THE CRITICAL MASS OF FEMALE DIRECTORS ON THE BOARD OF US FIRMS

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DEDICATION

Dedicated to my Heavenly Father, family and friends who made this milestone a success.

ABSTRACT

Following Kanter's critical mass theory, this paper argues that the relationship between gender-diverse boards and firm performance is curvilinear and that free cash flows and firm complexity moderate the relationship. Fixed effect regression and two-stage system GMM estimator are used to model the relationships and effectively control for unobservable firm and governance factors, using a sample of S&P 1500 firms, spanning from 1998 to 2018. We also use the Heckman selection model to test for the possibility of a self-selection bias. We find evidence that women directors self-select firms in which they are appointed as directors based on profitability, the firm's stock performance, and the firm's growth potential. We also find that complex firms with more than 30 per cent female representation on the board are more likely to reduce firm risk than firms with a lesser proportion of women. Theoretical and practical implications, as well as areas for further research, are discussed.

Keywords: critical mass, agency cost of free cash flows, firm complexity

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TABLE OF CONTENTS

LIST OF TABLES

CHAPTER 1: INTRODUCTION

Following the wave of financial scandals in the early twenty-first century and the formulation of policies and corporate governance codes such as the Sarbanes-Oxley Act, Higgs Review etc., there has been increased scrutiny on the activities of boards of directors as it relates to their independence and ability to effectively monitor whilst providing strategic advice with a bid to maximize shareholder value (Terjesen, Couto, & Francisco, 2016). An area that has been long debated is the composition of the board. There have been arguments that favour diverse boards in terms of age, experience, education, race and other demographics. However, the role gender diversity plays in improving board effectiveness is still subject to debate.

The call for increased participation of women on the board has become a major issue worldwide. It has been observed that despite the marked increase in the proportion of women in the workforce in the last ten years, there has been little or no corresponding significant increase in the proportion of female directors on boards in the same period (Farrell and Hersch (2005). Several countries are, however, taking the lead in enforcing board diversity through legislation. For example, Norway passed a law that took effect from January 2008, requiring 40% female representation on the boards of public limited companies (Adams & Ferreira, 2009). On the contrary, countries like Canada, Germany, United States (except for California) have adopted the 'comply or explain' policy, thereby making implementation voluntary. However, most firms in these countries seek to recruit more women on their boards to avoid explaining exceptions of this nature in their annual report, whilst yielding to pressure from gender equality civil groups. For example, according to a recent publication by Spencer Stuart board index, there is no S&P 500 firm in the US without a female on their board as of year-end 2019. Of the 432 newly appointed

directors in 2019, a significant 46% are women, bringing the total percentage of women on S&P 500 boards to 26% (Stuart, 2019)

Although it has been established that it is socially responsible and ethical for companies to pay attention to female representation in their top management teams and boards (Setó□Pamies, 2015; Zhang, Zhu, & Ding, 2013), the empirical evidence in the prior literature on gender diversity and firm performance is mixed.

Some studies find a positive relationship between gender diversity and firm performance (Campbell & Mínguez-Vera, 2008; Carter, Simkins, & Simpson, 2003; Erhardt, Werbel, & Shrader, 2003; Mahadeo, Soobaroyen, & Hanuman, 2012). However, there are also studies that fail to find any form of relationship between gender diversity and firm performance (Miller and Del Carmen Triana, 2009; Rose (2007) and there are even other studies that find a negative relationship between the number of women on the board and performance (Adams & Ferreira, 2009; Shrader, Blackburn, & Iles, 1997).

Several reasons for the varying results have been put forward. Firstly, differences in corporate governance systems and laws may account for the mixed result. For example, Post and Byron (2015) find that board gender diversity has a greater positive effect in countries with stronger shareholder protection laws. Secondly, several studies carried out did not account for the endogeneity problems common in corporate governance research. Adams and Ferreira (2009) highlight that omitted variables and reverse causality are the two most common endogeneity sources.

Additionally, studies carried out in countries where female board representation is enforced by law, the effect on performance may be negative because companies are forced, within a specific

period of time, to either increase their board size to accommodate women (which could lead to an inefficient board) or replace existing male directors with females even though the females may not be as experienced as the men who are replaced (Bertrand, Black, Jensen, & Lleras-Muney, 2019)

Also, there is the problem of what constitutes an optimal representation of females on the board. The relations between gender diversity and firm performance may not be linear as postulated by the critical mass theory by (Kanter, 1977). As there is a minimum number of people required in a group before their impact can be objectively measured, this forms the basis upon which this study shall be executed.

Lastly, board characteristics are known to be endogenous in nature (Adams & Ferreira, 2009) and studies that fail to correctly address this, are bound to produce outcomes that are inconsistent and unreliable. While a few studies addressed omitted variable and simultaneity biases, there is hardly a study that has correctly applied the right econometric technique to correct for the possibility that a firm's board structure may be because of its past performance.

Hence, this study contributes generally to the corporate governance literature and specifically to gender diversity literature by investigating the relationship between gender diversity, firm performance and firm risk from the theoretical lenses of Kanter (1977) critical mass theory and Jensen (1986) agency cost of free cash flow. It investigates the role of firm complexity and free cashflows in moderating the aforementioned relationships, using robust econometrics techniques such as Heckman Two-stage sample selection model to test for the possibility of a self-selection bias and the two-stage system generalized methods of moments to test the regression models.

The study identified self-selection bias as a major source of endogeneity in the gender diversity and firm performance/risk relationship. It also finds that there is no relationship between gender diverse boards and firm performance or firm risk, however, for firms with more complex businesses, boards with more than thirty per cent female representation reduce firm risks than firms with lesser levels of representation.

CHAPTER 2: LITERATURE REVIEW

2.1 Gender Diversity

Board diversity is defined as a variety in the composition of a corporate board (Kagzi & Guha, 2017). Kang, Cheng, and Gray (2007) and Erhardt et al. (2003) categorized diversity into observable or demographic diversity, including race, nationality and gender and less-observable diversity such as the background of directors, industry experience and membership of an organization. Similarly, Srivastava (2015) categorized diversity based on board structure, including board size, the proportion of inside directors and CEO duality. Of all demographic attributes, the most common and most debated is gender (Kang et al., 2007). Female representation in corporate boards and executive positions are at the fore of corporate governance debates in several jurisdictions. Presently, sixteen countries encourage firms to appoint women to the boards, and fourteen other countries that enforce gender quotas for publicly traded firms (Terjesen et al., 2016). For example, Norway passed a law in 2008, requiring a minimum of 40% representation on the board. In the United Kingdom, the Alexander-Hampton report of 2016 set a target for all FTSE boards to attain a female representation of a minimum of 33% by 2020 (Hampton & Alexander, 2016), even though compliance will be left to the discretion of the firm. As of June 2018, the UK had 23.7% of female directors on the FTSE 250 board, an improvement from 2014 (15.6%) (Vinnicombe, Doldor, & Sealy, 2018).

Similarly, in the US, according to National Center for Education Statistics (2017), the United States has one of the most diversified educational systems in the world, whereby of associate, bachelor's, master's and PhD degree recipients, 61, 57, 59 and 53 per cent are women,

respectively.[1]. However, we do not observe similar statistics in corporate boardrooms or senior management. For example, according to Catalyst (2018), in 2017, only 21.2% of board seats at S&P 500 companies were held by women, which has only slightly increased to 24% as of December 2018.

While some countries are strictly enforcing the quota policy with punitive measures for defaulters, other countries like Canada and Australia are following the 'comply or explain' route. Emerging economies are also implementing rules aimed at improving female representation on the board. For example, in 2014, India mandated the appointment of at least one female on the board of publicly quoted companies (Goel, 2018).

2.2 The role of women on the board

It has been established in the psychology literature that there are psychological differences between men and women. For example, in terms of communication, Mulac, Bradac, and Gibbons (2001) suggested that women make use of communication to deepen relationships and social networks, while their male counterparts use communication to achieve social dominance. Putrevu (2001) and Mason (1994) further suggested that in communicating, males generally focus on enhancing their controlling tendencies which makes them more assertive and self-efficacious while females are more guided towards communal concerns.

The differences between genders are not only limited to their style of communicating as males and females also differ by the way they exact influence and lead others. Women tend to foster relationships in the workplace thereby increasing social interaction with their followers, unlike their male counterparts that are power-oriented and would rather wield authority in

[1] Statistics are as of 2015-16 academic year.

controlling subordinates (Eagly & Karau, 2002), (Martell & DeSmet, 2001). Furthermore, Charness and Gneezy (2012) find a significant difference between men and women in their investment behaviors. Men are more likely to invest than women thus, appear to be greater risk-takers than women and there have been several other studies carried out to affirm that women are less risk-takers than men (Bernasek & Shwiff, 2001; Byrnes, Miller, & Schafer, 1999; Jianakoplos & Bernasek, 1998).

Several factors were postulated by (Croson & Gneezy, 2009) as the reasons for the differences in investment behavior between genders. Such reasons include, women tend to be more nervous than their male counterparts when anticipating negative outcomes. Also, men tend to be more overconfident than women in situations of high levels of uncertainty. It has been further established that women have a lesser propensity to participate in risky endeavors than their male counterparts (Lenard, Yu, York, & Wu, 2014). In a meta-analysis conducted by (Byrnes et al., 1999), the scholars find that men are more likely to take risks than their female counterparts, however, according to their studies, the propensity to take risks varies by contexts and age.

Also, Kang et al. (2007) identified two major advantages of having women on the board. First, they tend to be more independent and second; they have a better grasp of consumer behavior, customer needs and can easily identify opportunities to meet those needs.

Similarly, Singh, Terjesen, and Vinnicombe (2008), in their study of the UK's FTSE 100 corporations, discovered that women directors are more likely to have an MBA qualification than their male counterpart. In terms of experience, Terjesen, Sealy, and Singh (2009) suggested that women are more likely to have experience working overseas in addition to serving as directors in smaller firms. It is therefore expected that the boards and senior management positions of organizations should reflect the new reality in terms of gender parity.

Several studies show that females have a different work ideology (Nielsen & Huse, 2010), and are less likely to tolerate and or participate in board vices such as absenteeism, lateness to board meetings and passive participation (Dobbin & Jung, 2010). In addition, they are more thorough with regards to scrutinizing and reviewing board documents (Adams & Ferreira, 2009), and are less likely to be absent from board meetings and are more detailed in the process of making decisions (Dobbin & Jung, 2010). Finally, women are more likely to spot and report unethical activities in a group than their male counterparts (Adams & Ferreira, 2009).

Therefore, women have unique skill sets, ethical behaviors and confidence levels that they bring to the boardroom and any other group setting (Kagzi & Guha, 2017). Aside from the psychological attributes, Levi, Li, and Zhang (2014) have argued that women should be given as many roles as their male counterparts on the board because both genders should be treated equally irrespective of gender, race and background. However, the question of the impact of women on the board is a strongly debated topic given the mixed empirical evidence.

2.3 Female representation on the board, firm performance and firm risk

There are several studies that investigate the relationship between female representation on the board and firm performance. However, the evidence to date is at best mixed (Adams & Ferreira, 2009). The varied results are due to several reasons.

Firstly, several studies fail to find a relationship between gender diversity and firm performance. For example, Carter, D'Souza, Simkins, and Simpson (2010) find no significant relationship between gender diversity and performance (using Tobin Q and ROA), using a sample from S&P 500 index (1998 – 2002). Similarly, (Shrader et al., 1997) find no significant positive

relationship between the percentage of women on a board and a firm's financial performance (using quite a number of accounting measures). In fact, in some cases, there is a significantly negative relationship. Additionally, Miller and Del Carmen Triana (2009) used the Blau index as a measure of gender diversity but also find no relationship with firm performance.

The second group of studies show a significant positive relationship between firm performance and gender diversity. For example, (Carter et al., 2003) posited that firms with two or more female directors are larger in terms of size, have larger boards and perform better in terms of ROA and Tobin Q. Similarly, Erhardt et al. (2003) find a significant positive relationship between minorities and women ratio and firm performance, using 112 US firms from the Fortune 1000 lists. Typically, studies that find a positive relationship tend to be from a sample of large firms. Also, most studies in this category used the proportion of female directors as a measure of gender diversity (Campbell & Mínguez-Vera, 2008; Carter et al., 2003; Erhardt et al., 2003; Mahadeo et al., 2012).

Thirdly there are those that have established a significant negative relationship between gender diversity and firm performance (Adams & Ferreira, 2009; Ahern & Dittmar, 2012; He & Huang, 2011; Shrader et al., 1997).

Having highlighted the varying and inconclusive results with respect to gender diversity, it is also important to highlight the reasons for the variations. First, Adams & Ferreira (2009) recognized the fact that most studies did not consider the endogenous nature of the relationship between board composition and firm performance. For example, while Catalyst (2018) identified that fortune 500 companies with the highest representation of females on the board and top management team reported higher returns to shareholders, it is not clear if this is a clear case of reverse causality. However, Campbell and Mínguez-Vera (2008) used a two-stage least square

(2SLS) approach in dealing with the issue of reverse causality and still find a significant positive relationship between both variables. From a psychological research perspective, a second reason as identified by (Dobbin & Jung, 2010) is that diversity is two-edged in the sense that boards with women are more effective in problem-solving, but such boards may also frustrate problem-solving by raising conflicts. Furthermore, simply having a single female director may not be enough female representation to have a significant impact on firm performance. It is also possible that there is an optimal level of gender diversity beyond which firm value/performance is negatively affected. Hence, the relationship may be non-linear. One other major difference might be the legal constraint placed on firms by reason of quota legislations. For example, in Norway, an ultimatum was given to companies to maintain a quota of 40% of female directors on publicly quoted firms by 2008 (Marinova, Plantenga, & Remery, 2016; Valentini, 2017). However, the outcomes of the legislation include; a significant decline in firms' financial performance and drastic decline in stock prices (Marinova et al., 2016), a number of firms who could not meet the deadline were voluntarily delisted from the stock exchange (Valentini, 2017), In fact, some firms had to appoint female directors without the requisite experience in a bid to avoid sanctions. Hence, several other countries have opted for the voluntary approach to gender diversity rather than a legislative quota.

In terms of firm risk, there have been numerous studies that have investigated the relationship between gender and risk. For example, Charness and Gneezy (2012) show that women are less likely to be averse in financial risk-taking than men. (Byrnes et al., 1999) conducted a meta-analysis of one hundred and fifty experiments on risk-taking among male and female and finds that men are more likely to be engaged in risky activities, gambling and "intellectual risk-taking" than women. Additionally, (Bernasek & Shwiff, 2001) posits that women are less likely to

accumulate wealth in retirement because they tend to invest in low-risk securities. All the studies highlighted above support the idea that women would generally take less risks than men.

However, a limited number of researches have been done to investigate the relationship between women on boards and firm risk, as most studies have focused on firm performance. Similar to studies on firm performance, the results on firm risks are also mixed majorly because of the inability of researchers to take endogeneity problems into account in their estimations (Wintoki, Linck, & Netter, 2009). Thus, Berger, Kick, and Schaeck (2014), in a study of German banks, find that an increase in the presence of women on the board is positively related to an increase in portfolio risk. Contrary to this finding, Sila, Gonzalez, and Hagendorff (2016) find no evidence of a relationship between women on boards and equity risk. (Levi et al., 2014) posits that mergers and acquisition activities are more common with a male-dominated board than boards with sufficient women representation. It is, however, worthy to note that the evidence in the prior literature may be susceptible to endogeneity. In fact, (Sila et al., 2016) investigates the reasons for the varying results and finds that several results are driven by omitted variable bias. In this paper, we shall account for the major sources of endogeneity utilizing panel regression, Heckman sample selection and dynamic panel GMM.

CHAPTER 3: THEORETICAL FRAMEWORK AND HYPOTHESIS DEVELOPMENT

3.1 Agency Theory

Agency theory was first used in the economics literature to explore the level of risk-sharing among individuals working together as a group. The theory was used to examine how risks are optimally shared among various parties with varying risk appetites (Keeler, Spence, & Zeckhauser, 1971; Ross, 1973; Wilson, 1968). However, in recent times, agency theory has been grafted into the field of business/management to solve the problems[2] (Eisenhardt, 1989). A very common example of this problem is seen in the owner (shareholders) - manager relationship in publicly traded firms.

Agency theory, therefore, posits that agency cost is incurred because of the separation of ownership and control of firms as managers may pursue their interest at the expense of maximizing shareholder wealth (Eisenhardt, 1989; Shleifer & Vishny, 1997). Managers can be driven by their personal interest to expropriate financial resources provided by shareholders by engaging in activities that would lead to entrenching themselves in the offices they occupy (Shleifer & Vishny, 1997). These self-entrenching activities could lead to high volatility in the returns of the firm and degrade financial performance (Lenard et al., 2014; Sila et al., 2016). Hence, it has become imperative to adequately protect the interest of shareholders by appointing representatives to oversee the activities of the managers, with a view to minimizing agency cost and maximizing returns to owners (Terjesen et al., 2009). The theory proposes that monitoring and controlling the activities of managers are an effective way of minimizing agency cost (Eisenhardt, 1989; Fama & Jensen, 1983). While establishing a board is a step in the right direction, the characteristics and

[2] Eisenhardt (1989) posits that the problems are because of two reasons: first, conflict of interest between principal and their agents and second, it is not feasible for principals to directly monitor and control their agents.

structure of the board are equally pivotal to executing its monitoring role (Kang et al., 2007). For example, (Cheng, 2008) find that organizations with larger boards experience lower variability in their performance as a result of the extent of scrutiny applied to each decision-making process. Similarly, gender diverse boards allow for the pooling of alternate views in a decision-making process, thereby leading to better quality decisions being made (Torchia, Calabrò, & Huse, 2011). Women are also known to be more active in board meetings, are more likely to be detailed in examining board documents than their male counterparts (Adams & Ferreira, 2009). Women are more risk-averse, more conservative in making investment decisions and more likely to point out wrongdoings in the firm (Sila et al., 2016).

Furthermore, there are studies that have empirically investigated the relationship between women on the board and the risk-taking attitude of firms. (Chen, Crossland, & Huang, 2016; Levi et al., 2014) show that there is a negative relationship between the proportion of women on the board and the likelihood of firms to participate in a mergers and acquisition process. In a study of UK listed firms, Nadeem, Suleman, and Ahmed (2019) find that board female representation moderates the relationship between firm risk and firm performance.

Therefore, a gender diverse board is more likely to be effective in monitoring and controlling managerial activities than a non-diverse board, thereby limiting agency problems between shareholders and managers. (Adams & Ferreira, 2009; Carter et al., 2010) assert that female directors play a more prominent role in terms of actively participating in board activities and in monitoring. When a board keeps up to its responsibility of monitoring the activities of managers, the quality of decisions made is enhanced thereby having a positive impact of the performance of the organization (Carter et al., 2003) whilst reducing firm risk (Lenard et al., 2014)

3.2 Agency Cost of Free Cash Flow

The problem associated with the separation of ownership and control is evidenced in firms with surplus free cash flows (Jensen, 1986). Free cash flows are the excess cash flows that are available for the suppliers of capital. However, managers, in a bid to enhance control, often find themselves investing the excess cashflows in less profitable ventures instead of paying them out as dividends, to consolidate their control over the firm. The free cash flow agency theory, therefore, posits that surplus cash left at the disposal of managers will result in the misappropriation of funds in the pursuit of the private benefits for managers, at the expense of shareholders (Jensen, 1986).

Preceding studies find that surplus free cashflow fosters managerial inefficiencies, wastages, and empire-building, resulting in negative firm performance and heightened variations in the firm value (Jensen, 1986; Wang, 2010). However, firms with a gender-diverse board are more likely to have a stronger monitoring mechanism that prevents managers from expropriating excess cash flows to fuel their personal interests. In terms of performance, a limited number of studies test Jensen (1986) theory of the free cash flow. Brush, Bromiley, and Hendrickx (2000) find that firms with free cash flow are less profitable than firms without free cash flow, even though all the firms had experienced growth in sales. Similarly, Dechow, Richardson, and Sloan (2008) also discovered a direct relationship between firms with excess cash flows and a decline in their performances.

Furthermore, Jensen's (1986) view was empirically supported by Byoun, Chang, and Kim (2016). They show that there is a relationship between diverse boards, high levels of free cash flow and high levels of corporate pay-outs. While, Jurkus, Park, and Woodard (2011) find that there is a significant negative relationship between women in management positions and agency cost,

although the relationship did not hold when endogeneity was considered (Wellalage & Locke, 2013).

While several prior studies examine roles women play in reducing the agency cost of free cash flow and the resultant impact on performance, this paper will be examining performance and firm risk at different levels of female representation on the board.

3.3 Critical Mass Theory

The agency theory has established that to minimize agency cost, certain structures surrounding the board and management of a firm should be in place in a bid to minimize agency cost and maximize returns to the principals – the owners of the firm (shareholders). However, while proponents of the theory have been able to establish that gender diversity leads to improved monitoring and more effective decisions (Adams & Ferreira, 2009), the same cannot be said about the relationship between gender diversity and firm performance or firm risk, as the results have been mixed (Adams & Ferreira, 2004).

One of the reasons posed for the mixed results is that the relationship between the two variables may be non-linear (Torchia et al., 2011). This implies that there may be a critical mass of female directors that would be required for gender diversity to have an impact on firm performance or minimize firm risk. Thus, the Critical Mass Theory suggests that the relationship between gender diversity and firm performance is inverted "U" shaped.

In social dynamics, critical mass is used to describe "*the scale of a social system at which the system becomes self-sustaining and fuels further growth*" (Westland, 2010). In terms of gender politics and collective action, Dahlerup (1998) defines critical mass as the optimal number of women required to be able to influence policy or change. In a seminal paper, Kanter (1997),

examines the experiences of women in large corporations in America in the '70s, the author observed that women were given token statuses in the companies they worked in, and therefore their impacts were not felt in such organizations. She referred to such groups as being skewed in favor of the dominant players, that is, the dominant players (in this case, the male) control the minority players (the females). She discovered that women, as members of a minority group, find it difficult to optimally perform for three broad reasons. Firstly, the undue pressures and expectations they face from their male counterparts. Secondly, they are expected to act within pre-defined gender roles and finally, they suffer isolation by the men who capitalize on their gender differences to prevent free entry of women into the group. Kanter (1977), therefore concluded that the impact of women (or any other minority) would be significantly enhanced as the number of women (or any other minority) in a group increase. Hence, it was observed that social and cultural differences among group participants are "critical in shaping interaction dynamics" in such groups (Kanter, 1977).

Similarly, Dobbin and Jung (2010) argue that "when the status of a minority group is made salient through experimental manipulation, members of that group may underperform because they feel they are being judged as group members rather than as individuals" (Dobbin and Jung, 2010, p. 186). Kanter (1977) maintains that being perceived as a token negatively affects the perception one has about himself, and this would, in turn, lead to poor performance. The solution to this poor performance would be to increase the number of people that make up the minority group, such that they are no longer viewed as tokens (Bear, Rahman, & Post, 2010).

The critical mass theory, therefore, holds that the nature of group interactions depends upon the size of the minority group (Granovetter, 1978; Kanter, 1977; Torchia et al., 2011). Along this line, Konrad, Kramer, and Erkut (2008) interviewed 50 women who had sat on the boards of 36

companies that had no more than three women on the board, and on 27 boards that had more than three women on the board. The women interviewed confirmed that the boards with three or more females were characterized by professionalism, constructive feedback system, and greater levels of interaction among the directors. Thus, having three or more women on the board provides a critical mass that gives women the opportunity to express themselves like any other member of the board. Thus, they proposed that the three is the "magic number" that changes the narrative and dynamics of the board with respect to the women directors.

Examining diversity and CSR, Bear et al. (2010) find that firms that had more women on the board were more likely to have a better CSR rating which enhanced the overall reputation of such firms. Similarly, as the number of women on a board increases, communication barriers are broken down, and the minority voice becomes more assertive while at the same time, the people that form the majority are more likely to integrate with the minority (Bear et al., 2010).

In a similar view, Torchia et al. (2011) conducted a study with Norwegian firms and find that heterogeneous boards are better than homogenous ones, provided that the women on the boards are at least three in number. Bear in mind that the study was conducted in Norway, which had enacted a law in 2003 that took effect in 2008, requiring publicly listed firms to have at least 40% of women on every board. Furthermore, Torchia et al., (2011) find that the impact three or more women on a board have on firm innovation is mediated by their impact on board strategic tasks. Conducting similar research in the German context, Joeck, Pull and Vetter (2013) find that gender diversity is positively related to firm performance only when the number of women directors exceed two; otherwise, the results were found to be negative. The results stated above are consistent with other studies in the literature (Erkut, Kramer, & Konrad, 2008; Konrad et al., 2008).

In terms of firm risk, several studies have been carried out to investigate the relationship between board gender diversity and firm risk. Sila et al. (2016) studied gender diversity and firm risk.[3], without taking critical mass into consideration and found no significant relationship between gender diversity and firm risk. However, a study by (Lenard et al., 2014) reports a significant negative relationship between the number of women on the board and volatility.

Following the widely varied evidence highlighted above and the methodological problems surrounding endogeneity issues in prior studies, this paper will investigate the relationship between the critical mass of women represented on the board and firm performance as well as the relationship between gender diversity and firm risk. We, therefore, formulate the following hypotheses:

H1: The is a positive relationship between the critical mass of gender-diverse boards and firm performance

H2: There is an inverse relationship between the critical mass of gender-diverse boards and firm risk.

H3: There is a positive relationship between gender diversity on corporate boards and firm performance due to their impact on reducing agency cost of free cash flow

H4: There is a negative relationship between gender diversity on corporate boards and firm risk due to their impact on reducing agency cost of free cash flow

Following the contradictions in empirical findings with respect to gender diversity and performance and risk, scholars have suggested that the gender diversity – performance relationship

[3] (Sila et al., 2016) used multiple models such as OLS, FE Panel regression, propensity score matching and first-differenced GMM to account for diversity endogeneity in the study.

may be dependent on other factors yet to be considered in literature (Miller & del Carmen Triana, 2009; Richard, Kirby, & Chadwick, 2013). To further strengthen this argument, Boyd, Haynes, and Zona (2011) suggests that the level of impact corporate governance structures would have on a firm would largely depend on organizational contexts. For example, Torchia et al. (2011) find that board strategic tasks mediate the relationship between women on board and firm innovation. Similarly, Li and Chen (2018) argues that the impact of women directors changes at different levels of firm size.

Furthermore, Kanter (1977), suggests that riskier and complex firms are more likely to have homogenous top management and/or boards as there is a greater level of co-operation among members of a homogenous group. This is based on the maxim that "social similarity breeds trust." Fama and Jensen (1983) argue that the structure of a board is largely determined by the level of complexity of the operations of the firm. Similarly, it is argued that complex firms require greater levels of monitoring and therefore would require more independent boards (Coles, Daniel, & Naveen, 2008; Linck, Netter, & Yang, 2008). It is therefore expected that women on complex boards should have a greater impact on performance/risk than women in less complex boards.

We formulate the following hypothesis:

H5: The non-linear inverted "U" relationship between gender diversity and firm performance vary according to the complexity of the firm

H6: The non-linear inverted "U" relationship between gender diversity and firm risk vary according to the complexity of the firm

CHAPTER 4: DATA AND METHODOLOGY

This section focuses on the methodology that will be used in conducting this study. In this section, I describe the data and sample collection techniques, the endogeneity problem, variables to be measured and lastly, the econometric models to be used in dealing with the problems of endogeneity.

4.1 Sample and Data Collection

The initial sample was drawn from Institutional Shareholders Services (ISS) database, which contains 318,908 individual director observations of S&P 1500 firms from 1997 to 2018. The accounting data was extracted from Compustat and stock market data from the Centre of Research in Security Prices (CRSP). The director data contains information about each director's name, age, number of shares owned, type of directorship, duration on the board, ownership status of the director and gender. Monthly stock market data and accounting data contained over two million and 267,290 observations, respectively, for a period spanning between 1996 and 2019. The stock market data was used to extract annualized observations for annual stock return, market, total and idiosyncratic risks, bringing the number of stock market observations to 21,891. The director data were subsequently collapsed into firm-year observations and merged with the accounting and stock market data with 17,448 observations and 2,495 unique firms.

4.2 The Endogeneity Problem

Ullah, Akhtar, and Zaefarian (2018) described endogeneity as a situation in which one or more independent variables are in correlation with the error term. When endogeneity is not

properly addressed, results cannot be relied on as the empirical estimations may be inconsistent. There are several reasons that may cause an independent variable to be correlated with the error term. However, three are most commonly found in literature – measurement error, omitted variables and simultaneity Wooldridge (2001). In corporate governance research, it has been established that board characteristics are endogenously determined by firms to reflect the peculiarity of their business environment Sila et al. (2016) and are set up to respond to governance problems faced by the firms Adams, Hermalin, and Weisbach (2010). Hence, it is practically impossible to capture all the factors that would impact firm performance and risk. These factors, which could be observable or unobservable, Wintoki et al. (2009) can affect either side of the model, i.e., dependent variable (Firm performance or risk) and the firm and board characteristics. For example, an observable factor that impact firm performance is the firm's policy on corporate social responsibility. According to the Freeman and McVea (2001), a company can enhance its public image my maintaining a good relationship with its stakeholders, and this could in turn lead to enhanced performance of the firm Bear et al. (2010), sustained profitability in unfavorable economic conditions and improved brand loyalty. On the other hand, a firm may choose to demonstrate its social responsibility by appointing women to its board. In fact, given that women are more focused on communal concerns than their male counterparts, it may be the case that women are attracted to firms that show strong social values. Given the above stated scenarios, the company's attitude to CSR, though unobservable, influences the performance of the firm.

There is also the problem of reverse causality. For example, it is possible that the presence of women on a board may be as a result of the firm to increase monitoring of the CEO Adams and Ferreira (2009) or high performing firms may appoint more women to their boards (Joecks, Pull,

& Vetter, 2013). On the other hand, female directors may self-select firms with lower risk or firms that are performing better (Joecks et al., 2013; Sila et al., 2016).

Lastly, another very common source of endogeneity is the dynamic relationship between a company's past performance and its current performance. Wintoki, Linck, and Netter (2012) provided evidence that board characteristics are usually not strictly exogenous. The current corporate governance structure of a firm is most likely a reflection of its performance in prior years. For example, (Hermalin & Weisbach, 1988) finds that whenever a firm performs firmly, such firm is most likely going to change its structure as its earliest form of reaction to the poor performance. In a similar study, Kole (1996) posits that when firms perform well, managers are usually compensated by increasing their ownership stake in such firms.

The structural models required to deal with these endogeneity problems will be discussed in subsequent sections.

4.3 Model

Having outlined the various sources of endogeneity in corporate governance research, it is equally important to come up with a model that will address the above endogeneity issues. The underlying assumptions for an ordinary least square cannot be used in estimating the beta coefficients because it completely ignores unobserved variables (Wintoki et al., 2009) as firms make the choice of the level of female representation they would have on their boards. The choices made by these firms may, however, be unobservable and therefore, would lead to a correlation between gender diversity and the residual error term leading to the inconsistent estimation of beta (Wooldridge, 2001).

The fixed-effect model may also lead to inconsistency in estimates. Strict exogeneity is one of the assumptions for which fixed effect estimations may be used. (Wooldridge, 2001). A variable is said to be strictly exogenous where there is no form of dynamic relationship between the variable and the error term. However, it is not certain that gender diversity is not affected by the past, present, or future performance of the firm as gender diversity may just be contemporaneously exogenous.

Another alternative to the fixed effect model is the two-stage least square (2SLS). The 2SLS makes use of instrumental variables to eliminate all endogeneity sources in the model. The problem, however, is that the instruments to be used must be strictly exogenous. Wintoki et al. (2009) suggest that "in an environment where all market participants are even only weakly rational (as expected with publicly traded firms), identifying valid exogenous instruments is very difficult, if not practically impossible" (p. 2).

Given the above setbacks with OLS, fixed effects and 2SLS, the study will require a model that potentially resolves endogeneity problems stated above. One of such models that has gained popularity in literature is the Dynamic Panel System Generalized Method of Moments (DPS-GMM). DPS-GMM was developed by Holtz-Eakin, Newey and Rosen (Econometrica, 1988) and first utilized by Arellano and Bond (1991). The DPS-GMM model was developed as a result of the limitations of using Two-Stage Least Squares (2SLS) in solving endogeneity problems in the explanatory variables, especially in cases involving panel data, i.e., where the endogeneity bias is dynamic (Ullah et al., 2018) because it does not make use of the strict exogeneity assumption which is inherent in OLS and 2SLS. DPS-GMM makes use of internal instruments that are functions of the model parameters and the data, such that their expectation is zero at the parameters' true values. It uses the lagged values of the dependent variable as the instruments in solving for

the major cases of endogeneity namely; reverse causality, simultaneity and omitted variables (Leszczensky & Wolbring, 2018) in a panel model. In literature, the use of two lags of the outcome variable is quite common. It is best suited for situations where the panel is characterized by "small T, large N" (Wooldridge, 2001).

This paper shall be making use of the second-order transformation, which is also known as the two-step GMM (Arellano and Bond, 1995). The two-step GMM is usually preferred to the first difference transformation because it eliminates the loss of data that arises from the process of deriving internal instruments, through the creation of lagged variables where there are missing values (Ullah et al., 2018). In other words, first-difference GMM is not ideal when working with unbalanced panel data because it exposes gaps within the data set.

Following Arellano & Bond (1991) and (Roodman, 2009), the following two-step GMM models will be used in this study.

$$FP_{it+1} = \alpha + \sum\varphi_p FP_{it} + \sum\varphi_p FP_{2it-p} + \beta BD_{it} + \delta FC_{it} + year_i + C_i + \mu_{it} \qquad p = 1, \ldots., N,$$

where FP represents the firm performance and firm risk, FP_{2it-p} represents past performance and risk measures, BD are the board diversity variables, and FC are the firm characteristic variables, $year_i$ are the time (year) dummy variables, C_i are the unobserved time-invariant firm characteristics, and μ_i is the random error term, and t is time (year). In the next few paragraphs, each of the variables will be further explained.

4.4 Dependent Variables

From the model above, the dependent variables are firm performance and firm risk. As outlined in Table 1 below, firm performance will be proxied with ROA, Tobin Q and Annual Stock Return. Return on Assets (ROA) measures how profitable a company is in generating revenues with the company's assets. It is usually expressed as the ratio of the net income to total assets in a given year. Return on Assets is a common measure of performance in corporate governance literature (Campbell & Mínguez-Vera, 2008; Carter et al., 2010; Terjesen et al., 2016). Tobin's Q which is also known as Q ratio is the ratio of the market value of the company's assets to its book value (book value of debt + market value of equity)/total assets. Tobin Q is considered to be a widely used measure of a firm's market-based performance (Dobbin & Jung, 2010). The last proxy of firm performance is annual stock return (Baulkaran, 2014).

Following previous papers (Baulkaran, 2014; Sila et al., 2016), the study also makes use of three risk measures: market risk, idiosyncratic risk, and total risk. Data were extracted from the CRSP database. To estimate market risk (beta), market returns was regressed on five years of monthly stock returns. Idiosyncratic risk was measured using the residuals from the model used in estimating beta. The standard deviation of monthly returns was used to estimate total risk.

Table 1
Dependent Variables

Variables	**Proxy**	**Measurement**
Performance	Return on Assets (t+1)	Net income divided by the book value of total assets.
	Annual Stock return (t+1)	
	Ln Tobin Q (t+1)	The ratio of the market value of firm assets to the replacement cost of firm assets

	Market risk (t+1)	Market risk is calculated by regressing market returns on five years of monthly returns.
	Idiosyncratic risk (t+1)	The variance of the residuals generated from the estimation of market risk
	Total risk (t+1)	The standard deviation of monthly returns

4.5 Independent Variables

Table 2 shows the independent variable for the study. Percentage of female board members is used as a proxy for Gender diversity in this study, broken down into four levels – up to ten per cent, 10 to 20 per cent, 20 to 30 per cent and above 30 per cent female board representation. The level of representation stops at 30 per cent as there are very few boards with more than 30 per cent representation. Each of the levels of representation are coded as continuous variables. Boards with zero female representation are not included in any of the categories. For example, for boards with up to 10 per cent representation, we record the percentage proportion of female directors for firms with 1 to 10 percent, and zero is recorded for firms that do not fall within this category. The same thing is done for other levels of female representation). The percentage of women on the board is the number of females on a board divided by the total number of directors and multiplying by 100

Table 2
Independent Variables

Variables	**Proxy**	**Measurement**
Gender Diversity	Percentage of women directors	Total number of women directors divided by the total number of board members.

4.6 Control Variables

Based on extant literature, the paper controls for several factors that can influence financial performance outside of our key independent variables. These factors can be broadly categorized into firm and board characteristics as outlined in Table 3 below. In terms of firm characteristics, I control for firm size, the age of the firm, leverage levels, capital expenditure, and sales growth (Carter et al., 2010; Singh et al., 2008; Terjesen et al., 2016).

Board characteristics are also added to the list of control variables based on previous studies. Board size is critical to the ability of a firm to be properly positioned to respond in a timely manner to changes in the business environment (Van der Walt & Ingley, 2003). When boards are too large, decision making becomes slow, thereby hampering their ability to promptly steer the firm, especially in times of uncertainty. Other governance related control variables include CEO duality percentage of independent directors (Sila et al., 2016), board tenure (Erhardt et al., 2003; Hermalin & Weisbach, 2001), and the average age of board members (Kagzi & Guha, 2017).

Table 3
Control Variables

Variables	**Proxy**	**Measurement**
Firm Characteristics	Capex to total assets ratio	The ratio of the firm's capital expenditure to total assets of the firm
	Ln total assets	Log of total book value of firm assets
	Sales growth	Percentage change in annual sales
	Firm leverage	Total debt/total assets
Board Characteristics	Average age	The average age of board members in years
	CEO duality	Dummy variable. 1 if the CEO is also chair of the board, otherwise 0.

Average board tenure	The average tenure of board members in years
Board size	Number of directors on the board
Percentage of outside directors	The ratio of outside directors to board size
board to total shares ratio	This is the ratio of shares owned by board members to the total outstanding shares of the firm.

4.7 Moderating Variables

Prior studies across diverse fields indicate that there is a critical mass of 30 per cent (Joecks et al., 2013) or a number of three (Konrad et al., 2008) are required before the impact of a subgroup is felt (Dahlerup, 1988; Joecks et al., 2013; Kanter, 1977; Westland, 2010). We shall be testing various levels of female representation, i.e., up to ten per cent, ten to twenty per cent, twenty to thirty per cent and above thirty per cent female representation to ascertain the critical mass.

Furthermore, the paper will also be introducing firm complexity and free cash flow as moderators. The number of business segments in the firm shall be used as a proxy for firm complexity in line with extant studies (Adams & Ferreira, 2009; Barinov, Park, & Yıldızhan, 2019) and will be used as a continuous variable. Free cash flow refers to the cash flow available to the ordinary shareholders after all investments in fixed and working capital, and operating expenses, principal and interest payments have been made. With respect to this study, free cash flow is scaled by total assets and will be used as a continuous variable.

CHAPTER 5: RESULTS

This chapter presents the findings from the research hypotheses highlighted in the previous section. This section begins with descriptive statistics showing a comparison of means between firms with female directors and all-male boards. Next, we run a panel regression and a two-step system GMM to estimate the relationship between levels of gender diversity and firm performance (and firm risk). Using the same empirical techniques, we further test for the critical mass of female directors required to drive performance and reduce firm risk, given certain levels of free cashflows. Lastly, we examine how the complexity of a firm affects the ability of female directors to impact firm performance and firm risk.

5.1 Descriptive Statistics

Table 4
Means, Standard Deviations and Tests of Differences in Means

		All firms [a]		**Firms without females [b]**		**Firms with one or more female [c]**		**Diff. in means**	
	No. of Obs.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev	[b] - [c]	t-stat
ROA	14,108	0.05	0.07	0.05	0.08	0.05	0.06	-0.01	-6.51***
Annual Stock return	16,564	0.36	2.79	0.31	1.58	0.39	3.22	-0.09	-2.15**
Tobin Q	15,562	2.04	1.61	2.14	1.86	1.99	1.46	0.15	5.27***
Idiosyncratic Risk	16,565	0.02	0.31	0.02	0.35	0.02	0.28	0.0002	0.04
Market risk	16,565	1.12	0.66	1.23	0.73	1.06	0.62	0.16	14.86***
Total Risk (annualized)	17,440	0.44	0.19	0.52	0.21	0.41	0.17	0.12	37.41***
capex to total Assets	16,264	0.05	0.04	0.05	0.05	0.05	0.04	0.01	7.32***
Log of Total Assets (Ln at)	17,448	7.54	1.46	6.73	1.11	7.96	1.45	-1.23	-62.71***

Sales Growth	17,440	0.10	0.19	0.12	0.22	0.09	0.18	0.03	6.94***
Firm Leverage	17,448	0.22	0.17	0.19	0.18	0.24	0.17	-0.05	-16.15***
Average Age	17,448	60.55	3.98	60.07	4.56	60.80	3.62	-0.73	-10.78***
CEO Duality	17,448	0.10	0.30	0.11	0.31	0.10	0.30	0.01	1.63
Avg. Board Tenure	16,494	10.15	3.61	10.55	3.93	9.95	3.42	0.60	9.63***
Board Size	17,448	9.00	2.15	7.65	1.73	9.70	2.02	-2.05	-70.10***
Percentage of Outside Directors	17,448	0.81	0.10	0.78	0.10	0.83	0.09	-0.06	-34.93***
Board to Total Shares	16,483	0.08	0.11	0.10	0.12	0.06	0.10	0.04	22.14***
Number of segments	17,448	2.69	1.79	2.28	1.57	2.91	1.86	-0.06	-23.73***

***p<0.01, **p<0.05, *p<0.1

Table 4 reports the descriptive statistics showing means, standard deviations, and test of differences in means between firms without female directors and firms with at least one female director in their firm and board characteristics, firm performance, and firm risk. In terms of the sub-sample analysis, in years where firms have at least one female director on the board, the firms are larger in terms of asset size, have more business segments, have better performance in terms of ROA but perform worse in terms of stock return and Tobin Q, have lower volatility, have larger boards and are more independent than firms without female directors. The results cannot be totally relied upon as they are an indication that the decision of firms to appoint or nominate female directors may be because of the characteristics of such firms. Hence, it is important to control for these factors (Adams & Ferreira, 2009).

5.2 Regression Results

In this section, I present the results of the tests of the hypotheses. Please note that the number of firm-year observations varies under each model as a result of missing observations. For example, ROA has only 14,108 observations. This implies that in running the regression, Stata would exclude all observations with missing data when running a regression.

Table 5
Results of Regressing Firm Performance on the Critical Mass of Female Directors

VARIABLES	(1) ROA	(2) Ann. Stock Return	(3) Tobin Q	(4) ROA	(5) Ann. Stock Return	(6) Tobin Q	(7) ROA	(8) Annual Stock Return	(9) Tobin Q
Up to ten percent Female	0.0005*	0.0007	0.0047	0.0005*	0.0008	0.0050	-0.0005	-0.0003	0.0017
	(1.8544)	(1.5592)	(1.4982)	(1.7327)	(1.4522)	(1.5675)	(-1.5284)	(-0.3192)	(0.5315)
Ten to Twenty Percent	0.0001	-0.0000	0.0008	0.0001	0.0000	0.0009	-0.0001	-0.0006	0.0006
	(0.3394)	(-0.1076)	(0.4682)	(0.3328)	(0.1190)	(0.4915)	(-0.7856)	(-1.0583)	(0.3259)
Twenty to Thirty Percent	0.0001	-0.0001	-0.0010	0.0001	-0.0002	-0.0017	-0.0002	-0.0004	0.0012
	(0.5936)	(-0.6682)	(-0.6966)	(0.5180)	(-1.3532)	(-1.1299)	(-1.0407)	(-0.9008)	(0.8671)
Above Thirty Percent	0.0001	0.0002	-0.0017	0.0001	0.0003	-0.0022	0.0004**	0.0008	0.0006
	(0.6785)	(0.7483)	(-0.5818)	(0.4111)	(0.6635)	(-0.6662)	(2.0209)	(0.8164)	(0.2990)
Capex to Total Assets	0.0151	-0.0327	2.2886***	0.0043	-0.0134	1.8790***	0.0771***	0.1259	0.1846
	(0.3886)	(-0.9077)	(5.4946)	(0.1130)	(-0.5023)	(4.3230)	(3.5406)	(1.0526)	(0.8369)
Average Board Tenure	0.0003	0.0019***	0.0098	0.0002	0.0012**	0.0107	0.0005	0.0054***	-0.0081
	(0.6463)	(3.7990)	(1.3822)	(0.5281)	(2.4125)	(1.5238)	(0.7735)	(2.8248)	(-1.2454)
Average Age	-0.0007*	-0.0004	-0.0220***	-0.0005	-0.0002	-0.0203***	-0.0015	-0.0049	-0.0098
	(-1.6310)	(-0.6255)	(-3.0461)	(-1.1416)	(-0.3307)	(-2.6781)	(-1.5845)	(-1.3372)	(-0.9788)
Proportion of Outside Directors	-0.0222**	-0.0083	-0.3615**	-0.0176	-0.0039	-0.3848**	-0.0268*	-0.0903**	-0.2429
	(-2.0249)	(-0.5867)	(-2.1632)	(-1.4247)	(-0.2831)	(-2.1602)	(-1.8243)	(-1.9764)	(-1.5167)
CEO Duality	-0.0028*	0.0007	-0.0112	-0.0021	0.0026	-0.0086	0.0020	0.0060	-0.0172
	(-1.9042)	(0.2252)	(-0.6633)	(-1.2734)	(0.9650)	(-0.4781)	(1.2275)	(1.5763)	(-0.9998)
Firm Leverage	-0.0406***	-0.0056*	-0.5532***	-0.0411***	-0.0167*	-0.6800***	-0.0673***	-0.1250**	-0.1303
	(-6.0624)	(-1.6419)	(-4.4533)	(-4.6702)	(-1.6391)	(-4.4578)	(-5.1621)	(-2.3537)	(-1.0018)
Sales Growth	0.0132***	-0.0014	0.0711***	0.0166***	0.0025	0.0905***	0.0551***	-0.0187	-0.0163
	(7.7663)	(-0.5241)	(3.5727)	(7.4246)	(0.8440)	(3.9206)	(11.5118)	(-1.3381)	(-0.4496)
Ln Total Assets	-0.0151***	0.0034	-0.3516***	-0.0239***	-0.0037	-0.4836***	0.0076*	0.0724***	-0.0641*
	(-3.9321)	(1.3062)	(-10.2548)	(-5.2180)	(-0.8812)	(-6.5030)	(1.7443)	(3.8103)	(-1.6793)
Ln Board Size	-0.0059	0.0140*	-0.2523***	-0.0097**	0.0132*	-0.2819***	0.0028	0.0549**	-0.1879**
	(-1.1867)	(1.7084)	(-3.5991)	(-1.9012)	(1.6470)	(-4.1822)	(0.3643)	(2.2638)	(-2.2671)
Board to total Shares Ratio	-0.0158	-0.0116	-0.2871*	-0.0180	-0.0002	-0.2599	-0.0097	0.0597	-0.0004
	(-1.2920)	(-0.7228)	(-1.7306)	(-1.3842)	(-0.0143)	(-1.5241)	(-0.5840)	(1.1845)	(-0.0024)
IMR				-0.0319***	-0.0278*	-0.5262**			
				(-2.5608)	(-1.8026)	(-2.2364)			
L.ROA							0.4153***		
							(19.4128)		
L. Annual Stock Return								1.5116***	
								(9.2838)	
L.Tobin Q									0.6443***
									(25.9406)

Constant	0.2372***	0.4471***	6.5435***	0.3158***	0.4994***	7.8597***	0.0819	-0.5701**	2.4860***
	(6.1864)	(12.0210)	(14.2581)	(6.6775)	(10.1125)	(9.8463)	(1.3581)	(-2.0837)	(3.4837)
Observations	12,601	15,331	13,685	10,122	11,794	10,933	12,161	12,510	12,752
R-squared	0.0657	0.0127	0.1529	0.0777	0.0168	0.1726			
Number of PERMNO	2,006	2,495	2,197	1,793	2,214	1,962	2,082	2,119	2,165
PERMNO FE	YES	YES	YES	YES	YES	YES			
Year FE	YES	YES	YES	YES	YES	YES	YES	YES	YES
adjusted R-squared	0.0632	0.0105	0.151	0.0745	0.0139	0.170			

Robust t-statistics in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 6
Results from the First Stage Heckman Selection Model

VARIABLES	
Idiosyncratic Risk	0.00766
	(0.204)
Market risk	-0.211***
	(-11.92)
Leverage	-0.0110
	(-0.151)
Total Assets	0.433***
	(42.92)
Constant	-2.536***
	(-34.41)
Observations	13,475

In Hypothesis 1, we expect to find a significant relationship between the critical mass of female directors on the board and firm performance. We test this hypothesis using three methods – fixed effects panel regression, Heckman two-step model and GMM and report the results in Table 5 above.

Models 1 to 3 present results from the panel regression for ROA, annual stock return and Tobin's Q respectively. Results from the panel regression indicate that there is a significant relationship between boards with up to 10 per cent female representation and return on assets (β: 0.0005, p-value < 0.1). However, for other levels of board representation, the relationship is insignificant.

The relationship between gender and performance may, however, be driven by self-selection bias, as there is a possibility that women self-select into firms based on certain attributes or may decide not to seek a directorship role in spite of their eligibility for such roles. We control for sample selection bias using the Heckman sample selection model (in Models 4 to 6). We use a probit estimation technique in the first stage of the model to predict the likelihood of a firm having

at least one female director (Table 6). The dependent variable is female firms, which is a binary variable equal to 1 if the firm has at least one female director and 0 otherwise. We use idiosyncratic risk and market risk, as our exclusion restrictions, as explained in the previous chapter. We also use leverage and total assets to control the effect of the probability ratio. The inverse mills ratio is then computed from the predicted values in Table 6 and used to control for self-selection bias in the second stage of the regression. We find that the results from the Heckman two-stage are very similar to the panel regression in Models 1-3. However, there is evidence of the presence of self-selection bias as the Inverse Mills Ratio (IMR) is significant for all three measures of performance (ROA – β: -0.0319, p-value < 0.01; Annual Stock Return – β: -0.0278, p-value < 0.1 and Tobin's Q – β: -0.05262, p-value < 0.005).

To further correct for the possibility that the gender variables are dynamically endogenous, we introduce the two-stage general method of moments. Models 7 to 9 of Table 5 report the results from the GMM equations, with ROA, annual stock return and Tobin's Q respectively. Results indicate a significant relationship between boards with more than 30% female representation and Return on Assets (β: 0.0004, p-value < 0.05). Given that the results are not consistent with other measures of firm performance, the hypothesis is therefore not supported.

Table 7
Results of regressing Firm Risk on the Critical Mass of Female Directors

VARIABLES	(1) Market Risk	(2) Total Risk	(3) Idiosyncratic Risk	(4) Market Risk	(5) Total Risk	(6) Idiosyncratic Risk	(7) Market Risk	(8) Total Risk	(9) Idiosyncratic Risk
Up to Ten Percent Female	-0.0010	0.0006	-0.0002	-0.0005	0.0008	-0.0002	-0.0021	-0.0003	0.0002
	(-0.4037)	(1.5492)	(-0.6204)	(-0.2025)	(1.0182)	(-0.4783)	(-1.0236)	(-0.2944)	(0.4278)
Ten to Twenty Percent Female	-0.0014	-0.0000	-0.0000	-0.0019	0.0000	0.0001	-0.0017	-0.0006	-0.0002
	(-0.8894)	(-0.1076)	(-0.1867)	(-1.1417)	(0.1682)	(0.3247)	(-1.6371)	(-1.0129)	(-0.6388)
Twenty to Thirty Percent Female	-0.0015	-0.0001	0.0000	-0.0020	-0.0002	0.0000	-0.0020**	-0.0004	-0.0001
	(-1.3009)	(-0.6682)	(0.1263)	(-1.5580)	(-1.3197)	(0.1175)	(-2.3583)	(-0.9039)	(-0.3273)
Above Thirty Percent Female	-0.0025*	0.0002	0.0000	-0.0041**	0.0003	-0.0001	-0.0015	0.0008	-0.0000
	(-1.7335)	(0.7483)	(0.0376)	(-2.5613)	(0.6790)	(-0.4107)	(-1.1487)	(0.7901)	(-0.1657)
CAPEX to Total Assets Ratio	0.2901	-0.0327	-0.0530	0.3430	-0.0139	-0.0550	0.0861	0.1163	-0.0008
	(0.9413)	(-0.9077)	(-1.4134)	(1.2070)	(-0.5207)	(-1.3543)	(1.2007)	(0.9597)	(-0.0347)
Average Board Tenure	-0.0019	0.0019***	0.0001	-0.0015	0.0012**	-0.0000	0.0024	0.0054***	0.0005
	(-0.4616)	(3.7990)	(0.2446)	(-0.3523)	(2.5298)	(-0.0370)	(0.6820)	(2.8103)	(0.5208)
Average Age	-0.0084**	-0.0004	0.0005	-0.0081*	-0.0002	0.0006	-0.0088	-0.0048	-0.0003
	(-2.2407)	(-0.6255)	(1.0226)	(-1.8195)	(-0.2973)	(1.1509)	(-1.5609)	(-1.2953)	(-0.2764)
Proportion of Outside Directors	-0.1515	-0.0083	-0.0178	-0.1543	-0.0031	-0.0153	-0.0519	-0.0869*	-0.0141
	(-1.3149)	(-0.5867)	(-1.1492)	(-1.2272)	(-0.2225)	(-0.8979)	(-0.6349)	(-1.8824)	(-0.5291)
CEO Duality	-0.0381***	0.0007	-0.0007	-0.0377***	0.0027	-0.0010	-0.0227**	0.0060	0.0017
	(-3.1187)	(0.2252)	(-0.3046)	(-2.7776)	(1.0102)	(-0.3921)	(-2.3878)	(1.5589)	(0.5638)
Firm Leverage	0.2866***	-0.0056	0.0223***	0.3030***	-0.0172*	0.0243**	0.0935	-0.1258**	0.0246**
	(3.6843)	(-0.5419)	(2.6320)	(3.2330)	(-1.6971)	(2.5063)	(1.5773)	(-2.3261)	(2.1175)
Sales Growth	-0.0293**	-0.0014	-0.0089***	-0.0109	0.0027	-0.0073**	-0.0092	-0.0201	-0.0149***
	(-2.0947)	(-0.5241)	(-3.1964)	(-0.6659)	(0.9134)	(-2.2775)	(-0.5582)	(-1.4310)	(-3.0754)
Ln Total Assets	-0.0326	0.0034	-0.0058	0.0862	0.0018	0.0065	0.0009	0.0737***	0.0007
	(-1.1814)	(1.3062)	(-1.6351)	(1.5414)	(0.2865)	(0.8599)	(0.0444)	(3.8523)	(0.1976)
Ln Board Size	-0.1965***	0.0140*	0.0175**	-0.1892***	0.0140*	0.0186**	-0.0877**	0.0547**	0.0168
	(-3.9652)	(1.7084)	(2.0940)	(-3.6397)	(1.7689)	(2.0431)	(-2.0236)	(2.2331)	(1.3100)
Board to Total Shares Ratio	-0.1040	-0.0116	0.0103	-0.0807	-0.0016	0.0053	-0.1183	0.0547	0.0456
	(-0.7790)	(-0.7228)	(0.6905)	(-0.5530)	(-0.1160)	(0.3162)	(-1.2685)	(1.0806)	(1.5144)
IMR				0.5935***	-0.0032	0.0535**			
				(2.6681)	(-0.1236)	(1.9970)			
				(3.9187)	(3.0796)	(0.0430)			
L. Market Risk							0.9048***		
							(60.8681)		

L. Total Risk								1.4971***	
								(8.9472)	
L. Idiosyncratic Risk									0.0178
									(1.2256)
L2. Idiosyncratic Risk									0.0213
									(1.5797)
Constant	2.2232***	0.4471***	-0.0158	0.9393*	0.4399***	-0.1494**	0.7582*	-0.5687**	-0.0325*
	(8.6057)	(12.0210)	(-0.5076)	(1.7885)	(5.9636)	(-2.2120)	(1.9556)	(-2.0369)	(-1.9231)
Observations	14,710	15,331	14,751	11,453	11,798	11,475	12,068	12,510	12,389
R-squared	0.0884	0.0127	0.0783	0.1126	0.0164	0.0920			
Number of PERMNO	2,315	2,495	2,328	2,070	2,216	2,081	1,997	2,119	2,070
PERMNO FE	YES	YES	YES	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES	YES	YES	YES
adjusted R-squared	0.0881	0.0123	0.0779	0.1121	0.0162	0..919			

Robust t-statistics in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 8
Results from the First Stage Heckman Selection Model

VARIABLES	(1) Heckman
ROA	0.80**
	(4.84)
Firm Leverage	0.15
	(1.93)
Ln Total Assets	0.43**
	(39.79)
Constant	-2.82**
	(-37.58)
Observations	12,147

Next, we test Hypothesis 2 - the relationship between the critical mass of female directors and firm risk. Three different regression estimation methods are used to address various potential endogeneity issues. The results of the estimations and test for Hypothesis 2 are reported in Table 7. In Columns 1 to 3, the estimated results using fixed effects panel regression show a significant negative relationship between boards with more than 30 per cent female representation and market risk (β: -0.0025, p-value < 0.1). A Heckman model was also used in Columns 4 to 6 to test for self-selection bias. A significant inverse mills ratio is obtained for market (β: 0.5935, p-value < 0.01) and idiosyncratic (β: 0.0004, p-value < 0.05) risks which is an indication that women self-select firms based on the risk levels of such firms.

We obtain similar results after correcting self-selection bias in Columns 4 to 6 as the results show a significant negative relationship between that firms with more than 30 per cent female representation and market risk (β: -0.0041, p-value < 0.05). However, in Columns 7 to 9, we control for the possibility that firms with women directors are as a result of past performance by

introducing the lag of the dependent variables in the estimation. We find that an additional increase in female representation, such that there are between 20 to 30 per cent female representation leads to a 0.2 per cent decline in market risk (at 5% level of significance). Given the inconsistent results in the GMM model, we conclude that Hypothesis 2 is not supported.

Table 9
Results of the Moderating Effects of Free Cashflow on the Relationship Between the Critical Mass of Female Directors and Firm Performance

VARIABLES	(1) ROA	(2) Annual Stock Return	(3) Tobin Q	(4) ROA	(5) Annual Stock Return	(6) Tobin Q
Up to ten Percent Female	0.0003	0.0012**	0.0025	-0.0011**	0.0002	0.0025
	(1.0000)	(2.1585)	(0.7236)	(-2.3245)	(0.2947)	(0.7236)
Ten to Twenty Percent	-0.0003	0.0002	-0.0028	-0.0007**	-0.0003	-0.0008
	(-1.6017)	(0.7546)	(-1.4014)	(-2.4022)	(-0.5412)	(-0.4100)
Twenty to Thirty Percent	-0.0001	-0.0002	-0.0032*	-0.0003	-0.0005	0.0006
	(-0.8303)	(-1.0443)	(-1.8718)	(-1.1482)	(-1.3607)	(0.3962)
Above Thirty Percent Female	-0.0004*	0.0006	-0.0124***	-0.0009	0.0001	0.0029
	(-1.7859)	(1.0672)	(-4.2133)	(-1.5467)	(0.0478)	(0.8521)
FCF to Total Assets Ratio	0.2279***	0.2970	1.6965***	0.0926***	0.0418	0.4165*
	(10.6517)	(1.1121)	(6.0006)	(2.9526)	(1.0541)	(1.7528)
Ten Percent Female x FCF	0.0022	-0.0067	0.0392	0.0094**	-0.0036	-0.0233
	(0.7833)	(-1.2142)	(1.1328)	(2.3052)	(-0.7736)	(-0.7299)
Twenty Percent Female x FCF	0.0044***	-0.0026	0.0566***	0.0060***	0.0004	0.0169
	(3.2146)	(-1.0509)	(3.3129)	(3.2965)	(0.1585)	(0.9564)
Thirty Percent Female x FCF	0.0027**	-0.0005	0.0260	0.0038*	0.0002	-0.0043
	(2.3681)	(-0.2453)	(1.1179)	(1.8812)	(0.0843)	(-0.2596)
Above Thirty Percent x FCF	0.0048***	-0.0046	0.1206***	0.0109***	0.0021	-0.0185
	(3.6891)	(-1.5467)	(4.9196)	(2.9223)	(0.3326)	(-0.7504)
Capex to Total Assets Ratio	0.1754***	-0.0241	3.0966***	0.1096***	0.0452	0.4925*
	(4.4082)	(-0.8074)	(5.8866)	(3.9842)	(0.6652)	(1.8328)
Average Board Tenure	0.0003	0.0012**	0.0113*	-0.0010	0.0029**	-0.0054
	(0.6736)	(2.4748)	(1.6918)	(-1.3502)	(2.1365)	(-0.7951)
Average Age	-0.0005	-0.0001	-0.0198***	0.0001	-0.0008	-0.0005
	(-1.2106)	(-0.2412)	(-2.6154)	(0.0574)	(-0.3510)	(-0.0482)
Proportion of Outside Directors	-0.0141	-0.0053	-0.3490**	-0.0259	-0.0343	-0.2571
	(-1.1922)	(-0.3820)	(-2.0026)	(-1.3766)	(-1.1518)	(-1.4784)
CEO Duality	-0.0022	0.0027	-0.0078	-0.0043**	0.0024	-0.0208
	(-1.4148)	(1.0010)	(-0.4590)	(-2.0507)	(0.7826)	(-1.1668)
Firm Leverage	-0.0152*	-0.0179*	-0.5080***	0.0150	-0.0769**	-0.1210
	(-1.9206)	(-1.8075)	(-3.2295)	(1.1760)	(-2.4755)	(-0.9120)
Sales Growth	0.0146***	0.0029	0.0812***	0.0109**	-0.0098	-0.0129
	(7.1365)	(0.9985)	(3.4647)	(2.5410)	(-1.3179)	(-0.3308)
Ln Total Assets	-0.0168***	0.0024	-0.3628***	-0.0071**	0.0391***	-0.0814**
	(-5.5716)	(0.9241)	(-8.7299)	(-2.3893)	(3.0540)	(-2.0803)
Ln Board Size	-0.0109**	0.0145*	-0.2917***	-0.0191*	0.0360**	-0.1875**
	(-2.3978)	(1.8409)	(-4.3368)	(-1.9592)	(2.1778)	(-2.1299)

Board to Total Shares Ratio	-0.0102	-0.0037	-0.2092	-0.0053	0.0604*	0.1213
	(-0.8453)	(-0.2571)	(-1.1999)	(-0.2459)	(1.8418)	(0.6032)
L. ROA				0.3981***		
				(15.3701)		
L2. ROA				0.0468**		
				(2.0249)		
L. Annual Stock Return					1.2117***	
					(11.2640)	
L. Tobin Q						0.6390***
						(23.0369)
Constant	0.2218***	0.4339***	6.4570***	0.0000	-0.3959**	1.9412**
	(6.6613)	(10.8282)	(12.5739)	(.)	(-2.1994)	(2.5147)
Observations	10,135	11,811	10,952	11,790	11,923	11,259
R-squared	0.1318	0.0174	0.1916			
Number of PERMNO	1,795	2,215	1,965	2,160	2,265	2,055
PERMNO FE	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES
adjusted R-squared	0.129	0.0141	0.189			

Robust t-statistics in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 9 is a representation of results from panel regression with fixed effects of female representation on the board and firm performance. Models 1 to 3 tests the relationship using fixed effects panel regression with a two-way interaction between free cash flow and each level of female board representation. A Hausman test is conducted to establish a preference for fixed effect or random effect estimation. Results indicate a preference for a fixed-effects model with a significant chi-square of 22.70 at 10% level of significance. Each model is also estimated using robust standard errors to correct for heteroskedasticity. In Columns 4 to 6, we estimate the models using the two-step system dynamic model. A lag is introduced as instruments for Annual stock return and Tobin's Q. However, to pass the Hansen test of overidentifying restrictions, we introduce a second lag for ROA.

Hypothesis 3 states that female representation on the board would have a direct positive relationship on firm performance because of their effect on free cash flow. It is expected that the

relationship between gender diversity and performance should take the shape of an inverted "U", such that there would be an optimal number (critical mass) of women that should drive performance, given certain levels of free cash flow. Using panel regression to test the hypothesis in Table 9 above, we find that a unit increase in the FCF to total assets ratio leads to a significant increase in ROA and Tobin's q); β: 0.2279, p-value < 1% and 1.6965, p-value < 0.01), respectively. This is also consistent with results obtained using the GMM model.

Additionally, the results of the interaction term between FCF and each level of gender diversity indicate that the higher the levels of free cash flows, the greater the impact a board with ten to twenty per cent female representation has on performance (ROA – β: 0.0044, p-value < 0.01; Tobin's q – β: 0.0566, p-value < 0.01). We also find a significant relationship between the moderation effect of FCF on firms with more than 30 per cent female board representation and performance Free cashflows also moderates the relationship between female board representation and performance (ROA – β: 0.048, p-value < 0.01; Tobin's q – β: 0.1206, p-value < 0.01).

Given the evidence by (Wintoki et al., 2009) that past performance may influence firms to appoint women on their boards, we take a further step by using the two-step GMM to estimate the model. We find a significant relationship between all levels of female representation and ROA. Given that the results obtained with ROA are inconsistent with annual stock return and Tobin's Q, the hypothesis is not supported.

Table 10
Results of the Moderating Effects of Free Cashflow on the Relationship Between the Critical Mass of Female Directors and Firm Risk

VARIABLES	(1) Market Risk	(2) Total Risk	(3) Idiosyncratic Risk	(4) Market Risk	(5) Total Risk	(6) Idiosyncratic Risk
Up to ten Percent Female	0.0010	0.0012**	-0.0000	-0.0037	0.0002	0.0003
	(0.3073)	(2.1585)	(-0.1075)	(-1.4932)	(0.2947)	(0.4116)
Ten to Twenty Percent	-0.0018	0.0002	0.0000	-0.0030**	-0.0003	-0.0001

	(-0.9799)	(0.7546)	(0.1552)	(-2.3237)	(-0.5412)	(-0.2053)
Twenty to Thirty Percent	-0.0018	-0.0002	-0.0001	-0.0036***	-0.0005	0.0001
	(-1.2314)	(-1.0443)	(-0.2747)	(-3.2870)	(-1.3607)	(0.3981)
Above Thirty Percent	-0.0028	0.0006	-0.0000	-0.0046	0.0001	0.0004
Female						
	(-1.4064)	(1.0672)	(-0.0581)	(-1.6124)	(0.0478)	(0.4794)
FCF to Total Assets Ratio	-0.3813**	0.0082	-0.0209	-0.2598**	0.0418	-0.0487
	(-2.2033)	(0.5143)	(-1.0621)	(-1.9852)	(1.0541)	(-1.2731)
Ten Percent Female x	-0.0273	-0.0067	-0.0027	-0.0011	-0.0036	-0.0008
FCF						
	(-0.9731)	(-1.2142)	(-0.5932)	(-0.0576)	(-0.7736)	(-0.1224)
Twenty Percent Female x	0.0018	-0.0026	0.0007	0.0122	0.0004	0.0031
FCF						
	(0.1243)	(-1.0509)	(0.3135)	(1.5059)	(0.1585)	(1.1359)
Thirty Percent Female x	-0.0007	-0.0005	0.0013	0.0160**	0.0002	0.0009
FCF						
	(-0.0604)	(-0.2453)	(0.7690)	(1.9807)	(0.0843)	(0.3488)
Above Thirty Percent x	-0.0143	-0.0046	-0.0007	0.0291	0.0021	-0.0025
FCF						
	(-0.9775)	(-1.5467)	(-0.2580)	(1.1872)	(0.3326)	(-0.3178)
Capex to Total Assets	-0.0379	-0.0241	-0.0746*	0.0142	0.0452	-0.0393
Ratio						
	(-0.1173)	(-0.8074)	(-1.8395)	(0.1470)	(0.6652)	(-1.2886)
Average Board Tenure	-0.0022	0.0012**	-0.0001	0.0057	0.0029**	0.0014
	(-0.5142)	(2.4748)	(-0.1003)	(1.4858)	(2.1365)	(1.3024)
Average Age	-0.0077*	-0.0001	0.0006	-0.0090	-0.0008	-0.0027
	(-1.7301)	(-0.2412)	(1.2077)	(-1.4396)	(-0.3510)	(-1.5442)
Proportion of Outside	-0.1671	-0.0053	-0.0163	-0.0611	-0.0343	-0.0091
Directors						
	(-1.3104)	(-0.3820)	(-0.9563)	(-0.7112)	(-1.1518)	(-0.3535)
CEO Duality	-0.0375***	0.0027	-0.0010	-0.0200**	0.0024	0.0010
	(-2.7636)	(1.0010)	(-0.4052)	(-2.0220)	(0.7826)	(0.3328)
Firm Leverage	0.2218**	-0.0179*	0.0197**	0.0229	-0.0769**	0.0457**
	(2.3388)	(-1.8075)	(1.9849)	(0.3675)	(-2.4755)	(2.5151)
Sales Growth	-0.0189	0.0029	-0.0081***	-0.0116	-0.0098	-0.0157***
	(-1.1988)	(0.9985)	(-2.6217)	(-0.6706)	(-1.3179)	(-3.1270)
Ln Total Assets	-0.0427	0.0024	-0.0052	0.0301	0.0391***	-0.0061
	(-1.4669)	(0.9241)	(-1.3567)	(1.3908)	(3.0540)	(-0.9478)
Ln Board Size	-0.1881***	0.0145*	0.0181**	-0.0926**	0.0360**	0.0129
	(-3.6456)	(1.8409)	(1.9991)	(-2.0598)	(2.1778)	(0.9904)
Board to Total Shares	-0.0566	-0.0037	0.0075	-0.0597	0.0604*	0.0290
Ratio						
	(-0.3914)	(-0.2571)	(0.4540)	(-0.6188)	(1.8418)	(1.0295)
L. Market Risk				0.9013***		
				(56.3250)		
L. Total Risk					1.2117***	
					(11.2640)	
L. Idiosyncratic Risk						0.0214***
						(47.5145)
Constant	2.2861***	0.4339***	-0.0277	0.5745	-0.3959**	0.1567
	(8.1670)	(10.8282)	(-0.8132)	(1.3384)	(-2.1994)	(1.3695)
Observations	11,469	11,811	11,491	11,180	11,223	11,493
R-squared	0.1128	0.0174	0.0917			
Number of PERMNO	2,071	2,215	2,082	2,062	2,065	2,169

PERMNO FE	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES
adjusted R-squared	0.110	0.0141	0.0886			

Robust t-statistics in parentheses
*** p<0.01, ** p<0.05, * p<0.1

In Hypothesis 4, it was predicted that free cash flow moderates the relationship between the critical mass of female directors and firm risk. It is expected that firms with an optimal board female representation would be able to bring the risk aversion appetite of females on the board to bear on firm risk, particularly when free cash flows are high. Models 1 to 3 makes use of fixed effects panel regression with interaction effects of levels of female board representation and FCF to test the hypothesis. The expectation with the interaction terms is that as free cash flows increase, boards with optimal women representation would have a reducing impact on firm risk. From the Panel regression, we find no significant relationship between any of the levels of female board representation and firm risk. To control for the possibility of dynamic endogeneity, we use GMM to estimate the model in Hypothesis 4 to 6. The results report a significant positive relationship for firms with 20 to 30 per cent female board representation and market risk (β: 0.016; $p < 0.5$). However, the relationship between each level of female representation and performance is insignificant; therefore, Hypothesis 4 is not supported.

Table 11
Results of the Moderating Effects of Firm Complexity on the Relationship Between the Critical Mass of Female Directors and Firm Performance

VARIABLES	(1) ROA	(2) Annual Stock Return	(3) Tobin	(4) ROA	(5) Annual Stock Return	(6) Tobin Q
Up to Ten Percent Female	0.0007	0.0009	-0.0028	0.0004	0.0007	-0.0070
	(1.5645)	(1.2851)	(-0.4995)	(0.5517)	(0.4358)	(-1.1312)
Ten to Twenty Percent Female	0.0000	0.0003	-0.0037	-0.0002	-0.0002	-0.0043
	(0.1950)	(1.1525)	(-1.3288)	(-0.5297)	(-0.1668)	(-1.1902)
Twenty to Thirty Percent Female	0.0001	0.0004	-0.0028	-0.0001	0.0000	-0.0041
	(0.2818)	(1.4599)	(-0.9784)	(-0.2060)	(0.0193)	(-1.5532)
Above Thirty Percent Female	0.0002	0.0004	-0.0113**	0.0001	0.0027	-0.0046

	(0.4734)	(0.8391)	(-2.1974)	(0.1885)	(1.6124)	(-1.0151)
Firm Complexity	-0.0026***	0.0023*	-0.0479***	-0.0014	0.0025	-0.0400***
	(-2.6236)	(1.7627)	(-4.0996)	(-0.9473)	(0.6521)	(-3.4136)
Firm Complexity and Up to Ten Percent Female	-0.0001	-0.0001	0.0028**	-0.0000	-0.0003	0.0031**
	(-0.6174)	(-0.6282)	(2.1598)	(-0.1559)	(-0.7244)	(2.0578)
Firm Complexity and Ten to Twenty Percent Female	0.0000	-0.0001	0.0018**	0.0001	-0.0002	0.0020**
	(0.0732)	(-1.5409)	(2.3783)	(0.8575)	(-0.6692)	(2.3252)
Firm Complexity and Twenty to Thirty Percent Female	0.0000	-0.0002**	0.0007	0.0001	-0.0002	0.0016**
	(0.0094)	(-2.5717)	(1.0726)	(1.4757)	(-0.7404)	(2.4316)
Firm Complexity and Above Thirty Percent Female	-0.0000	-0.0001	0.0036**	0.0000	-0.0007*	0.0009*
	(-0.2359)	(-0.5446)	(2.1330)	(0.1291)	(-1.7087)	(1.6771)
Capex to Total Assets Ratio	0.0115	-0.0309	2.2382***	0.0413*	0.1173	0.0263
	(0.3003)	(-0.8556)	(5.3846)	(1.9208)	(1.0072)	(0.1370)
Average Board Tenure	0.0003	0.0019***	0.0105	-0.0009	0.0057***	-0.0018
	(0.7028)	(3.7188)	(1.4888)	(-1.3377)	(3.0725)	(-0.2834)
Average Age	-0.0007*	-0.0004	-0.0219***	-0.0001	-0.0055	-0.0106
	(-1.6559)	(-0.6523)	(-3.0463)	(-0.0961)	(-1.5598)	(-1.2209)
Proportion of Outside Directors	-0.0206*	-0.0089	-0.3405**	-0.0189	-0.0890**	-0.2119
	(-1.8801)	(-0.6311)	(-2.0348)	(-1.2142)	(-1.9853)	(-1.2314)
CEO Duality	-0.0027*	0.0006	-0.0098	-0.0031*	0.0057	-0.0175
	(-1.8527)	(0.1981)	(-0.5739)	(-1.8114)	(1.5051)	(-0.9641)
Firm Leverage	-0.0400***	-0.0057	-0.5468***	-0.0000	-0.1090**	-0.0912
	(-6.0419)	(-0.5574)	(-4.4817)	(-0.0037)	(-2.1591)	(-1.0098)
Sales Growth	0.0132***	-0.0013	0.0711***	0.0113***	-0.0199	-0.0795***
	(7.7857)	(-0.5124)	(3.6266)	(2.8324)	(-1.4607)	(-2.6017)
Ln Total Assets	-0.0145***	0.0032	-0.3467***	-0.0089**	0.0688***	-0.0295
	(-3.7451)	(1.2102)	(-10.1752)	(-2.2172)	(3.6722)	(-1.2898)
Ln Board Size	-0.0054	0.0134*	-0.2428***	-0.0103	0.0505**	-0.2010**
	(-1.0952)	(1.6629)	(-3.4676)	(-1.2452)	(2.1096)	(-2.3851)
Board to Total Shares Ratio	-0.0179	-0.0099	-0.3114*	0.0113	0.0542	-0.0990
	(-1.4340)	(-0.6111)	(-1.8867)	(0.5649)	(1.0943)	(-0.5331)
L.ROA				0.3951***		
				(14.6444)		
L. Annual Stock Return					1.5189***	
					(9.4971)	
L. Tobin Q						0.6708***
						(29.0535)
L2. Tobin Q						0.0429**
						(2.3971)
Constant	0.2363***	0.4461***	6.5675***	0.1482**	-0.5094*	2.2747***
	(6.1870)	(11.8415)	(14.3887)	(2.1782)	(-1.9183)	(3.8374)
Observations	12,601	15,331	13,685	10,352	12,510	11,774
R-squared	0.0678	0.0132	0.1560			
Number of PERMNO	2,006	2,495	2,197	1,979	2,119	2,029

PERMNO FE	YES	YES	YES			
Year FE	YES	YES	YES	YES	YES	YES
adjusted R-squared	0.0649	0.0107	0.154			

Robust t-statistics in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Hypothesis 5 concerns the moderating role firm complexity plays in the relationship between gender diversity and firm performance. We use number of business and geographical segments as a proxy for firm complexity. Models 1 to 3 of Table 10 represents panel regression that tests for the moderating effect of firm complexity in the gender diversity – performance relationship. In terms of annual stock return, the interaction of firm complexity and boards with 20 to 30 per cent female representation is significantly negative at 5 per cent level of significance. Furthermore, except for firms with 20 to 30 per cent female board representation, all other levels of female representation are significant at 5%.

Lastly, we control for dynamic endogeneity as demonstrated in prior tests above in Models 4 to 6 and find that there is indeed a significant negative relationship between the interaction effect for boards with more than 30% female representation and annual stock return (β: -0.0007; $p < 0.1$). In terms of Tobin's Q, however, the results are quite different from other measures of performance. we find a significant positive relationship between boards with female representation of up to 10 percent, (β: 0.0031; $p < 0.05$), 10 to 20 percent (β: 0.0020; $p < 0.05$), 20 to 30 percent (β: 0.0016; $p < 0.05$) and above 30 percent (β: 0.009; $p < 0.1$). This implies that there is a diminishing marginal decline in annual return and Tobin's Q for every additional woman added on the board. This is contrary to our inverted "U" hypothesis and as such, not supported.

Table 12
Results of the Moderating Effects of Firm Complexity on the Relationship Between the Critical Mass of Female Directors and Firm Risk

VARIABLES	(1) Market Risk	(2) Total Risk	(3) Idiosyncratic Risk	(4) Market Risk	(5) Total Risk	(6) Idiosyncratic Risk
Up to Ten Percent Female	-0.0096**	0.0009	-0.0005	-0.0070*	0.0007	0.0007
	(-2.3793)	(1.2851)	(-0.7164)	(-1.8828)	(0.4358)	(0.7225)
Ten to Twenty Percent Female	-0.0062**	0.0003	-0.0002	-0.0034**	-0.0002	0.0002
	(-2.5501)	(1.1525)	(-0.6523)	(-2.0246)	(-0.1668)	(0.3389)
Twenty to Thirty Percent	-0.0040**	0.0004	-0.0001	-0.0038***	0.0000	0.0005
	(-2.1357)	(1.4599)	(-0.2445)	(-2.6094)	(0.0193)	(1.2090)
Above Thirty Percent Female	-0.0044	0.0004	0.0001	0.0008	0.0027	0.0011**
	(-1.5655)	(0.8391)	(0.4402)	(0.3275)	(1.6124)	(2.0792)
Firm Complexity	-0.0290***	0.0023*	-0.0019	-0.0073	0.0025	0.0012
	(-2.9423)	(1.7627)	(-1.2830)	(-1.0565)	(0.6521)	(0.5737)
Firm Complexity and Up to Ten Percent Female	0.0032***	-0.0001	0.0001	0.0018*	-0.0003	-0.0001
	(2.9574)	(-0.6282)	(0.5261)	(1.9063)	(-0.7244)	(-0.4594)
Firm Complexity and Ten to Twenty Percent Female	0.0018***	-0.0001	0.0001	0.0007	-0.0002	-0.0000
	(3.0855)	(-1.5409)	(0.7813)	(1.4407)	(-0.6692)	(-0.3531)
Firm Complexity and Twenty to Thirty Percent Female	0.0010**	-0.0002**	0.0000	0.0006*	-0.0002	-0.0001
	(2.2769)	(-2.5717)	(0.4474)	(1.6780)	(-0.7404)	(-1.1269)
Firm Complexity and Above Thirty Percent Female	0.0007	-0.0001	-0.0000	-0.0007	-0.0007*	-0.0003**
	(0.8892)	(-0.5446)	(-0.4898)	(-1.1253)	(-1.7087)	(-2.4676)
Capex to Total Assets Ratio	0.2636	-0.0309	-0.0549	0.0919	0.1173	-0.0224
	(0.8565)	(-0.8556)	(-1.4742)	(1.2464)	(1.0072)	(-1.0240)
Average Board Tenure	-0.0016	0.0019***	0.0001	0.0023	0.0057***	0.0009
	(-0.3955)	(3.7188)	(0.2727)	(0.6703)	(3.0725)	(0.9671)
Average Age	-0.0083**	-0.0004	0.0005	-0.0083	-0.0055	-0.0008
	(-2.2013)	(-0.6523)	(1.0290)	(-1.5325)	(-1.5598)	(-0.5289)
Proportion of Outside Directors	-0.1442	-0.0089	-0.0171	-0.0576	-0.0890**	-0.0204
	(-1.2598)	(-0.6311)	(-1.1032)	(-0.7111)	(-1.9853)	(-0.8902)
CEO Duality	-0.0368***	0.0006	-0.0006	-0.0229**	0.0057	0.0027
	(-3.0209)	(0.1981)	(-0.2737)	(-2.4088)	(1.5051)	(0.9177)
Firm Leverage	0.2879***	-0.0057	0.0226***	0.0901	-0.1090**	0.0328**
	(3.6960)	(-0.5574)	(2.6383)	(1.6115)	(-2.1591)	(2.1237)
Sales Growth	-0.0290**	-0.0013	-0.0089***	-0.0098	-0.0199	-0.0145***
	(-2.0550)	(-0.5124)	(-3.2092)	(-0.5825)	(-1.4607)	(-3.0519)
Ln Total Assets	-0.0313	0.0032	-0.0055	-0.0003	0.0688***	-0.0020
	(-1.1268)	(1.2102)	(-1.5381)	(-0.0174)	(3.6722)	(-0.3629)
Ln Board Size	-0.1902***	0.0134*	0.0178**	-0.0817*	0.0505**	0.0097
	(-3.8386)	(1.6629)	(2.1634)	(-1.9128)	(2.1096)	(0.7945)
Board to Total Shares Ratio	-0.1166	-0.0099	0.0092	-0.1274	0.0542	0.0459*
	(-0.8613)	(-0.6111)	(0.6208)	(-1.3714)	(1.0943)	(1.6871)
L. Market Risk				0.9019***		
				(60.9411)		
L. Total Risk					1.5189***	
					(9.4971)	

L. Idiosyncratic Risk						0.0144
						(1.1221)
Constant	2.2493***	0.4461***	-0.0149	0.7530**	-0.5094*	0.0292
	(8.6507)	(11.8415)	(-0.4779)	(2.0020)	(-1.9183)	(0.2999)
Observations	14,710	15,331	14,751	12,068	12,510	12,092
R-squared	0.0904	0.0132	0.0785			
Number of PERMNO	2,315	2,495	2,328	1,997	2,119	2,006
PERMNO FE	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES
Adjusted R-Squared	0.0880	0.0107	0.0761			

Robust t-statistics in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Hypothesis 6 seeks to test the hypothesis that firm complexity moderates the relationship between female board representation and firm risk. Models 1 to 3 in Table 12 reports the panel regression results. With the exception of firms with above 30 per cent female representation, all levels of female board representation have a significant impact on market risk. A similar result is reported by the GMM estimation. However, a striking difference is the fact that the interaction effect of firm complexity and firms with more than 30 per cent female representation is negatively significant for total (β: 0.0007; $p < 0.1$) and idiosyncratic risk (β: 0.0003; $p < 0.05$). In terms of the economic significance, we find that a standard deviation increase in boards with more than 30 percent female representation would lead to a 10.74 per cent decline in total risk and a 0.52 per cent decline in firm-specific risk. This, therefore, supports our hypothesis that complex firms moderate the relationship between boards with a female representation above 30 per cent and firm risk.

CHAPTER 6: DISCUSSION AND CONCLUSION

This study was focused on investigating the impact of board gender diversity on firm performance and risk. We explored the possibility that a critical mass of female directors would drive performance and reduce firm risk. We also tested the hypothesis that free cash flow and firm complexity moderate the positive relationship between diversity and performance and the negative relationship between diversity and firm risk.

6.1.1 Critical mass, firm performance, and firm risk

The first hypothesis investigates the relationship between levels of gender diversity and firm performance. We do not find sufficient evidence of a significant relationship between gender-diverse boards and firm performance. However, we find evidence that women self-select firms based on how profitable the firm is, the performance of the firm's stock in the market or the growth potential of the firm. This finding is consistent with studies in the board diversity literature (Carter et al., 2010; Shrader et al., 1997) and as such, has become a part of the "no-relationship" category of results in the gender diversity and performance literature.

Secondly, the paper considered the relationship between gender diversity and firm risk. Our expectation was that there should be a certain proportion of women representation on the board such that through monitoring, they are able to significantly limit volatility in stock returns. We carried out robust analysis using three empirical estimation models whilst considering the presence of endogeneity. The results indicate that although some form of relationship was established for firms with 20 to 30 per cent female board representation, the result is inconsistent with other measures of firm risk. Hence, the hypothesis is not supported. This finding is also consistent with the "no-relationship" portion of the gender diversity – firm risk relationship (Sila et al., 2016)

Several reasons have been put forward to support the lack of empirical evidence for BGD and firm performance/risk relationship. Firstly, a gender diverse board may facilitate conflict of interest among board members which could hamper their ability to efficiently carry out their monitoring function. A gender-diverse board may also be faced with a slow-paced decision-making process which could negatively affect their ability to respond promptly to problems emanating from their business environments. In addition, women in corporate boards may be faced with the glass cliff effect such that they are given tough board positions not on the basis of their qualification but because they are viewed as "expendable" thereby impeding their ability to succeed on their role. Furthermore, women may be faced with board members that are misogynistic and therefore would want to stifle their performance on the board. Such misogynistic tendencies may arise from cultural biases. Lastly, Tacheva and Huse (2006) suggest the impact of gender-diverse boards are better measured on an individual basis; hence, it would be quite unrealistic to isolate their contribution to firm performance.

6.1.2 Moderating effect of Free cash flows on gender diversity

Using panel regression and GMM to analyze the moderating effect of free cashflows on firm performance, we had expected a positive significant moderating effect of free cash flows on the gender diversity – performance relations. However, our hypothesis is not supported as we fail to find sufficient evidence in this regard.

Similarly, we fail to accept the hypothesis that agency cost of free cashflows moderates the relationship between gender diversity and firm risk. Going by the postulations of Jensen (1986), shareholders of poor growth firms are at a greater risk of incurring agency cost of free cash flows;

we limited our sample to check the impact of female directors of such firms on reducing the cost of free cash flow.[45], but found no results.

The following are reasons for the lack of sufficient empirical evidence of the BGD and firm risk relationship in firms.

First, whilst it has been sufficiently proven that women are better monitors, their impact on reducing firm risk could be more evident in firms with weak corporate governance structures. Also, control of the firm goes beyond the purview of the board and also includes top management. The results are likely to be different if top management positions are considered in the empirical analysis, particularly in recent times where countries like the US has witnessed a rapidly growing female workforce in areas that were predominantly male-dominated. Thirdly, despite findings that women are generally less risky than men, Adams and Funk (2012) suggest that such risk aversion traits may be done away with when women get acclimatized to the business environment the firms operate in.

While it is plausible that the attention of directors, particularly women could be triggered when firms declare high levels of free cash flows, it's a different ball game entirely to translate such high levels of scrutiny to better performance except in situations where some form of external governance mechanisms are employed (Jensen, 1986).

6.1.3 Moderating effect of firm complexity

[4] Results are not reported in this study but are available upon request.
[5] Tobin Q, being an indication of growth prospects of a firm, was used in this computation in line with (Jurkus et al., 2011).

Lastly, we examined how firm complexity affects the relationship between board gender diversity and firm performance and firm risk. We find no evidence that complex firms have a moderating effect on the gender diverse boards – performance relations.

In terms of firm risk, we had hypothesized that the complexity of a firm moderates the relationship between the critical mass of gender-diverse boards and firm risk. In other words, we had expected that as firms get more complex in their operations, there is an optimal number of female directors required on the board to reduce volatility in stock returns. Our finding does support the hypothesis as we find that as firms increase the ratio of female directors beyond 30 per cent, total risk and idiosyncratic risks reduce by 0.07% and 0.03% respectively. This is consistent with the literature on board monitoring (Adams & Ferreira, 2009; Adams et al., 2010). As the operations of firms get more complex, greater levels of monitoring are required. Since women are known as better monitors (Adams & Ferreira, 2009), a board with more women would lead to reduced risk levels for the firm.

This section of the research is also new to literature as no other paper has attempted to examine the moderating role of firm complexity in the BGD – firm risk relationship. The finding from this study considered the four major forms of endogeneity, including dynamic endogeneity. The interpretation of the finding is as follows.

The proportion of female directors required to pull an impact on the boards of complex firms is as much as their male counterpart. This is a strong case against the tokenization of minority groups, in this case, women. The presence of women on the board is not sufficient, as they should be given as much opportunities as their male counterparts in leadership positions. Furthermore, it is not enough to create gender quotas, but having laws that would ensure that a sufficient

proportion of women on the board to prevent them from getting overwhelmed by the male directors.

This research provides novel insight into the relationship between gender diversity and firm performance as this is the first known attempt in literature to investigate the role of firm complexity in moderating the BGD-performance relationship in the S&P 1500 context. A different study conducted by Krishman & Park (2004) find that environmental complexity does not moderate the relationship between gender diversity and firm performance. The difference in methodology may have contributed to the contrast in results, as Krishman & Park (2004) failed to account for the fact that the board characteristics used in their study are subject to endogeneity problems.

6.2 Limitations and Future Research

The findings of this study must be considered with caution, as there are some limitations to bear in mind while analyzing its results.

First, the sample used in conducting this empirical research is limited to S&P firms in the United States. The generalization of its findings beyond the US is therefore limited. Limitations in the generalizability of the findings could stem from the difference in legislations in terms of women representation on boards, the level of cultural biases against the female gender which prevents a level playing field that is gender-neutral amongst several other reasons. Given the legal and social peculiarities of different geographical locations, it is recommended for similar studies to be conducted using samples drawn from a different population.

Secondly, the study only focuses on large firms in the S&P 1500 as it is quite seamless to collect data of larger, capitalized firms. This, however, places a limitation on the generalization of the findings of this study. For further research, it is important that the impact of gender-diverse boards be considered in smaller and family firms.

Lastly, this study only looked at the board diversity in terms of the gender dichotomy. However, the diversity of the board is not only limited to the gender of members as other factors such as the educational background, race, experience, etc., may also influence the impact that gender diverse boards have on performance or risk and this may have accounted for the insignificance in most of the results. For example, a board that consists of an optimal number of women may not produce the same outcome as a similar board because of the differences in experiences or background of the female members.

6.3 Conclusion

This research focused on investigating the critical mass of female representation required on the board of firms. To achieve this, we considered the relationship between levels of female board representation and firm performance and risk and looked into the moderating effects of agency cost of free cash flows and firm complexity. Fixed effects panel regression and two-stage GMM estimator was used to account for problems relating to endogeneity.

The study finds that gender-diverse boards are not significantly related to firm performance. However, we find evidence that women are more likely to self-select into the boards they are appointed to, based on the profitability, stock performance or growth prospects of the firm. The study also finds that boards with more than 30 per cent female representation in complex firms have a significant inverse relationship with total and idiosyncratic risks.

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