial arguments and implications for increased board gender heterogeneity (Adams & Ferreira, 2009; Ahern & Dittmar, 2012; Bøhren & Strøm, 2010).

Research findings concerning the relationship between Board Gender Diversity ("BGD") and Corporate Financial Performance ("CFP") are largely contradicting, where some scholars argue the relationship to be positive (Campbell & Mínguez-Vera, 2008; Carter, Simkins, & Simpson, 2003), while others find negative or no correlation (Adams & Ferreira, 2009; Carter, D'Souza, Simkins, & Simpson, 2010). Further, this general ambiguity of findings has brought forth two parallel viewpoints with regard to research on the relationship between BGD and CFP: the first argues that this area of research has reached maturity, suggesting efforts are better directed at other indicators of diversity (Hillman, 2015); the second viewpoint suggests there is a need for a deeper understanding of *how* board gender diversity impacts firm financial performance through *Interaction* between variables (Milliken & Martins, 1996; Post & Byron, 2015).

Despite a call for further investigation of the relationship between BGD and CFP through possible interaction between variables, literature in this field remains scarce, thus constituting part of the purpose of this study. Some previous scholars have considered the interaction effect of *Innovation* on the relationship between BGD and CFP, albeit the results are largely inconclusive. Specifically, researchers Miller and del Carmen Triana (2009) hypothesise innovation to be a mediator in the BGD-CFP relationship; however, they fail to find statistical support for their findings. Contrary to this, contemporary research by Cabeza-García, Del Brío, and Rueda

(2021), finds evidence that innovation has a moderating effect on the relationship between a critical mass of female directors and subsequent financial performance in European firms. This leads us to believe that innovation is a relevant variable to include in further investigation of an ambiguous field of research. Thus we aim to investigate the following research questions in a contemporary U.S. setting: *What is the relationship between board gender diversity and corporate financial performance, and how is it affected by different types of innovation?*

## 1.1 Contribution

This study contributes to the current field of research by investigating the inter-relationship between board gender diversity, innovation, and firm financial performance. Prior literature has provided mixed and ambiguous results on the relationship between board gender diversity and financial performance; thus, we aim to add to this line of research by attending to previous scholars' calls to investigate the potential effect of innovation. Therefore, we introduce an interaction term between innovation intensity and board gender diversity as well as consider the potential effect of relative innovation importance in industries. Furthermore, to the best of our knowledge, the current research constitutes a gap in the academic literature which we aim to fill by focusing on the U.S. in a contemporary setting, capturing the recent and ongoing work for gender equality on corporate boards.

## 1.2 Delimitations

This study is delimited to include firm-year observations between 2012-2019 to avoid the financial aftermath following the financial crisis (2008) and the COVID-19 pandemic (2020). However, partial data from 2010 is used in order to calculate annual growth rates. Further, variables are lagged one year, ultimately resulting in our final sample consisting of firm-year observations between 2012-2019. We use secondary data to obtain observations for public U.S. firms with available data for board gender diversity and R&D expenses.

## 1.3 Disposition

This study is composed of eight sections; where the first section covers introduction and contribution; section two focuses on theory and literature review; section three explains our data and methodology; section four presents our empirical data; section five describes our regression results and subsequent analysis; section six discusses our results and findings as well as limitations to the quality of our study; section seven provides suggestions for future research; lastly section eight provides a conclusion.

# 2. Theory and Literature Review

## 2.1 Introduction

In the following sections we will outline literature and theory upon which we develop our hypotheses in section 2.5. First, section 2.2 considers frequently used theories in corporate governance and diversity research. Then, we define board gender diversity and present literature theorising its impact on subsequent financial performance in section 2.3. We then acknowledge prior studies investigating the inter-relationship between board gender diversity, innovation, and financial performance in section 2.4. Lastly, we conclude our hypotheses in section 2.5.

## 2.2 Theoretical Framework

As suggested by the ambiguity of research findings within this field, no isolated theory can serve as a complete framework for understanding the inter-relationship between board gender diversity, innovation, and firm financial performance (Carter et al., 2003; Kiel & Nicholson, 2003). Therefore, we delimit our discussion to three recurring theories shaping the main arguments for increased board gender diversity: *Resource Dependence Theory (“RDT”)*, *Agency Theory (“AT”),* and *Human Capital Theory (“HCT”).*

### 2.2.1 Resource Dependence Theory

The first theory frequently used in analysing corporate boards’ function and subsequent performance is the *Resource Dependence Theory* (Pfeffer & Salancik, 2003). In short, RDT puts emphasis on the relationship between the board of directors and its external environment. According to the theory, it is crucial for the firm to mitigate uncertainty and harmful interdependencies with its environment through effective governance of resources, reducing the power of external actors over the firm. Consequently, Pfeffer & Salancik (2003) emphasise the function of boards of directors as a means of reducing dependencies and uncertainty. Further, boards should, in theory, provide the firm access to external support, function as a channel of communication with external actors, provide legitimacy as well as offer counsel and advice (Pfeffer & Salancik, 2003). Hence, high gender diversity within boards should constitute better accessibility to a wider group of stakeholders (Siciliano, 1996) and increase the legitimacy of the organisation (Hillman & Dalziel, 2003). Further, it might also be that increased legitimacy among key stakeholders, such as customers and investors, subsequently boosts firm value and profitability (Carter et al., 2003; Erhardt, Werbel, & Shrader, 2003).

### 2.2.2 Agency Theory

Despite the emergence of a multitude of theories explaining the need for well-functioning corporate governance, *Agency Theory* is still one of the most influential within this scope of research (Raelin & Bondy, 2013). The Agency Theory of corporate governance argues that in the absence of relevant initiatives or sufficient monitoring, managers will use their discretion to maximise their own benefits, thus preventing value maximisation for the firm (Alchian & Demsetz, 1972; Jensen & Meckling, 2019). Accordingly, the theory puts forth that conflicts, and thereby agency costs, arising from asymmetric information between owners and managers can be mitigated by adequate corporate governance structures. Subsequently, insufficient governance should have a negative effect on firm performance through increased agency costs (Core, Guay, & Rusticus, 2006). Cognizant of AT, the board of directors acts as an instrumental tool in aligning the views of managers and shareholders. Rooted in the argument that a more diverse board possesses greater control features through a broader range of viewpoints, ultimately increasing board independence, board heterogeneity can function as a means of increasing firm value by decreasing agency costs (Carter et al., 2003; Hillman & Dalziel, 2003). As suggested by Adams and Ferreira (2009), female directors are more inclined to attend board meetings and join monitoring committees than their male counterparts.

### 2.2.3 Human Capital Theory

The *Human Capital Theory* of corporate governance is closely related to RDT, however, specifically focusing on the unique expertise of individuals, e.g., education, skills, or knowledge. According to Terjesen, Sealy & Singh (2009), board gender heterogeneity imposes a wide range of unique human capital on the firm. However, while female directors possess similar levels of education, they have less experience as business experts compared to their average male counterparts (Terjesen, Sealy, & Singh, 2009). Recent literature finds evidence that innovation outcomes are significantly impacted by the human capital of directors (Nguyen, Nguyen, Locke, & Reddy, 2017). Closely related to HCT, the *Behavioural Theory* of the firm stipulates that increased board gender diversity can have a subsequent impact on innovation through the effectiveness of decision-making due to heterogeneity (Cyert & March, 1963).

## 2.3 Board Gender Diversity and Firm Financial Performance

### 2.3.1 Board Gender Diversity

"With corporate governance, the concept of diversity relates to board composition and the varied combination of attributes, characteristics, and expertise contributed by individual board members in relation to board process and decision making"

- *(Van der Walt & Ingley, 2003)*

When assessing diversity in the board room, a large portion of research focuses on a demographic categorisation of diversity, based on visible factors such as gender, race, education, etc. (Milliken & Martins, 1996; Pelled, 1996). Board gender diversity, in particular, has become a frequently assessed topic of corporate governance and performance research in recent decades, attracting the attention of scholars worldwide (Adams & Ferreira, 2009; Campbell & Mínguez-Vera, 2008; Reguera-Alvarado, de Fuentes, & Laffarga, 2017). Although social arguments for increased board gender diversity are seemingly clear cut, the so-called "business case", emphasising the financial reasoning, has resulted in more ambiguous conclusions. Previous scholars find support for gender quotas in Spanish boards through increased economic efficiency and provide evidence that more gender-diverse boards of directors broaden knowledge and skills, ultimately translating into better economic performance (Lucas-Pérez, Mínguez-Vera, Baixauli-Soler, Martín-Ugedo, & Sánchez-Marín, 2015). However, others have found limited support for imposed gender quotas (Bøhren & Strøm, 2010; Ferreira, 2015) and some even negative results (Ahern & Dittmar, 2012; Labelle, Francoeur, & Lakhal, 2015).

### 2.3.2 Gender Diversity and Performance

Arising from the issue of corporate governance, board gender diversity and its effect on firm financial performance has become a topic of research for many scholars. However, empirical evidence has proven ambiguous in terms of results and methods used, making the interpretation of previous literature cumbersome. Hence, a clear consensus is yet to be established concerning the nature of the relationship.

While a clear consensus has not been reached, the majority of research has found a positive relationship between board gender diversity and firm financial performance (Bonn, Yoshikawa, & Phan, 2004; Campbell & Mínguez-Vera, 2008; Carter et al., 2003; Erhardt et al., 2003; Miller & del Carmen Triana, 2009). Some scholars use Agency Theory to explain this outcome, articulating the controlling and monitoring function of boards of directors. They argue that through increased board gender heterogeneity, the variety of questions asked by the board should increase, causing higher independence and thereby increased firm performance (Carter et al., 2003; Hillman & Dalziel, 2003). Further, Robinson and Dechant (1997) puts emphasis on three positive business implications of increased gender diversity. First, closely related to RDT, they argue that greater diversity contributes to a better understanding of the market by linking director diversity to the diversity of markets and employees. Second, they argue innovation and creativity to be positively linked to diversity through systematic variation. Third, the broader view and understanding of business surroundings that comes with increased diversity is argued to enhance problem solving (Robinson & Dechant, 1997).

The opposing side of the literature finds evidence to the contrary - that increased board diversity, including gender diversity, in fact, has a negative impact on firm financial performance. Adams and Ferreira (2009) find that an increase of female directors had a negative impact on firm financial performance, as indicated by Tobin’s Q. However, they further conclude this result to be contingent on the situation of the firm, stating that firms with weaker shareholder rights benefit from the increased monitoring function of female directorship (Adams & Ferreira, 2009). Further, research by Ahern and Dittmar (2012) resulted in the discovery of a significant negative correlation between the implementation of gender quotas in Norwegian firms, and subsequent financial performance indicated by Tobin’s Q. A third stream of research subsequently found no significant evidence for neither a positive nor negative relationship (Carter et al., 2010; Chapple & Humphrey, 2014; Rose, 2007), further exaggerating the ambiguity in this field of research.

## 2.4 Board Gender Diversity, Innovation, and Financial Performance

While a majority of scholars have identified a positive correlation between BGD-CFP (Carter et al. 2003; Campbell & Mínguez-Vera, 2008; Miller & del Carmen Triana, 2009), broad research providing a deeper understanding of the underlying mechanisms of the relationship is yet to be widely established. Consequently, previous scholars have called for the examination of underlying interaction effects in order to further understand the relationship between BGD-CFP (Kochan et al., 2003; Milliken & Martins, 1996). However, contrary to popular belief, some scholars argue that an underlying relationship between an independent and a dependent variable need not be significant in order for indirect effects to be present between the two (Preacher & Hayes, 2004). Hence, acknowledging the ambiguity of previous research on the relationship between board gender diversity and firm financial performance, we aim to contribute to the current literature by providing a more nuanced understanding of the BGD-CFP relationship through the incorporation of the interaction effect of *Innovation.*

### 2.4.1 Board Gender Diversity and Innovation

Current literature finds gender diversity, in terms of higher female representation on corporate boards, to be positively associated with the effectiveness of internal governance through increased monitoring efforts (Adams & Ferreira, 2009; Hillman, 2015) and higher independence of directors (Carter et al. 2003). In adjacent literature, scholars find a positive relationship between board gender diversity and corporate innovation, indicated by the number of patents and citations (Chen, Leung, & Evans, 2018). The aforementioned relationship is argued to be largely attributable to the increased monitoring function of female directors, thereby mitigating agency problems and costs associated with innovation. More specifically, they articulate two theoretical frameworks emphasising the relative importance of monitoring for firm-innovation. First, the *Quiet Life Hypothesis* suggests that managers are reluctant to invest in innovation as it generally entails deviating from standard routines and imposes incremental effort (Bertrand & Mullainathan, 2003). Second, the *Career Concern Hypothesis* attributes managers' unwillingness to invest in innovation to the perceived extent to which innovation failure is associated with poor managerial skills (Aghion, Van Reenen, & Zingales, 2013). Consequently, the increased monitoring function of female directors is believed to mitigate these agency problems related to managers' willingness to invest in innovation. Further, support for the relationship between firm innovation and board gender diversity can be identified in the *Behavioural Theory* of the firm (Cyert & March, 1963), indicating that innovation within organisations varies with the extensiveness of decision-making and search processes. Similarly, related to *Human Capital Theory*, a diverse board should provide a wider variety of both human capital, in terms of skills and ideas, as well as social capital in the form of creativity and network, ultimately suggesting innovation should increase with board heterogeneity (Miller & del Carmen Triana, 2009).

### 2.4.2 Innovation and Financial Performance

Innovation is widely considered to be a positive driver of financial performance (Abernathy & Clark, 1985; Burns & Stalker, 1961), as well as a crucial determinant of competitiveness on both firm (Porter, 1992) and national level (Solow, 1957). Scholars even argue innovation is essential for firm survival (Covin & Miles, 1999; Hamel & Prahalad, 1994). Schumpeter and Backhaus (2003) articulate that companies unable to adapt to emerging market trends are likely to be wiped out, whereas those who differentiate through innovation might experience abnormal returns. Further, research suggests that firms that identify and organise according to new opportunities generate superior performance (Teece, Pisano, & Shuen, 1997). Since innovation impacts the financial performance of a firm, investing activities involving innovation are to be seen as a strategic concern for boards of directors as they decide on the corporate strategy (Post & Byron, 2015). Contingent with RDT, Miller and del Carmen Triana (2009), therefore, argue that corporate boards should invest in relationships, ideas, and resources that affect innovation.

### 2.4.3 Innovation as an Interaction Term

Despite the call for scholars to investigate possible interaction effects for the board gender diversity and firm financial performance relationship, literature in this field remains scarce, partly constituting the purpose of our study. Nonetheless, a few researchers have considered the moderating/mediating effect of innovation on the relationship between board gender diversity and firm financial performance. Scholars Miller and del Carmen Triana (2009) find a positive relationship between board gender diversity and innovation. However, their subsequent findings fail to support the relationship between female directors and firm financial performance; hence innovation is deemed not to have a mediating effect on the relationship. In response to the aforementioned findings, Cabeza-García, Del Brío, and Rueda (2021) investigate if R&D expenditures (used as a proxy for innovation intensity) instead function as a moderator of the relationship between the critical mass of female board members and firm financial performance (ROI) in six European firms. Their study finds innovation to be a significant moderator of the relationship, confirming support of the Critical Mass Theory; Human Capital Theory, as heterogeneity imposes a variety of views and resources improving decision-making; Agency Theory, through increased monitoring and reduced agency costs; and also Resource Dependence Theory, as gender diversity impose broader availability to resources through an enlarged network of stakeholders (Cabeza-García, Del Brío, & Rueda, 2021).

### 2.4.4 Relative Innovation Importance Across Industries

Related to the interplay between female board representation, innovation strategy, and firm financial performance discussed in previous sections, we also consider how the relative importance of innovation for a given industry might alter the relationship. Specifically, Chen et al. (2018) conducted a study on U.S. firms between 1998 and 2006 to shed light on the notion of contingency when assessing the effect of innovation on firm financial performance, arguing that successful innovation is not, by definition, beneficial for financial performance. Instead, they believe the relationship to be contingent on the relative importance of innovation in a given industry or firm. Accordingly, their results indicate that the relationship between board gender diversity and firm financial performance is significantly stronger for firms operating in industries where innovation is considered important. Suggesting that increased innovation through effective monitoring by female board members is increasingly prone to result in greater financial performance in industries that are heavily reliant on innovation (Chen et al., 2018).

## 2.5 Hypothesis Development

### 2.5.1 First Hypothesis

Inconclusiveness of previous studies provide some difficulties to the hypothesis development. However, with a majority of research finding a positive relationship between board gender diversity and firm financial performance (Carter et al., 2003; Campbell & Minguez-Vera, 2008; Miller & del Carmen Triana, 2009), primarily attributed to Agency Theory and Resource Dependence Theory, we construct our first hypothesis as follows:

*H1: There is a positive relationship between board gender diversity and firm financial performance.*

### 2.5.2 Second Hypothesis

The inter-relationship between board gender diversity, innovation, and firm financial performance puts forth the issue of contingency, as previously suggested by Chen et al., (2018). Intuitively, if board gender diversity improves innovation through increased monitoring (Adams & Ferreira, 2009; Hillman, 2015), and innovation has a positive impact on financial performance, as suggested by (Post & Byron, 2015; Schumpeter & Backhaus, 2003) - the relative importance of innovation, for financial success, should influence the relationship between board gender diversity and firm financial performance. Thus, we construct our second hypothesis as follows:

*H2: There is a more positive relationship between board gender diversity and firm financial performance for firms in industries where the relative importance of innovation is high, than for firms in industries where the relative importance of innovation is low.*

### 2.5.3 Third Hypothesis

The research gap of previous literature examining the interaction effect of innovation on the relationship between board gender diversity and firm financial performance, in part constitutes the intended contribution of our study, however, it also increases complexity for the hypothesis formulation. Thus, we adapt reasoning from previous scholars investigating similar interaction relationships between BGD, innovation and CFP, albeit, in different settings in terms of time and geography. Consequently, rooted in the Behavioural Theory of the firm (Cyert & March, 1963) and the superiority of heterogeneous boards in mitigating agency problems concerning innovation (Chen et al., 2018), we hypothesise the following:

*H3: There is a more positive relationship between board gender diversity and firm financial performance for firms with high innovation intensity than for firms with low innovation intensity.*

# 3. Data and Methodology

The following section provides a detailed outline of our sample selection process and the general characteristics of our sample. We also provide elaborate descriptions and definitions of our selected variables and regression models.

## 3.1 Sample selection

The process for selecting our sample is the result of a multitude of factors. We chose to construct our sample from secondary data on U.S. public firms, providing a relatively large number of firm-year observations. The reasoning behind exclusively including public firms in our sample is twofold. First, the market value of equity is a key component of Tobin's Q and is naturally only available for public firms. The second reason is due to a higher degree of data availability that is generally associated with public firms, reflecting a greater demand for transparency in financial reporting (Hope, Thomas, & Vyas, 2013). Since most earlier research with a similar focus uses samples with observations from older time periods, our aim is to contribute to the existing literature by conducting research in a more contemporary setting, thus the time period for our sample is observations between 2012-2019. Furthermore, the U.S. is considered to be at the forefront of innovation in the global landscape as categorised by their top ranking in the Global Innovation Index in 2019 through 2021, making U.S. firms highly relevant for the purpose of our study. As for gender diversity, according to the World Economic Forum's Global Gender Gap Report (2022), North America ranked as the best region in the world in terms of closing the gender gap in 2021, outranking Europe by a slight margin. This in turn provides a solid motivator for examining gender diversity in the board rooms of U.S. firms.

In the data collection process we used *Thomson Reuters' Refinitiv Eikon ("Eikon")* database to capture secondary data on financial performance and governance indicators. Eikon is considered the most comprehensive financial time series database in the world (Refinitiv, 2022). We extracted data for the period 2010-2019, although, due to the implementation of lagged variables and growth rate calculations, we dropped the first two years in the data set, ending up with firm-year observations for public companies during the period 2012-2019, with headquarters in the U.S. and available data for R&D expenses. This sample has been formatted into a longitudinal panel data set which in turn has been methodically reduced as a result of data availability in order to obtain an unbalanced panel data set excluding missing values for all variables. The data selection process illustrated in Table 1, yields a final sample of 2,305 firm-year observations and 476 unique firms. Variable descriptions are presented in section 3.3.

**Table 1.** Sample Construction Process

| | Difference | # firm-year observations | Difference | # firms |
|---|---|---|---|---|
| **Total sample** | | 14,230 | | 1,423 |
| *ROA* | *-2,471* | 11,759 | *0* | 1,423 |
| *TQ* | *-5,095* | 6,664 | *-535* | 888 |
| *Blau* | *-3,612* | 3,052 | *-249* | 639 |
| *Liq* | *-548* | 2,504 | *-151* | 488 |
| *RevG* | *-185* | 2,319 | *-6* | 482 |
| *Lev* | *-2* | 2,317 | *-1* | 481 |
| *Innov* | *-2* | 2,315 | *-1* | 480 |
| *Negative Tobin's Q* | *-10* | 2,305 | *-4* | 476 |
| ***Full sample for regressions*** | | **2,305** | | **476** |

**Note: GD, FDP, FS, BS, PPE, and NAICS did not remove any observations and are thus excluded from the table.*

Furthermore, we winsorize continuous variables at the 1st and 99th percentiles in order to address outliers in the unbalanced panel data set. These variables are ROA, TQ, Lev, PPE, RevG, Liq and FS. We deem such an adjustment to the data set necessary in order to improve statistical efficiency and prevent results being biased by outliers. Moreover, we intentionally exclude the continuous innovation variable Innov_C from winsorization as it is converted into an indicator variable (Innov) for the purpose of our intended application, rendering winsorization redundant.

## 3.2 Design

This study is designed to investigate the inter-relationship between board gender diversity, firm financial performance and innovation in public U.S. firms. Regression analysis examining our research questions will initially be conducted using firm-year observations from our full sample, which is later split into two subsamples for further analysis. The sample split is based on the relative importance of innovation for the industry in which the firm operates. In line with previous studies, we use IP-intensive industries as a proxy for innovation importance (Chen et al. 2018). The definition of IP-intensive industries is based on the report by the Economics and Statistics Administration (ESA) and the U.S. Patent and Trademark Office (USPTO) where 75 industries are identified as IP-intensive. The industry definitions are in turn based on the NAICS[1] which is a standard classification system used by American federal statistical agencies. Splitting the sample in this way allows for further analysis where board gender diversity is examined in a context of innovation importance rather than innovation intensity (proxied by R&D divided by revenue).

The analyses are based on multivariate OLS regressions with ordinary least squares and fixed effects on an unbalanced panel data set, described in 3.4. We include conventional control variables associated with board gender diversity in firm financial performance which are described below in section 3.3.4.

## 3.3 Variables

This section provides a detailed description of the variables used in our regression models. All independent variables are lagged by one year in order to assess their ability to predict financial performance in the subsequent fiscal year. Winsorization is performed at the top and bottom 1 percent of continuous variables, except for the percentage of female directors and the Blau index.

### 3.3.1 Dependent Variables

Measurements for firm financial performance vary tremendously across previous literature, however, two measures appear to be recurring: *Return on Assets ("ROA"),* which is frequently adopted to indicate operational performance using accounting data and *Tobin's Q ("TQ")* which, in corporate governance studies, is used as a proxy for financial performance using market-based figures (Tobin, 1969; Tobin, 1978). Although literature frequently displays utilisation of either accounting or market-based indicators for financial performance, we include both in our study. The reasoning behind this is explained further in section 6.3.3.

*Return on Assets ("ROA"):* This variable is an accounting-based ratio, indicating firm profitability in terms of efficiency in generating profit from assets on the balance sheet. The ratio is derived by dividing Net Income After Taxes by opening book value of Total Assets, as operationalised by scholars (Adams & Ferreira, 2009; Carter et al., 2010).

[1]*North American Industry Classification System*

*Tobin's Q ("TQ"):* This variable on the other hand, is a market-based metric of firm financial performance, applied by Campbell and Mínguez-Vera (2008), Reguera-Alvarado et al. (2017) and Adams and Ferreira (2009). At its core, Tobin's Q expresses the relation between a firm's Total Market Value and Total Asset Value (Tobin, 1969; Tobin, 1978).

### 3.3.2 Independent Variables

Contingent with previous scholars (Campbell & Mínguez-Vera, 2008; Miller & del Carmen Triana, 2009), we operationalise *Board Gender Diversity ("BGD")* using three different independent variables: *Blau's Index of Heterogeneity, Percentage of Female Directors* and *Gender Dummy Variable.*

*Blau's Index of Heterogeneity ("Blau"):* Blau's Index of Heterogeneity is a widely used index for measuring different types of diversity, for instance, gender diversity (Blau, 1977). In line with previous research, it is considered to be the preferred measure of diversity within a population of individuals in an organisational setting (Harrison & Klein, 2007). Further, Blau's Index has been proven to provide a non-skewed measure of diversity with regards to the categories chosen (Harrison & Sin, 2006). The index itself is attained through the following formula: $\left(1 - \Sigma p_i^2\right)$, where "$p$" represents the percentage of group members that fall into each of the "$i$" categories. For the purpose of data availability, we identify two categories: female and male. Consequently, the index spans from 0, where all members of the population belong to one group, to 0.5 where all members are equally distributed across the groups.

*Percentage of Female Directors ("FDP"):* This variable represents the percentage of female directors on the board and has previously been operationalised by Miller and del Carmen Triana (2009) and Campbell & Mínguez-Vera (2008)

*Gender Dummy Variable ("GD"):* This variable is constructed as a dummy which takes on the value of 1 if at least one female is present on the board, and 0 otherwise (Campbell & Mínguez-Vera, 2008; Joecks, Pull, & Vetter, 2013).

*Innovation ("Innov"):* This is constructed as an indicator variable for different levels of innovation intensity, proxied by R&D Expenses divided by Revenue. We introduce this variable in order to provide nuance to the discussion on board gender diversity and its effect on firm financial performance. R&D is defined by the Eikon database as "expenses for research and development of new products and services by a company in order to obtain a competitive advantage". Further, previous literature establishes R&D intensity as a proxy for firm innovation (Balkin, Markman, & Gomez-Mejia, 2000; Hoskisson, Hitt, Johnson, & Grossman, 2002).

To distinguish between different levels of innovation, we construct the variable as an indicator divided into three tiers depending on the quartile distribution of firm innovation intensity. Tier 1 represents the first quartile (0%-25%) of observations with the lowest innovation intensity, Tier 2 represents the second and third quartiles (25%-75%), and Tier 3 represents the fourth quartile (75%-100%). We deem this a necessary procedure to properly assess our regression results.

#### 3.3.2.1 Interaction Term

*Innovation Tier×Board Gender Diversity ("InnovTier×BGD")*: We construct three interaction terms using the independent variables described in section 3.3.2. These interaction terms are a combination of the independent variables for board gender diversity (GD, FDP, Blau) and the indicator variable for innovation (Innov). The purpose of this interaction term is to capture the hypothesised positive interaction effect between innovation and board gender diversity and its subsequent effect on firm financial performance.

### 3.3.3 Control Variables

When choosing which variables to control for, we largely emulate models utilised by previous scholars in the field (Adams & Ferreira, 2009; Li & Chen, 2018; Miller & del Carmen Triana, 2009). Consequently we use firm-level controls for *Board Size*, *Firm Size, Liquidity, Leverage, Revenue Growth* and *PPE-ratio.* All variables have been gathered from the Eikon database.

*Board Size ("BS"):* Similar to Adams and Ferreira (2009) we introduce *Board Size* as a firm-level control. The Eikon database variable definition is: "The total number of board members at the end of the fiscal year". When examining the relationship between board characteristics and financial performance, *Board Size* is a frequently utilised control variable (Huang & Hilary, 2018).

*Firm Size ("FS"):* This variable is operationalised as the natural logarithm of closing book value of Total Assets (Li & Chen, 2018; Miller & del Carmen Triana, 2009). A logarithmic form is used in order to account for the vast differences in firm sizes in our sample. It is argued that larger firms might benefit from economies of scale when it comes to generating patents, thus suggesting firm size should have a positive effect on innovation (Hall & Ziedonis, 2001).

*PPE-ratio ("PPE")*: Calculated as Net Property, Plant and Equipment divided by Total Assets, we control for PPE-ratio (Li & Chen, 2018). Hall and Ziedonis (2001) find that the PPE-ratio can impact patenting behaviour of firms and thus we control for any effect this might have on our dependent variables.

*Revenue Growth ("RevG"):* We calculate Revenue Growth as the annual growth rate of revenue. Yearly revenue data has been extracted from the Eikon database, with the variable definition: "Represents revenue from all of a company's operating activities after deducting any sales adjustments and their equivalents".

*Leverage ("Lev"):* The control variable is operationalised as Debt-to-Equity ratio, measuring leverage of the firm. Debt-to-Equity is calculated by dividing Total Debt with Total Equity. These book values are collected from the Eikon database. Related to the capital structure, leverage is connected to firm financial performance (Ibhagui & Olokoyo, 2018), thus controlled for in our regressions.

*Liquidity ("Liq"):* The control variable is operationalised as Total Current Assets subtracted by Total Inventory which is divided by Total Current Liabilities. In line with Miller and del Carmen Triana (2009), we control for *Liquidity* as it is argued to influence firm innovation (Baysinger & Hoskisson, 1989).

## 3.4 Description of Applied Models

### 3.4.1 OLS Multivariate Regression Models

We estimate two separate multivariate OLS regression models in order to examine the research questions for this paper. Choosing a multivariate model allows for the incorporation of multiple predictor variables and subsequent assessment of their relationship with the dependent variables.
This also allows for the use of interaction terms, aligning with methods by previous scholars (Chen et al., 2018; Dwyer, Richard, & Chadwick, 2003; Li & Chen, 2018), and the purpose of

our study. Controls are also included for fixed effects in both models. Specifically, *Year Fixed Effects* are added to our models with the purpose of accounting for yearly fluctuations and trends in the financial environment that might have an impact on our dependent variables (Li & Chen, 2018; Miller & del Carmen Triana, 2009). Further, we control for *Firm Fixed Effects* as previous research found support for firm-level characteristics to have a more substantial impact on firm performance than industry-level characteristics (Mauri & Michaels, 1998).

A Hausman test, seen in Appendix 1, indicates a Prob>chi2 of 0.000. Hence, we reject the null hypothesis that the estimators for the random effect and the fixed effect are equivalent. Consequently, the model deems fixed effects (FE) rather than random effects (RE) to be appropriate.

### 3.4.2 Generic Regression Model for Testing H1 & H2

To test our first hypothesis, that board gender diversity is positively linked to firm financial performance, and second hypothesis, that the aforementioned relationship is stronger for firms operating in industries where relative innovation importance is high, we construct the following generic model:

$$CFP_{i,t} = \beta_0 + \beta_1 BGD_{i,t-1} + \beta_2 Liq_{i,t-1} + \beta_3 Lev_{i,t-1} + \beta_4 PPE_{i,t-1} + \beta_5 RevG_{i,t-1} + \beta_6 FS_{i,t-1} + \beta_7 BS_{i,t-1} + FE_{i,t} + \varepsilon_{i,t}$$

Subscript $i$ denotes firm index and $t$ time; *Corporate Financial Performance* (*CFP)* represents the dependent variable, denoted either *Return on Assets (ROA)* or *Tobin's Q (TQ)*; *Board Gender Diversity (BGD)* represents the three independent measures for gender diversity: *Blau's Index (Blau)*, *Percentage of Female Directors (FDP)* and a *Gender Dummy Variable (GD)* taking on the value of 1 if women are present on the board and 0 otherwise. Control variables for the model are: *Liquidity (Liq)*, calculated as Current Assets less Inventory, divided by Current Liabilities; *Leverage (Lev)* is the Debt-to-Equity ratio; *PPE-ratio (PPE)* is the firm's Net Property, Plant and Equipment divided by Total Assets; *Revenue Growth (RevG)* is the one year growth rate in Revenue; *Firm Size (FS)* is calculated as the natural logarithm of Total Assets; *Board Size (BS)* is the reported number of board members at the fiscal year-end; *FE* is the year and firm fixed effects respectively; $\beta_0$ is the constant; and $\varepsilon_{i,t}$ is the error term.

### 3.4.3 Generic Regression Model for Testing H3

To test our third hypothesis, that there is a more positive relationship between board gender diversity and firm financial performance for firms with high innovation intensity than for firms with low innovation intensity, we construct the following generic model:

$$CFP_{i,t} = \beta_0 + \beta_1 InnovTier_{j,i,t-1} + \beta_2 BGD_{i,t-1} + \beta_{3-5}(InnovTier_j \times BGD)_{i,t-1} + \beta_6 Liq_{i,t-1} + \beta_7 Lev_{i,t-1} + \beta_8 PPE_{i,t-1} + \beta_9 RevG_{i,t-1} + \beta_{10} FS_{i,t-1} + \beta_{11} BS_{i,t-1} + FE_{i,t} + \varepsilon_{i,t}$$

We add the following independent variables to our second model. $InnovTier_j$ is constructed as an indicator variable for different levels of innovation intensity split across three tiers ($Tier_{1-3}$). Also, the interaction term between Innovation ($InnovTier_j$) and Board Gender Diversity (BGD) is added, where variations of BGD equal those of our first model (i.e. Blau, FDP, GD). Controls are identical as in the first model and we also control for year and firm fixed effects respectively. Subscripts *i*, *t* and *j* correspond to firm index, time and *Innovation* $Tier_{1-3}$ respectively.

# 4. Empirical Data

This section provides an overview of descriptive statistics for our full sample as well as both subsamples after conducting the split. Furthermore, we address the issue of multicollinearity by presenting results from Variance Inflation Factors (VIF) and Pearson Correlation matrices.

## 4.1 Descriptive Statistics

The descriptive statistics presented in Table 2 are firm-year observations, mean, standard deviation and median. Further descriptives for our full sample are found in Appendix 2. The descriptives have been winsorized for the following variables at the 1st and 99th percentiles: ROA, TQ, Lev, PPE, RevG, Liq and FS.

**Table 2.** Descriptives

| | Full sample N=2,305 | | | Innovation sample N=1,784 | | | Non-Innovation sample N=521 | | |
|---|---|---|---|---|---|---|---|---|---|
| | Mean | Median | SD | Mean | Median | SD | Mean | Median | SD |
| *ROA* | 0.020 | 0.051 | 0.162 | 0.014 | 0.052 | 0.176 | 0.039 | 0.049 | 0.101 |
| *TQ* | 1.819 | 1.433 | 1.418 | 1.873 | 1.481 | 1.450 | 1.634 | 1.241 | 1.286 |
| *Blau* | 0.245 | 0.260 | 0.141 | 0.247 | 0.260 | 0.141 | 0.239 | 0.260 | 0.142 |
| *GD* | 0.826 | 1.000 | 0.379 | 0.830 | 1.000 | 0.376 | 0.814 | 1.000 | 0.390 |
| *FDP* | 0.159 | 0.154 | 0.107 | 0.161 | 0.154 | 0.108 | 0.154 | 0.154 | 0.103 |
| *Liq* | 2.006 | 1.498 | 1.525 | 2.102 | 1.557 | 1.580 | 1.680 | 1.310 | 1.270 |
| *RevG* | 0.123 | 0.063 | 0.363 | 0.137 | 0.064 | 0.397 | 0.076 | 0.059 | 0.199 |
| *FS* | 22.100 | 22.11 | 1.782 | 21.961 | 22.047 | 1.759 | 22.573 | 22.508 | 1.779 |
| *Lev* | 0.931 | 0.582 | 2.746 | 0.867 | 0.582 | 2.444 | 1.150 | 0.579 | 3.587 |
| *BS* | 9.574 | 9.000 | 2.414 | 9.490 | 9.000 | 2.452 | 9.864 | 10.000 | 2.256 |
| *PPE* | 0.221 | 0.140 | 0.212 | 0.198 | 0.130 | 0.197 | 0.297 | 0.222 | 0.241 |
| *Innov_C* | 0.383 | 0.044 | 4.994 | 0.480 | 0.056 | 5.674 | 0.052 | 0.025 | 0.074 |

**Note: "Innov_C" is the continuous variable for innovation intensity before indicator transformation (Innov).*

Different variables for board gender diversity are used as independent variables for the regressions in the presented models. Considering Blau's Index (Blau) we obtain values ranging from 0 to 0.5, which in turn are the minimum and maximum values, respectively, for the index. In our full sample, we obtain a mean of 0.245 for Blau's Index, which can be compared to a mean of 0.210 in Miller and del Carmen Triana (2009), suggesting an increase in board gender diversity in U.S. public firms since the beginning of the 21st century. The dummy variable for board gender diversity generates (GD) a value of 0 or 1 where 1 represents boards with at least one female director and 0 otherwise. The mean value of 0.826 suggests that the majority of our observations include boards where at least one female is present. These two variables are complemented with a variable indicating the percentage of female directors (FDP). This variable shows values ranging between 0% to 60% indicating that no single observation shows a board composition where more than 60% of the members are female. The mean is 15.9%, indicating a general underrepresentation of women on boards.

For the dependent variables used in the regressions, ROA and Tobin's Q have been chosen as proxies for firm financial performance. For ROA, we obtain a mean of 2% with a range of values between -79.5% and 33.6%. In turn, Tobin's Q has a mean value of 1.819 with values varying between 0.229 and 8.271.

Firm Size (FS), measured as the natural logarithm of year-end Total Assets, has a mean value of 22.100 with minimum and respective maximum values of 17.686 and 26.169, indicating a relatively large variation in firm size between observations (see Appendix 2). Liquidity (Liq), measured as (Current Assets - Inventory)/Current Liabilities, has a mean of 2.006, with the lowest value being 0.395 and the highest observed value being 8.678. We obtain a mean for Board Size (BS) of 9.574 in the full sample.

Innovation, measured as R&D Expenses to Revenue, has been converted into an indicator variable *(Innov)* with three categories. These categories have been named Tier 1, Tier 2, and Tier 3 and are based on quartiles for the original continuous innovation variable *(Innov_C)* where Tier 1 represents the first quartile (0%-25%), Tier 2 represents the following two quartiles (25%-75%), and Tier 3 represents the last quartile (75%-100%). This distinction has been made in order to ensure a more easily interpreted result and deal with the potential issue of extreme outliers.

## 4.2 Multicollinearity

In testing for multicollinearity we use Pearson Correlation coefficients and Variance Inflation Factors (VIF). Tables 3 and 4 present results for the correlation between our variables, which in turn could potentially lead to skewed results. In Table 3, we use our full sample and ROA as the dependent variable, whereas in Table 4, we use Tobin's Q as the dependent variable. It is evident that the independent variables and the control variables in our model exhibit different levels of correlation with our dependent variables, although the overall trend suggests that high levels of correlation are not present in our models. This indicates that our independent variables, as well as the control variables, provide explanatory value to our model. One notable correlation coefficient obtained is between Firm Size (FS) and Board Size (BS), which presents a correlation of 0.502. However, this result is complemented by their respective VIF results, which both are well below the cut-off point of 5, indicating that multicollinearity is not present. Furthermore, considering the variables GD, FDP, and Blau, we see notably higher values for VIF and correlation, indicating a strong presence of multicollinearity between the variables. Nonetheless, this is expected and does not constitute a concern considering that both GD and Blau are based on FDP. Moreover, since the presented VIF values for the other variables do not exceed the conventional cut-off point of 5, we conclude that multicollinearity is not present in our model. Thus we keep all variables in the model and proceed to perform the multivariate regressions.

**Table 3.** Pearson Correlation Coefficient Matrix and VIF for Full Sample, ROA

| | *ROA* | *GD* | *FDP* | *Blau* | *Lev* | *PPE* | *BS* | *RevG* | *Liq* | *FS* | *Innov* | *VIF* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *ROA* | 1.000 | | | | | | | | | | | |
| *GD* | 0.145 | 1.000 | | | | | | | | | | 5.355 |
| *FDP* | 0.125 | 0.683 | 1.000 | | | | | | | | | 39.020 |
| *Blau* | 0.142 | 0.797 | 0.975 | 1.000 | | | | | | | | 57.180 |
| *Lev* | -0.035 | 0.036 | 0.034 | 0.039 | 1.000 | | | | | | | 1.011 |
| *PPE* | 0.034 | -0.071 | -0.098 | -0.097 | -0.015 | 1.000 | | | | | | 1.204 |
| *BS* | 0.172 | 0.339 | 0.260 | 0.296 | 0.067 | 0.060 | 1.000 | | | | | 1.425 |
| *RevG* | -0.242 | -0.154 | -0.136 | -0.154 | -0.011 | -0.078 | -0.159 | 1.000 | | | | 1.109 |
| *Liq* | -0.146 | -0.151 | -0.187 | -0.189 | -0.066 | -0.171 | -0.201 | 0.249 | 1.000 | | | 1.287 |
| *FS* | 0.406 | 0.302 | 0.278 | 0.312 | 0.04 | 0.198 | 0.502 | -0.217 | -0.288 | 1.000 | | 1.533 |
| *Innov* | -0.266 | -0.028 | -0.075 | -0.063 | -0.062 | -0.345 | -0.141 | 0.169 | 0.375 | -0.189 | 1.000 | 1.310 |

**Note: The Pearson Correlation Matrix and VIF values represent the full sample for our first hypothesis, using ROA as the dependent variable.*

**Table 4.** Pearson Correlation Coefficient Matrix and VIF for Full Sample, Tobin's Q

| | *TQ* | *GD* | *FDP* | *Blau* | *Lev* | *PPE* | *BS* | *RevG* | *Liq* | *FS* | *Innov* | *VIF* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *TQ* | 1.000 | | | | | | | | | | | |
| *GD* | -0.006 | 1.000 | | | | | | | | | | 5.355 |
| *FDP* | 0.038 | 0.683 | 1.000 | | | | | | | | | 39.020 |
| *Blau* | 0.029 | 0.797 | 0.975 | 1.000 | | | | | | | | 57.180 |
| *Lev* | -0.053 | 0.036 | 0.034 | 0.039 | 1.000 | | | | | | | 1.011 |
| *PPE* | -0.171 | -0.071 | -0.098 | -0.097 | -0.015 | 1.000 | | | | | | 1.204 |
| *BS* | -0.060 | 0.339 | 0.260 | 0.296 | 0.067 | 0.060 | 1.000 | | | | | 1.425 |
| *RevG* | 0.183 | -0.154 | -0.136 | -0.154 | -0.011 | -0.078 | -0.159 | 1.000 | | | | 1.109 |
| *Liq* | 0.258 | -0.151 | -0.187 | -0.189 | -0.066 | -0.171 | -0.201 | 0.249 | 1.000 | | | 1.287 |
| *FS* | -0.215 | 0.302 | 0.278 | 0.312 | 0.040 | 0.198 | 0.502 | -0.217 | -0.288 | 1.000 | | 1.533 |
| *Innov* | 0.299 | -0.028 | -0.075 | -0.063 | -0.062 | -0.345 | -0.141 | 0.169 | 0.375 | -0.189 | 1.000 | 1.310 |

**Note: The Pearson Correlation Matrix and VIF values represent the full sample for our first hypothesis, using TQ as the dependent variable.*

# 5. Results and Analysis

This section presents results from each multivariate linear regression model in our full sample, as well as our subsamples. We will conduct the regressions in each sample using combinations of our dependent variables ROA and Tobin's Q for firm financial performance and our independent variables Gender Dummy (GD), Percentage of Female Directors (FDP), and Blau's Index for Heterogeneity (Blau) for board gender diversity. Furthermore, we will introduce interaction terms between innovation and board gender diversity measures to test the inter-relationship between board gender diversity, innovation, and firm financial performance.

## 5.1 First Hypothesis

Our first hypothesis - *there is a positive relationship between board gender diversity and firm financial performance* - is tested using the multivariate OLS model outlined in section 3.4.2. Table 5 shows results from six regressions incorporating our three main independent variables for gender diversity (GD, FDP, and Blau) and their subsequent impact on the dependent variables for financial performance (ROA and TQ). Robust standard errors are incorporated into all six regressions, as well as controls for year and firm fixed effects. At firm-level we control for Leverage, PPE-ratio, Revenue Growth, Liquidity, Firm Size, and Board Size.

Our first three regressions (1-3), using ROA as the outcome variable, indicate conflicting results. Coefficients for the independent variables Blau and FDP are positive, suggesting that increased board heterogeneity in terms of gender diversity leads to higher ROA. Conversely, the coefficient for the dummy variable (GD) is negative, suggesting that the presence of women on corporate boards impedes operational financial performance. However, as none of the independent variable coefficients in regressions 1-3 are statistically significant, at any conventional level, we can not draw any definitive conclusions from the aforementioned results.

Our latter three regressions (4-6), incorporating Tobin's Q as the outcome variable, yield more conforming results. The independent variables for board gender diversity show negative coefficients, implying that board gender diversity has a negative impact on market-based financial performance measured by Tobin's Q.

Without statistical significance, we neither accept nor reject our first hypothesis. However, following the rationale from adjacent literature, interaction effects might still be present in the BGD-CFP relationship. Hence we introduce *Innovation* to the model (Preacher & Hayes, 2004).

**Table 5.** Regression Results Hypothesis 1, Full Sample

| | ROA (1) | ROA (2) | ROA (3) | TQ (4) | TQ (5) | TQ (6) |
|---|---|---|---|---|---|---|
| *GD* | -0.002 | | | -0.016 | | |
| | (0.011) | | | (0.092) | | |
| *FDP* | | 0.013 | | | -0.048 | |
| | | (0.039) | | | (0.348) | |
| *Blau* | | | 0.007 | | | -0.018 |
| | | | (0.032) | | | (0.279) |
| *Lev* | -0.001 | -0.001 | -0.001 | -0.009 | -0.009 | -0.009 |
| | (0.001) | (0.001) | (0.001) | (0.007) | (0.007) | (0.007) |
| *PPE* | -0.039 | -0.039 | -0.039 | -0.699 | -0.697 | -0.698 |
| | (0.064) | (0.064) | (0.064) | (0.478) | (0.478) | (0.477) |
| *BS* | -0.000 | -0.000 | -0.000 | -0.010 | -0.011 | -0.011 |
| | (0.001) | (0.002) | (0.001) | (0.017) | (0.017) | (0.017) |
| *RevG* | 0.024** | 0.024** | 0.024** | -0.123 | -0.122 | -0.122 |
| | (0.011) | (0.011) | (0.011) | (0.119) | (0.118) | (0.119) |
| *Liq* | 0.001 | 0.001 | 0.001 | -0.050* | -0.050* | -0.050* |
| | (0.002) | (0.002) | (0.002) | (0.029) | (0.029) | (0.029) |
| *FS* | -0.032*** | -0.032*** | -0.032*** | -0.440*** | -0.441*** | -0.441*** |
| | (0.012) | (0.012) | (0.012) | (0.084) | (0.085) | (0.085) |
| *Constant* | *0.720**** | *0.720**** | *0.720**** | *11.430**** | *11.430**** | *11.430**** |
| | *(0.278)* | *(0.278)* | *(0.278)* | *(1.901)* | *(1.915)* | *(1.911)* |
| *Adj. R-sq.* | *0.825* | *0.825* | *0.825* | *0.769* | *0.769* | *0.769* |

**Note: Year and firm FE and VCE robustness included. Heteroskedasticity robust firm-clustered standard errors in brackets. Sig. levels 10%, 5% & 1% indicated by *, ** & *** respectively. Comparable base: InnovTier 1. # obs. for regressions: 2,305.*

## 5.2 Second Hypothesis

Our second hypothesis - *there is a more positive relationship between board gender diversity and firm financial performance for firms in industries where the relative importance of innovation is high, than for firms in industries where the relative importance of innovation is low* - is tested using the multivariate OLS model outlined in section 3.4.2. Similar to Chen et al. (2018), we split our sample, differentiating between firms operating in industries with high or low innovation importance. We use IP-intensity as a proxy for this application. The definition of IP-intensive industries is based on the report by the Economics and Statistics Administration (ESA) and the U.S. Patent and Trademark Office (USPTO).

The subsample including firms categorised as IP-intensive ("sample *I")* consists of 1,784 observations, whereas the other subsample ("sample *NI"*) consists of 521 observations. Our aim is thus to isolate and examine the effect of relative innovation importance and whether the relationship between board gender diversity and firm financial performance is higher in these industries.

Similar to our earlier models, we use ROA and Tobin's Q as dependent variables to proxy firm financial performance and GD, FDP, and Blau as proxies for board gender diversity. We run six regressions in samples I and NI, respectively. Considering the results in Table 6 we see that the coefficients for BGD in sample I, using ROA as the dependent variable, demonstrate a positive result for FDP and Blau, while GD is negative. This can be compared to the results in sample NI which show positive coefficients for each regression. Hence, an overall positive relationship between BGD and CFP is found in both subsamples. However, due to the lack of statistical significance for the coefficients, we are not able to draw any definitive conclusions.

Moreover, using Tobin's Q as the outcome variable, we obtain results more in line with our hypothesis. In sample I we find evidence of a positive relationship between board gender diversity and firm performance for all BGD variables. Furthermore, Table 6 indicates that the relationship between Tobin's Q and board gender diversity is negative in sample NI, consistent with our expectations. However, considering that the results are insignificant, the evidence provided is not strong enough to reject our null hypothesis.

**Table 6.** Regression Results Hypothesis 2, Subsamples I and NI.

| Sample I | ROA (1) | | ROA (2) | | ROA (3) | | T Q (4) | | TQ (5) | | TQ (6) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *GD* | -0.006 | (0.013) | | | | | 0.029 | (0.118) | | | | |
| *FDP* | | | 0.004 | (0.045) | | | | | 0.134 | (0.424) | | |
| *Blau* | | | | | 0.000 | (0.037) | | | | | 0.174 | (0.344) |
| *Lev* | -0.002 | (0.001) | -0.002 | (0.001) | -0.002 | (0.001) | -0.008 | (0.011) | -0.008 | (0.011) | -0.008 | (0.011) |
| *PPE* | 0.037 | (0.086) | 0.037 | (0.086) | 0.037 | (0.086) | -1.385* | (0.711) | -1.386* | (0.710) | -1.386* | (0.711) |
| *BS* | -0.000 | (0.002) | -0.000 | (0.002) | -0.000 | (0.002) | -0.021 | (0.017) | -0.021 | (0.018) | -0.021 | (0.018) |
| *RevG* | 0.021* | (0.012) | 0.021* | (0.012) | 0.021* | (0.012) | -0.170 | (0.130) | -0.170 | (0.130) | -0.170 | (0.130) |
| *Liq* | 0.000 | (0.003) | 0.000 | (0.003) | 0.000 | (0.003) | -0.069** | (0.033) | -0.069** | (0.033) | -0.069** | (0.033) |
| *FS* | -0.023* | (0.014) | -0.024* | (0.014) | -0.024* | (0.014) | -0.530*** | (0.104) | -0.528*** | (0.105) | -0.529*** | (0.105) |
| *Constant* | 0.508 | (0.317) | 0.514 | (0.321) | 0.514 | (0.319) | 13.570*** | (2.347) | 13.530*** | (2.379) | 13.550*** | (2.370) |
| *Adj. R-sq* | 0.845 | 0.845 | 0.845 | 0.845 | 0.845 | 0.845 | 0.752 | 0.752 | 0.752 | 0.752 | 0.752 | 0.752 |
| **Sample NI** | **ROA (1)** | | **ROA (2)** | | **ROA (3)** | | **Tobin's Q (4)** | | **Tobin's Q (5)** | | **Tobin's Q (6)** | |
| *GD* | 0.010 | (0.018) | | | | | -0.051 | (0.114) | | | | |
| *FDP* | | | 0.049 | (0.075) | | | | | -0.476 | (0.492) | | |
| *Blau* | | | | | 0.033 | (0.060) | | | | | -0.403 | (0.376) |
| *Lev* | -0.000 | (0.001) | -0.000 | (0.001) | -0.000 | (0.001) | -0.011* | (0.007) | -0.011* | (0.007) | -0.011* | (0.007) |
| *PPE* | -0.124 | (0.094) | -0.129 | (0.093) | -0.128 | (0.093) | 0.421 | (0.543) | 0.474 | (0.542) | 0.482 | (0.542) |
| *BS* | 0.000 | (0.002) | 0.001 | (0.003) | 0.000 | (0.003) | 0.044** | (0.020) | 0.040** | (0.020) | 0.041** | (0.020) |
| *RevG* | 0.061*** | (0.022) | 0.060*** | (0.022) | 0.060*** | (0.022) | 0.150 | (0.156) | 0.150 | (0.154) | 0.146 | (0.154) |
| *Liq* | 0.006 | (0.005) | 0.006 | (0.005) | 0.006 | (0.005) | 0.031 | (0.035) | 0.033 | (0.035) | 0.032 | (0.035) |
| *FS* | -0.055** | (0.022) | -0.056** | (0.022) | -0.055** | (0.022) | -0.287** | (0.128) | -0.285** | (0.128) | -0.289** | (0.128) |
| *Constant* | 1.304*** | (0.493) | 1.312*** | (0.498) | 1.306*** | (0.493) | 7.164** | (2.800) | 7.160** | (2.822) | 7.262** | (2.822) |
| *Adj. R-sq* | 0.620 | 0.620 | 0.620 | 0.620 | 0.620 | 0.620 | 0.840 | 0.840 | 0.841 | 0.841 | 0.841 | 0.841 |

**Note: Year and firm FE and VCE robustness are included. Heteroskedasticity robust firm-clustered standard errors reported in brackets. Sig. levels 10%, 5% & 1% indicated by *, ** & *** respectively. # obs. for sample I and NI regressions are 1,784 and 521, respectively.*

## 5.3 Third Hypothesis

Our third hypothesis is tested using the multivariate OLS Model outlined in section 3.4.3, examining whether there is a more positive relationship between board gender diversity and firm financial performance for firms with high innovation intensity than for firms with low innovation intensity. Innovation intensity is proxied by R&D Expenses divided by Revenue. In contrast to hypothesis 2, this allows for examining the effect of innovation intensity for firms as opposed to relative innovation importance in industries. Results presented in Table 7 are attained from six regressions, including robust standard errors and controls for year and firm fixed effects. Control variables are Lev, PPE, RevG, Liq, FS, and BS. The independent variables for the regressions are: "$InnovTier_{1\text{-}3}$", representing different levels of innovation intensity; GD, FDP, and Blau; the interaction term $BGD{\times}InnovTier_{1\text{-}3}$.

As seen in Table 7, regressions (1-3) focus on ROA as the outcome variable. Results yield negative coefficients for the simple effect relationship between each of the independent gender diversity variables (GD, FDP, Blau) and ROA. However, the results lack statistical significance at any conventional level. Examining coefficients for the interaction term between the Percentage of Female Directors (FDP) and the two tiers of Innovation $InnovTier_{2\text{-}3}$, using $InnovTier_1$ as the comparable base, we see that the coefficient is negative for $InnovTier_2$ and positive for $InnovTier_3$. This suggests that the relationship between board gender diversity (FDP) and firm financial performance (ROA) is more positive for firms with higher innovation than for firms with lower innovation. However, without statistical significance, we are unable to draw any definitive conclusions. Further, relating to the interaction terms for $InnovTier_{2\text{-}3}$ with Blau and GD, respectively, we acknowledge that the coefficients are positive, yet we draw no definitive conclusions due to the insignificance of our results.

The latter three regressions (4-6) instead focus on the market-based determinant of financial performance, Tobin's Q (TQ). Results from these regressions differ greatly from the first three, indicating that our independent variables have varying impact on outcome variables depending on whether we use accounting or market-based numbers for financial performance. We see that coefficients for the simple effect relationship between board gender diversity in terms of FDP and Blau are positive and significant at the 10% and 5% levels respectively. Meanwhile, the coefficient for GD is negative; however, without statistical significance, we defer from drawing definitive conclusions.

Assessing the interaction effect of innovation intensity in regressions 1-3, we find positive coefficients for interaction terms $FDP \times InnovTier_3$ and $Blau \times InnovTier_3$ to be statistically significant at the 10% and 5% levels, respectively. This indicates that higher levels of innovation intensity amplify the relationship between board gender diversity and firm financial performance, as illustrated by the positive coefficients. Nonetheless, due to the insignificant nature of the other regressions, we are only able to partially accept our third hypothesis. See section 6.1 for further discussion of the aforementioned findings.

**Table 7.** Regression Results Hypothesis 3, Full Sample

| | **ROA (1)** | **ROA (2)** | **ROA (3)** | **TQ (4)** | **TQ (5)** | **TQ (6)** |
|---|---|---|---|---|---|---|
| *Innov Tier 2* | -0.007 | 0.008 | 0.006 | -0.158 | -0.146 | -0.184* |
| | (0.020) | (0.013) | (0.016) | (0.117) | (0.091) | (0.101) |
| *Innov Tier 3* | -0.045 | -0.047* | -0.048* | -0.427 | -0.448** | -0.539** |
| | (0.032) | (0.025) | (0.028) | (0.272) | (0.220) | (0.249) |
| *GD* | -0.015 | | | -0.176 | | |
| | (0.019) | | | (0.118) | | |
| *GD×Innov Tier 2* | 0.017 | | | 0.115 | | |
| | (0.021) | | | (0.123) | | |
| *GD×Innov Tier 3* | 0.012 | | | 0.349 | | |
| | (0.029) | | | (0.262) | | |
| *FDP* | | -0.001 | | | -0.767* | |
| | | (0.054) | | | (0.427) | |
| *FDP×Innov Tier 2* | | -0.010 | | | 0.505 | |
| | | (0.056) | | | (0.466) | |
| *FDP×Innov Tier 3* | | 0.068 | | | 1.967* | |
| | | (0.095) | | | (1.068) | |
| *Blau* | | | -0.010 | | | -0.682** |
| | | | (0.048) | | | (0.330) |
| *Blau×Innov Tier 2* | | | 0.005 | | | 0.483 |
| | | | (0.049) | | | (0.340) |
| *Blau×Innov Tier 3* | | | 0.049 | | | 1.627** |
| | | | (0.077) | | | (0.793) |
| *Lev* | -0.001 | -0.001 | -0.001 | -0.009 | -0.009 | -0.009 |
| | (0.001) | (0.001) | (0.001) | (0.007) | (0.007) | (0.007) |

***(Continued)***

**Table 7.** Continued

| | | | | | | |
|---|---|---|---|---|---|---|
| *PPE* | -0.037 | -0.040 | -0.040 | -0.731 | -0.695 | -0.708 |
| | (0.062) | (0.062) | (0.062) | (0.477) | (0.480) | (0.479) |
| *BS* | -0.000 | -0.000 | -0.000 | -0.010 | -0.011 | -0.011 |
| | (0.001) | (0.002) | (0.001) | (0.017) | (0.017) | (0.017) |
| *RevG* | 0.022** | 0.022** | 0.022** | -0.137 | -0.130 | -0.133 |
| | (0.010) | (0.011) | (0.011) | (0.119) | (0.119) | (0.119) |
| *Liq* | 0.001 | 0.001 | 0.001 | -0.052* | -0.051* | -0.052* |
| | (0.002) | (0.002) | (0.002) | (0.029) | (0.029) | (0.029) |
| *FS* | -0.034*** | -0.034*** | -0.034*** | -0.452*** | -0.464*** | -0.467*** |
| | (0.012) | (0.012) | (0.012) | (0.084) | (0.084) | (0.084) |
| *Constant* | *0.777**** | *0.784**** | *0.786**** | *11.880**** | *12.140**** | *12.240**** |
| | *(0.261)* | *(0.263)* | *(0.262)* | *(1.867)* | *(1.885)* | *(1.877)* |
| *Adj. R-sq.* | *0.826* | *0.826* | *0.826* | *0.769* | *0.769* | *0.769* |

**Note: Year and firm FE and VCE robustness included. Heteroskedasticity robust firm-clustered standard errors in brackets. Sig. levels 10%, 5% & 1% indicated by *, ** & *** respectively. Comparable base: InnovTier 1. # obs. for regressions: 2,305.*

## 5.4 Robustness Tests

In this section, we present robustness tests incorporated into our study to ensure the validity of regression coefficient estimates. We consider the presence of heteroskedasticity in our models as well as performing a bootstrap for the regressions to test our sample estimates for accuracy. Moreover, we rationalise the use of winsorization to deal with outliers.

### 5.4.1 Heteroskedasticity

Heteroskedasticity refers to the circumstance when a predicted variable experiences standard deviations that are non-constant over time. This phenomenon is in violation of the Gauss Markov assumptions necessary for ordinary least squares regressions. A presence of heteroskedasticity in our model might impair the possibility of drawing accurate conclusions and therefore needs to be adjusted for. Thus, we perform a Breusch-Pagan test to see if heteroskedasticity is present in our models. Results reported in Appendix 3 show Prob>chi2 = 0.000 for both Models 1 & 2, respectively. These results indicate that heteroskedasticity is present in both our models, and we thus reject the null hypothesis of constant error variance in our models. Hence, we perform our OLS regressions using robust standard errors in order to obtain unbiased standard errors of the coefficients.

### 5.4.2 Bootstrap

Similar to the mediation model developed by Preacher and Hayes (2004), we incorporate bootstrapping to examine the validity of our regressions in the full sample. The coefficient estimates in both Model 1 and 2 are not altered following the bootstrap; however, we see a slight increase in the bootstrapped standard error term compared to the heteroskedasticity robust firm-clustered standard errors for the regressions, shown in Appendix 4 & 5. Furthermore, the overall significance levels for each coefficient estimate slightly decrease. The relatively small decrease in significance levels is indicative of a strong level of accuracy, suggesting that our sample is a good representation of the population.

### 5.4.3 Dealing with Outliers

In order to deal with outliers in the models, we winsorize all continuous variables at the 1st and 99th percentiles, similar to adjacent research (Chen et al., 2018). When comparing our regression results with winsorized variables to the same regressions without winsorized variables we can see that the adjusted R-squared has increased for every regression. As outliers have a tendency to deviate more from model predictions, this outcome is in line with our expectations and indicates that the explanatory value of our model increases. Concludingly, we see that some of our regression coefficients obtain different values without winsorization, suggesting avoidance of a potentially biased result due to outliers.

## 5.5 Summary of Findings

The regression results for our first hypothesis are inconclusive. Although our general findings indicate both a positive and negative relationship between board gender diversity and firm financial performance, due to the insignificant nature of our coefficient estimates, we fail to reject the null hypothesis. These findings add to a stream of research that fails to find a clear relationship between board gender diversity and financial performance (Carter et al., 2010; Chapple & Humphrey, 2014; Rose, 2007).

Regression results from using Model 1 in the split sample indicate alignment with our second hypothesis when Tobin's Q is the dependent variable. However, considering the lack of statistical significance for our findings, the model fails to reject the null hypothesis. Thus, we cannot draw definitive conclusions as to whether the relationship between board gender diversity and firm financial performance is amplified in industries where innovation is deemed important, contrasting to the findings of Chen et al. (2018).

Lastly, considering our third hypothesis, we find some significance for the inter-relationship between board gender diversity, innovation, and subsequent firm financial performance measured by Tobin's Q. Specifically, we find positive coefficients for the interaction terms $FDP \times InnovTier_3$ and $Blau \times InnovTier_3$. Consequently, suggesting that high levels of innovation intensity positively amplify the relationship between board gender diversity and subsequent firm financial performance. These findings provide partial evidence for the rejection of our null hypothesis, albeit, we acknowledge the general ambiguity of the regression results for which we provide further discussion in section 6.1.

# 6. Discussion

In this section, we discuss the results from our study on the inter-relationship between board gender diversity, innovation, and firm financial performance. The concepts and theories presented in the literature review have been used for the development of our hypotheses, which in turn have been tested using secondary data. Considering the overall insignificant nature of our results, we provide an elaborate discussion on the quality of our study. Lastly, we consider potential endogeneity concerns associated with our models.

## 6.1 Discussion of Findings

In general our research fails to find significant statistical evidence to reject our first and second null hypotheses, thus partially aligning our findings to those of previous scholars finding no relationship between board gender diversity and firm financial performance (Carter et al., 2010; Chapple & Humphrey, 2014; Rose, 2007). However, as concluded in section 5.5, and indicated in Table 7, we find partial evidence in support of our third hypothesis suggesting a significant positive interaction effect of innovation on the relationship between BGD and CFP for firms with high levels of innovation intensity. Specifically, indicated by the positive coefficients for the interaction terms $FDP \times InnovTier_3$ and $Blau \times InnovTier_3$, significant at the 10% and 5% levels, respectively.

Conceptualising these findings in the light of Agency Theory, board gender heterogeneity is an essential tool for mitigating agency costs associated with higher levels of innovation, further emphasising the importance of female directorship for firm value (Carter et al., 2003; Hillman & Dalziel, 2003). Using Human Capital Theory as a theoretical lens for discussion, the results reflect particular importance for female directorship in high-innovation environments, as innovation outcomes are argued to be significantly affected by diverse human capital on corporate boards (Nguyen et al., 2017). Related to Resource Dependence Theory, the results are reflective of arguments by Robinson and Dechant (1997) suggesting that systematic variation, through increased gender diversity, increases innovation.

However, we are aware of certain limitations with regard to the robustness of these results. Specifically, after bootstrapping our regressions, and testing our third hypothesis, the significance[2] of our coefficients is impaired. Hence, the general incoherence combined with a lack of overall statistical significance impedes our ability to fully reject the third null hypothesis. Conclusively, failing to align with findings by scholars who have found a positive interaction effect between innovation and the critical mass of female directors on firm financial performance (Cabeza-García et al., 2021).

## 6.2 Sample Selection

The process for our sample selection has been outlined in section 3.1, however, this section presents issues and concerns regarding the selection process which may have affected the study.

For the data extraction, we have used Thomson Reuters' Refinitiv Eikon database, which is deemed one of the most reliable databases for firm financial data (Refinitiv, 2022). Thus, we expect the reliability of our data to be high, however, data availability imposes certain limitations to our sample. For instance, many firms have missing values for board characteristics and financials, as illustrated in Table 1, limiting the size of our sample. Further, the choice to exclude firms with missing values for R&D expenses has excluded a large number of firms from our sample. In order to include more observations and increase our sample size a possible action,

[2] *Statistical significance is lost for the coefficient of the interaction term "FDP×InnovTier$_3$", and increases to the 10% level for the coefficient of "Blau×InnovTier$_3$".*

adapted by previous scholars (Chen et al., 2018), could be to include firms with missing values for R&D expenses and assign these observations a value of 0.

Moreover, the limitation to public U.S. corporations might impose a bias towards larger firms, since small private firms are excluded from our sample. Including private firms would remove such a bias, although this data is likely to be subject to scarcity as well as to impede the possibility of using Tobin's Q as a proxy for firm financial performance. Further, measuring innovation as R&D Expenses divided by Revenue skews our sample towards companies reporting R&D expenses rather than capitalising R&D costs. Issues regarding measures for innovation are discussed further in section 6.3.1. Lastly, splitting our sample based on relative innovation importance in industries created unequal sample sizes, with 1,784 firm-year observations in sample I and 521 observations in sample NI. Comparing two samples of different sizes is likely to have affected our findings, hindering the possibility to draw accurate conclusions.

## 6.3 Quality of Study

It is evident our study fails to provide significant results, thus rendering our findings incoherent with some previous scholars' notion of a positive or negative inter-relationship between board gender diversity, innovation, and firm financial performance. However, despite the insignificant nature of our regression coefficients, the results can provide interesting implications for the research area.

### 6.3.1 Issues on Measuring Innovation

In line with previous research, this study uses R&D Expenses divided by Revenue as a proxy for innovation intensity (Miller & del Carmen Triana, 2009; Saggese, Sarto, & Viganò, 2021). However, many studies which investigate the role of innovation as an interacting variable use various definitions for the innovation variable (Mastella, Vancin, Perlin, & Kirch, 2021; Sharma, 2016). Our definition of innovation intensity might be a possible reason behind the observed insignificance levels for our hypotheses. Using R&D expenses as a proxy for innovation means that only innovation inputs are measured, which fails to incorporate the effect of innovation output and the possibility to measure innovation efficiency in firms (Chen et al., 2018). This could be done, for instance, by using a firm's patenting activities as a proxy for innovation efficiency, thus measuring the effectiveness of a firm's utilisation of innovation inputs. Furthermore, R&D expenses are likely to be subject to managerial accounting issues where the question of whether R&D should be capitalised or expensed is likely to have affected our sample since we only include firms that have expensed R&D.

### 6.3.2 Issues on Measuring Board Gender Diversity

This study uses three different independent variables for measuring the gender diversity on corporate boards: GD, FDP and Blau. These various measures are used in order to cover a broad range of possible gender-based implications, in line with previous research (Campbell & Mínguez-Vera, 2008; Joecks et al., 2013; Kılıç & Kuzey, 2016). However, measuring board gender diversity has also been conducted through the use of alternative measures such as Total Board Diversity Index (TDBI) (Kagzi & Guha, 2018), Shannon Index (Campbell & Mínguez-Vera, 2008), and various dummy variables representing different levels of female board presence (Joecks et al., 2013). Furthermore, a tenure-weighted fraction of female directors is another interesting measure imposing additional implications (Chen et al., 2018). A tenure-weighted measure would be beneficial since directors with longer tenures are more active monitors and more likely to take action (Schwartz-Ziv & Weisbach, 2013). Thus, it would likely better capture the impact of female directors on innovation through internal governance; however, due to the lack of data availability, we were not able to use this measure. Moreover, we did not consider female board representation in terms of absolute numbers (Mastella et al., 2021). Using such a variable could potentially lead to different results and has been used in previous research which examines the "Critical Mass Theory" for the number of women on boards (Liu, Wei, & Xie, 2014).

### 6.3.3 Issues on Measuring Firm Financial Performance

When measuring firm financial performance in our models, we have used ROA and Tobin's Q as the dependent variables. These variables are common in studies investigating corporate governance and firm performance (Carter et al., 2003; Conyon & He, 2017; Kagzi & Guha, 2018; Mastella et al., 2021; Rossi, Hu, & Foley, 2017; Wiley & Monllor-Tormos, 2018). Alternative financial performance measures used by previous scholars are ROE, ROCE, ROS and ROI (Kılıç & Kuzey, 2016; Liu et al., 2014; Miller & del Carmen Triana, 2009; Noamene, Halcro, Chaher, & Talib, 2021; Rose, Munch-Madsen, & Funch, 2013). Similarly to ROA, these are accounting-based profitability measures using past financial data, thus failing to reflect a company's future estimates. Moreover, ROAA is an alternative version of ROA using "Average Total Assets" instead of "Total Assets" which can be argued to yield a more accurate representation of a firm's asset base used to generate its net income.

On the other hand, Tobin's Q is a vastly different performance measure, defined as the ratio between a firm's Total Market Value and its Total Asset Value (Chung & Pruitt, 1994). This captures the effect of market expectations for a firm's performance, which makes the ratio susceptible to investors' anticipation of the firm as an investment opportunity (Bhagat & Bolton, 2008; Carter et al., 2010). The Q ratio also avoids potential issues arising from accounting-based financial performance measurements (Bharadwaj, Bharadwaj, & Konsynski, 1999).

Using both ROA and Tobin's Q as outcome variables allows for capturing both operational financial performance and market-based performance, incorporating past performance, future financial outlooks, and market expectations into our models.

## 6.4 Endogeneity Concerns

Potential endogeneity concerns, indicating correlation between the predictor variable and the error term, must be acknowledged in our study. In fact, some scholars argue these concerns hold true for the interplay between most board characteristics and subsequent firm performance (Hermalin & Weisbach, 1998). For the specific case of the relationship between board gender diversity and firm financial performance, research split the conditions for endogeneity into two categories: *omitted variable bias* and *simultaneity bias.*

Regarding the former category specific to our selected variables, research suggests a concern for endogeneity problems due to omitted variables affecting both financial performance and the diversification of directors selected (Adams & Ferreira, 2009). To hedge for the possibility of omitted variable bias being present in our models, we implement appropriate measures in line with previous research. Similar to Adams and Ferreira (2009) and Carter et al. (2010) we add firm and year fixed effects to our models with the intention of mitigating omitted variables and unobserved fluctuations over time. Further, adjacent to the statistical model used by (Gujarati & Porter, 2009), we incorporate robust standard errors into our unbalanced panel data regression models.

Although we implement measures, in line with previous research, to help us mitigate endogeneity concerns in terms of omitted variable bias, we acknowledge potential shortcomings with regard to the implications of simultaneity bias in our regressions. Specifically, it might be that a higher degree of firm financial success increases the selection of diverse directors and not the other way around (Adams and Ferreira, 2009; Campbell and Mínguez-Vera, 2008; Carter et al. 2010). To effectively counter these endogeneity concerns, scholars frequently construct regression models utilising Instrumental Variables ("IV") (Reguera-Alvarado et al., 2017) and subsequently validating the IVs through Sargan test and Cragg-Donald Wald F-statistics test respectively (Li & Chen, 2018).

Cognizant of the fact that we neither perform IV-regressions, nor conduct subsequent validity tests, our regression results might have been subject to simultaneity bias affecting our findings. Further, we did not consider the possibility of endogeneity concerns connected to the interaction effect of innovation on the board gender diversity and financial performance relationship, hence constituting another plausible cause for ambiguity in our findings.

## 7. Suggestions for Future Research

In this research paper, we have examined the relationship between board gender diversity and firm financial performance and whether innovation affects this relationship. Throughout examining this relationship, we have identified potential limitations and opportunities, constituting a basis for future research presented in this section.

When considering the interacting effect of innovation, we have used R&D Expenses divided by Revenue as a proxy for innovation intensity. As discussed in section 6.3.1, there are a number of shortcomings to this measure, suggesting a need for further elaboration of alternative measures for innovation. Moreover, considering the TCJA[3] legislation passed in 2017 and taking effect in 2022, making it mandatory to capitalise R&D expenses, would provide an interesting basis for further research, likely to render managerial accounting a much smaller issue.

Another element of interest for our research is the potential effects of intangible assets other than innovation (Surroca, Tribó, & Waddock, 2010). Our study has been strictly limited to the interacting effect of innovation, although other intangible asset categories, such as firm reputation, human capital, organisational culture etc, would potentially have great implications for the relationship between board gender diversity and firm financial performance.

Another potential limitation to our study is the use of lagged variables. Although lagged variables are incorporated into our models, in order to capture subsequent firm financial performance, we only lag our variables one year. Previous literature studying the effect of innovation have lagged their variables for one, three or even five years (Chen et al., 2018), in order to try to more accurately capture the subsequent effect on firm performance arising from innovation efforts. Hence, future research would likely benefit from considering the effect of innovation on subsequent firm performance using a larger time lag.

Lastly, the measure for firm financial performance is subject to debate, rendering it reasonable to discuss whether a more suitable measure for financial performance can be incorporated into future studies. ROA and Tobin's Q have received some critique (Bharadwaj et al., 1999) with regard to its potentially misleading characteristics in the corporate governance research landscape.

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[3]*Tax Cuts and Jobs Act of 2017 (TCJA)*

# 8. Conclusion

This study investigated the inter-relationship between board gender diversity, innovation, and firm financial performance in a contemporary U.S. setting. Using two different multivariate OLS regression models, we examine whether innovation intensity in companies and relative innovation importance in industries, respectively, have a positive effect on the BGD-CFP relationship. The results fail to find sufficient statistical evidence to support the rejection of any of our null hypotheses, hence suggesting there is no relationship between board gender diversity and firm financial performance. However, when using innovation as an interacting term together with our independent variables for board gender diversity, we find partial evidence for a positive relationship between said interaction term and firm financial performance.

To the best of our knowledge, our study constitutes the only test using an interaction term for innovation and board gender diversity to examine its subsequent effect on firm financial performance in a contemporary U.S. setting. In response to the call for a deeper understanding of *how* board gender diversity affects firm financial performance, our study intends to examine further the "business case" of increased board gender diversity. Although our findings fail to provide statistical evidence for the inter-relationship between board gender diversity, innovation, and firm financial performance, we identify some limitations to our models and provide relevant areas for future research. Thus, considering the contemporary relevance for the topic of gender diversity in the business landscape, combined with the ambiguity of previous research in this field, we call upon future scholars to investigate this relationship further.

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**Appendix 1.** Hausman test

| | Coefficients | | | |
|---|---|---|---|---|
| | (b) | (B) | (b-B) | sqrt(diag(V_b-V_B)) |
| | fe | re | Difference | Std. err. |
| FDP | -6.590 | -6.343 | -0.247 | 0.114 |
| Blau | 6.859 | 6.796 | 0.063 | 0.084 |
| Lev | -0.000 | -0.001 | 0.000 | 0.000 |
| PPE | -0.112 | 0.003 | -0.115 | 0.075 |
| BS | 0.009 | 0.009 | -0.000 | 0.001 |
| RevG | -0.008 | 0.001 | -0.010 | 0.006 |
| Liq | -0.000 | -0.000 | -0.000 | 0.002 |
| FS | -0.004 | -0.001 | -0.003 | 0.010 |

b = Consistent under H0 and Ha; obtained from **xtreg**

B = Inconsistent under Ha, efficient under H0; obtained from **xtreg**

Test of H0: Difference in coefficients not systematic

chi2(8) = (b-B) ' [(V_b-V_B)^(-1)] (b-B) = 29.510

Prob > chi2 = 0.000

**Appendix 2.** Detailed Descriptive Statistics, Full Sample

| | N | Mean | SD | p25 | Median | p75 | Min | Max |
|---|---|---|---|---|---|---|---|---|
| *ROA* | 2,305 | 0.020 | 0.162 | 0.000 | 0.051 | 0.092 | -0.795 | 0.336 |
| *TQ* | 2,305 | 1.819 | 1.418 | 0.929 | 1.433 | 2.173 | 0.229 | 8.271 |
| *Blau* | 2,305 | 0.245 | 0.141 | 0.180 | 0.260 | 0.346 | 0.000 | 0.500 |
| *GD* | 2,305 | 0.826 | 0.379 | 1.000 | 1.000 | 1.000 | 0.000 | 1.000 |
| *FDP* | 2,305 | 0.159 | 0.107 | 0.100 | 0.154 | 0.222 | 0.000 | 0.600 |
| *Liq* | 2,305 | 2.006 | 1.525 | 1.068 | 1.498 | 2.378 | 0.395 | 8.678 |
| *RevG* | 2,305 | 0.123 | 0.363 | -0.015 | 0.063 | 0.162 | -0.502 | 2.506 |
| *FS* | 2,305 | 22.100 | 1.782 | 20.986 | 22.11 | 23.203 | 17.686 | 26.169 |
| *Lev* | 2,305 | 0.931 | 2.746 | 0.266 | 0.582 | 1.075 | -10.682 | 18.568 |
| *BS* | 2,305 | 9.574 | 2.414 | 8.000 | 9.000 | 11.000 | 1.000 | 51.000 |
| *PPE* | 2,305 | 0.221 | 0.212 | 0.083 | 0.140 | 0.274 | 0.010 | 0.904 |
| *Innov_C* | 2,305 | 0.383 | 4.994 | 0.017 | 0.044 | 0.128 | 0.000 | 198.740 |
| *Innov* | 2,305 | 1.000 | 0.707 | 1.000 | 1.000 | 1.000 | 0.000 | 2.000 |

**Appendix 3.** Bresuch-Pagan test

| **ROA** | **TQ** |
|---|---|
| $H_0$: Constant covariance | $H_0$: Constant covariance |
| chi2(1) = 1,372.640 | chi2(1) = 634.400 |
| Prob>chi2 = 0.000 | Prob>chi2 = 0.000 |

**Appendix 4.** Bootstrap Hypothesis 1, Full Sample

| ***Bootstrap*** | **ROA (1)** | **ROA (2)** | **ROA (3)** | **TQ (4)** | **TQ (5)** | **TQ (6)** |
|---|---|---|---|---|---|---|
| *GD* | -0.002 | | | -0.016 | | |
| | (0.012) | | | (0.102) | | |
| *FDP* | | 0.013 | | | -0.048 | |
| | | (0.042) | | | (0.382) | |
| *Blau* | | | 0.007 | | | -0.018 |
| | | | (0.034) | | | (0.307) |
| *Lev* | -0.001 | -0.001 | -0.001 | -0.009 | -0.009 | -0.009 |
| | (0.001) | (0.001) | (0.001) | (0.008) | (0.008) | (0.008) |
| *PPE* | -0.039 | -0.039 | -0.039 | -0.699 | -0.697 | -0.698 |
| | (0.066) | (0.065) | (0.065) | (0.499) | (0.501) | (0.501) |
| *BS* | -0.000 | -0.000 | -0.000 | -0.010 | -0.011 | -0.011 |
| | (0.002) | (0.002) | (0.002) | (0.023) | (0.023) | (0.023) |
| *RevG* | 0.024* | 0.024* | 0.024* | -0.123 | -0.122 | -0.122 |
| | (0.013) | (0.013) | (0.013) | (0.144) | (0.143) | (0.143) |
| *Liq* | 0.001 | 0.001 | 0.001 | -0.050 | -0.050 | -0.050 |
| | (0.003) | (0.003) | (0.003) | (0.031) | (0.031) | (0.031) |
| *FS* | -0.032** | -0.032** | -0.032** | -0.440*** | -0.441*** | -0.441*** |
| | (0.013) | (0.013) | (0.013) | (0.092) | (0.093) | (0.093) |
| *Constant* | *0.720*** | *0.720*** | *0.720*** | *11.430**** | *11.430**** | *11.430**** |
| | *(0.293)* | *(0.293)* | *(0.293)* | *(2.078)* | *(2.099)* | *(2.094)* |
| *Adj. R-sq.* | *0.825* | *0.825* | *0.825* | *0.769* | *0.769* | *0.769* |

**Note: Year and firm FE and VCE robustness included. Heteroskedasticity robust firm-clustered standard errors in brackets. Sig. levels 10%, 5% & 1% indicated by *, ** & *** respectively. Comparable base: InnovTier 1. # obs. for regressions: 2,305.*

**Appendix 5.** Bootstrap Hypothesis 3, Full Sample

| ***Bootstrap*** | **ROA (1)** | **ROA (2)** | **ROA (3)** | **TQ (4)** | **TQ (5)** | **TQ (6)** |
|---|---|---|---|---|---|---|
| *Innov Tier 2* | -0.007 | 0.008 | 0.006 | -0.158 | -0.146 | -0.184* |
| | (0.022) | (0.014) | (0.017) | (0.132) | (0.098) | (0.109) |
| *Innov Tier 3* | -0.045 | -0.047* | -0.048 | -0.427 | -0.448* | -0.539* |
| | (0.038) | (0.028) | (0.032) | (0.314) | (0.248) | (0.283) |
| *GD* | -0.015 | | | -0.176 | | |
| | (0.020) | | | (0.129) | | |
| *GD×Innov Tier 2* | 0.017 | | | 0.115 | | |
| | (0.022) | | | (0.136) | | |
| *GD×Innov Tier 3* | 0.012 | | | 0.349 | | |
| | (0.034) | | | (0.302) | | |
| *FDP* | | -0.001 | | | -0.767* | |
| | | (0.057) | | | (0.459) | |
| *FDP×Innov Tier 2* | | -0.010 | | | 0.505 | |
| | | (0.060) | | | (0.495) | |
| *FDP×Innov Tier 3* | | 0.068 | | | 1.967 | |
| | | (0.107) | | | (1.249) | |
| *Blau* | | | -0.010 | | | -0.682* |
| | | | (0.050) | | | (0.351) |
| *Blau×Innov Tier 2* | | | 0.005 | | | 0.483 |
| | | | (0.052) | | | (0.361) |
| *Blau×Innov Tier 3* | | | 0.049 | | | 1.627* |
| | | | (0.086) | | | (0.920) |
| *Lev* | -0.001 | -0.001 | -0.001 | -0.009 | -0.009 | -0.009 |
| | (0.001) | (0.001) | (0.001) | (0.008) | (0.008) | (0.008) |
| *PPE* | -0.037 | -0.040 | -0.040 | -0.731 | -0.695 | -0.708 |
| | (0.063) | (0.064) | (0.063) | (0.501) | (0.504) | (0.503) |
| *BS* | -0.000 | -0.000 | -0.000 | -0.010 | -0.011 | -0.011 |
| | (0.002) | (0.002) | (0.002) | (0.023) | (0.023) | (0.023) |
| *RevG* | 0.022* | 0.022* | 0.022* | -0.137 | -0.130 | -0.133 |
| | (0.013) | (0.013) | (0.013) | (0.144) | (0.145) | (0.145) |
| *Liq* | 0.001 | 0.001 | 0.001 | -0.052* | -0.051* | -0.052* |
| | (0.002) | (0.003) | (0.003) | (0.031) | (0.031) | (0.031) |
| *FS* | -0.034*** | -0.034*** | -0.034*** | -0.452*** | -0.464*** | -0.467*** |
| | (0.012) | (0.012) | (0.012) | (0.092) | (0.092) | (0.092) |
| *Constant* | *0.777**** | *0.784**** | *0.786**** | *11.880**** | *12.140**** | *12.240**** |
| | *(0.275)* | *(0.278)* | *(0.276)* | *(2.048)* | *(2.065)* | *(2.057)* |
| *Adj. R-sq.* | *0.826* | *0.826* | *0.826* | *0.769* | *0.769* | *0.769* |

**Note: Year and firm FE and VCE robustness included. Heteroskedasticity robust firm-clustered standard errors in brackets. Sig. levels 10%, 5% & 1% indicated by *, ** & *** respectively. Comparable base: InnovTier 1. # obs. for regressions: 2,305.*