Women on Board: Does boardroom gender diversity really affect firm risk?

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ABSTRACT

We investigate the gender diversity-risk relationship from the perspective of equity holders. A naïve analysis shows a negative relationship between boardroom gender diversity and equity risk across firms. This cross-sectional relationship applies to both systematic and idiosyncratic risks. However, when we employ more sophisticated identification strategies to investigate the variation within the firm (using Two-Stage Least Squares with Fixed Effects and Dynamic Panel GMM) or the impact of female director appointments on risk measures (using Difference-in-Difference Matching Estimator) the negative relationship disappears. Although we find that the director appointment process is not gender neutral, this process cannot be explained by the firm's risk. Our results lead to the conclusion that the negative relationship between gender diversity and equity risk is driven by between-firm heterogeneous factors that influence both boardroom female representation and the firm's risk measures.

1 Introduction

In the past decade, there have been political and legislative movements that are motivating firms to embrace gender diversity on their boards of directors. The European Parliament, for example, has backed the European Commission's proposed law to improve the gender balance in Europe's company boardrooms, aiming for at least 40% female representation by 2020[1]. In the US, the Securities and Exchange Commission (SEC) adopted a rule that requires public companies to disclose whether their boards have a diversity policy and how it is being implemented[2]. There is also a US-wide campaign that asks firms to pledge 20% female participation on board by 2020[3]. This campaign seeks voluntary rather than mandatory progress, fostering social pressure for gender diversity from firms' stakeholders e.g. shareholders, employees and customers. An example is Twitter Incorporated, which filed for an Initial Public Offering in August 2013. The company came under fire in the media over its exclusively male board of directors[4]. Although the company's CEO responded to this criticism by saying that the director appointment process should be more than just "checking a box"[5], the company appointed Marjorie Scardino as its first female director in December 2013. This example demonstrates that, even without a regulatory mandate, the disclosure requirements and the increased social pressure is likely to result in firms appointing more female directors over time, changing the demographic of boardrooms in the United States. As the gender composition of US boardrooms is still changing, the economic impact of having more female directors on boards is not yet well understood.

The movement towards a more gender-diverse board is partially due to the moral or social justification that the current demographic of board directors does not reflect that of the workforce or the population as a whole (Fairfax 2011). It also results from the belief that boardroom diversity can positively affect firm value. One often-cited notion is that female directors can help curb excessive risk taking. Christine Lagarde, Managing Director of the International Monetary Fund and former Finance Minister of France, famously stated in an interview that the recent financial crisis might not have been as severe if it had been 'Lehman Sisters' instead of 'Lehman Brothers'[6]. Studies in economics and psychology often find women to have less appetite for risk than men (see for example Hinz et al. (1997), Byrnes et al. (1999) and Barber and Odean (2001)). However, few studies have been conducted to assess whether there is a relationship between female participation on the board of directors and firm risk. Without a clear understanding of this diversity-risk relationship, the drive for gender diversity may result in unintended consequences: if female directors do indeed affect

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[1] European Commission: Women on Boards: Commission proposes 40% objective. http://ec. europa.eu/justice/newsroom/gender-equality/news/121114_en.htm

[2] United States Government, Code of Federal Regulations "Title 17: Commodity and Securities Exchanges § 229.407 (Item 407) Corporate Governance"; Securities and Exchange Commission, " Proxy Disclosure Enhancements," (December 16, 2009).

[3] http://www.2020wob.com

[4] Claire Cain Miller, "Curtain Is Rising on a Tech Premiere With (as Usual) a Mostly Male Cast", *The New York Times*, October 4, 2013 (http://www.nytimes.com/2013/10/05/technology/as-tech-start-ups-surge-ahead-women-seem-to-be-left-behind.html)

[5] Vivek Wedhwa, "Twitter Has Taken A Good Step Forward, But Needs More Than One Female Director" , *Forbes*, September 12, 2013 (http://www.forbes.com/sites/singularity/2013/12/09/twitter-has-taken-a-good-step-forward-but-needs-to-do-much-more/)

[6] Christine Lagarde, "What If It Had Been Lehman Sisters?", *The International Herald Tribune*, May 11, 2010 (http://dealbook.nytimes.com/2010/05/11/lagarde-what-if-it-had-been-lehman-sisters)

firm risk, the embrace for boardroom gender diversity may alter the risk profile of firms in an unforeseen way. As such, the relationship between gender diversity and firm risk is a research question worth pursuing.

Using a comprehensive data set of 2,429 US firms from 1996-2012, this paper aims to test the gender diversity and risk relationship from the perspective of equity holders. Specifically, we ask the following questions: first, is there any link between equity risk and gender diversity? Second, if the link exists, does gender affect equity risk or is it equity risk that affects gender choices? Finally, what corporate risk-taking actions are affected by gender diversity?

We attempt to answer these questions using various identification techniques that are commonly used in the literature. Although we find a negative relationship between equity risk and female boardroom participation, we fail to conclude that increasing a firm's proportion of female directors is associated with lower equity risk. Neither do we find that the appointment of female directors has any impact on firm risk measures. In addition, although variation in female representation on boards of directors can be explained by past firm risk measures, these risk measures do not have any impact on the choice regarding the gender of a director being appointed (except total risk measure which is marginally significant at 10%). Therefore, it is likely that the discovered link between gender diversity and risk measures comes from the variation between firms and is driven by firm-level heterogeneity. As such, it is unlikely that increasing female boardroom participation will have any impact on a firm's risk profile.

The paper provides the following contributions to the literature. First, we show that, from the risk perspective, gender diversity does not have any economic impact on firm value, informing the hitherto inconclusive debate on the costs and benefits of boardroom gender diversity (see for example Adams and Ferreira (2009) and Carter et al. (2010)). Second, we demonstrate that the director appointment process is not gender neutral even though a firm's risk profile has no impact on the gender of the appointed directors. Overall, we contribute to the larger debate of whether the demography of organizations matters (see, for example, Pelled et al. (1999), Linck et al. (2008), and Kaplan et al. (2012)). We investigate this question at the board level and argue that a director's gender, as a demographic attribute, does not influence the level of firm risk. Nor can the level of firm risk determine the appointee's gender. In addition, we also illustrate the impact of endogeneity on the estimated relationship between gender diversity and firm risk by showing that the negative relationship between diversity and risk is largely driven by the variation between firms. We also note that this is the first study that empirically tests the relationship between gender diversity and corporate risk-taking policies.

The rest of the paper is structured as follows. Section 2 discusses the relevant literature; Section 3 discusses methodological issues; and Section 4 discusses our hypotheses. The details of our sample and univariate analysis are presented in Section 5. The results are discussed in Sections 6-9 and Section 10 concludes the paper.

2 Literature review

Return and risk can be seen as two sides of the same coin. Firms engage in risky projects with positive Net Present Values in order to generate returns for shareholders. As firm value can be viewed as the sum of future cash flows discounted by appropriate rates of required return to account for risk, it is appropriate that both risk and return are considered together by managers. Agency theory suggests that managers are risk averse due to concerns about their own personal welfare (Fama 1980; Holmström 1999) and the literature investigates how managers can be induced to make risky choices through various corporate governance mechanisms. These mechanisms include both external mechanisms such as monitoring from debt holders and institutional shareholders as well as internal mechanisms such as remuneration (see, for example, Wright et al. (1996), Leland (1998) and Coles et al. (2006)). One mechanism believed to have impact on risk is the influence of the board of directors.

2.1 Board characteristics and firm risk-taking behavior

Studies have tried to identify the influence of board characteristics on corporate risk. The most prominent pattern that emerges in the empirical literature is that smaller boards are associated with riskier behaviors. Cheng (2008) finds that firms with smaller boards have higher performance variability, accounting accruals and participation in merger and acquisition. Pathan (2009) and Nakano and Nguyen (2012) find a negative relationship between board size and stock return volatility. Wang (2012) finds that smaller boards tend to use executive remuneration to induce risk. In addition, he finds that firms with smaller boards exhibit larger R&D expenditures, lower capital expenditure, lower leverage and higher future firm risk. Overall, existing studies have found that board matters in term of risk-taking decisions. However, the directors in these studies are treated as though they are the same while they are actually different as individuals. Corporate boards comprise people with different characteristics such as gender, ethnicity, qualifications, personalities and beliefs. These variations in characteristics, gender in particular, may be able to explain the difference in risk-taking choices amongst these firms.

2.2 Can female directors affect a firm's risk?

At the individual level, studies in both psychology and economic literature find that women tend to be more averse to risk. In a meta-analysis of 150 studies on risk-taking behaviors, it was observed that men are more likely to be involved in "risky experiments", "intellectual risk taking" and "gambling" than women (Byrnes *et al.* 1999). In experimental settings, men exhibit a greater tendency to make risky choices than women. For example, women are found to be more risk averse in experiments using lotteries with known probabilities and monetary outcomes (Levin et al. 1988; Powell & Ansic 1997; Fehr-Duda et al. 2006). It is also found that women are more conservative in making investment decisions (Sunden & Surette 1998; Bernasek & Shwiff 2001). Croson and Gneezy (2009) provide a good overview of literature in this area. However, these studies investigate the risk attitude of women in the population. Female directors may possess different characteristics that have helped them to climb the corporate ladder and become directors. Adams and Funk (2012) hypothesize that the degree of risk aversion in women may vanish when they have broken through the glass ceiling in order to adapt themselves to a male-dominated culture. In a Swedish sample, they find that female directors are more risk loving than their male counterparts. Nonetheless, provided that there are differences in risk attitude between genders, it is possible that the gender composition of the board, as a characteristic, may be able to explain the variation in corporate risk-taking behaviors.

At the board level, the interaction between directors of different genders may also impact decisions. On the one hand, board diversity may result in better quality of discussions which may lead to better decision making (Burgess & Tharenou 2002; Kang et al. 2007). On the other hand, diversity of director characteristics may lead to conflicts and as a result consensus may take longer. The risk implications of this interaction are difficult to gauge. Better quality discussion can potentially lead to lower firm risk given the same level of return whilst risk may increase if it is more time consuming for directors to reach decisions (Adams & Ragunathan 2013).

2.3 Empirical studies on board gender diversity

There are limited studies as to the impact of female representation on boards of directors on firms' risk-taking behaviors. Wilson and Altanlar (2011) find the chance of insolvency to be negatively related to the proportion of female directors. Berger et al. (2012) find that an increase in the proportion of female bank directors after a mandatory executive retirement results in increased portfolio risk. Levi et al. (2013) find that firms with male-dominated boards are more likely to participate in merger and acquisition activities and pay higher acquisition premiums. Levi et al. attribute these results to the tendency of female directors to be less overconfident than their male counterparts.

The majority of research in the area of gender diversity on boards of directors focuses on corporate performance and, so far, there is no consensus in the literature on the relationship between female representation and a firm's prospects. Some studies find that board diversity leads to better performance (Carter et al. 2003; Campbell & Minguez-Vera 2008) while others find no such relationship (e.g. Erhardt et al. (2003), Carter et al. (2010) and Rose (2007)). Adams and Ferreira (2009) find that the parameter estimates are very sensitive to the way endogeneity is handled. Nonetheless, they find that female directors are better at monitoring function. These findings can be viewed from the perspective of gender overconfidence bias: female directors may monitor more because they are more comfortable with decision making when there is sufficient relevant information.

Another strand of literature looks at the determinants of directors' gender and a firm's risk is found to be one of these determinants. Adams and Ferreira (2004) find that firms with more volatile stock returns tend to have fewer female directors on their board. The authors explain these results using the argument of Kanter (1977) that group homogeneity (i.e. male dominated) is essential in environments where uncertainty is high. This is consistent with Hillman et al. (2007) who find that the likelihood of a firm having female directors is higher in firms with lower stock return risk. Similarly, Farrell and Hersch (2005) find that the propensity of female director appointment is negatively related to low stock return volatility. They also find that female directors are more likely to be appointed on boards with fewer female directors or when the appointment follows female director departures. Gregory-Smith et al. (2012) investigate the gender of directors being appointed in the UK and find similar results. However, they cannot establish any relation between firm's risk and gender of directors being appointed. Overall, these results suggest that a director's gender or the proportion of female directors on boards are not exogenous random variables, and that reverse causality is likely an issue when investigating the impact of gender diversity.

3 Endogeneity on board studies and econometric methods

Hermalin and Weisbach (2003) explain two key issues regarding empirical studies on the board of directors. The first issue is the interpretation of the results. When a significant correlation is found in the data, it can be interpreted as either a causal out-of-equilibrium phenomenon or a spurious equilibrium phenomenon. To illustrate these phenomena we refer to the relationship between the proportion of female directors and a firm's risk measures. With the out-of-equilibrium interpretation, a negative relationship between the proportion of female directors and risk means that adding more female directors to the board will decrease, on average, a firm's risk, whereas the equilibrium interpretation suggests that both measures are driven by other factors in order to achieve an equilibrium. The latter is consistent with a number of studies, which argue that board gender diversity may already be optimized according to the firm's resource dependency or supervision needs (see for example Westphal (1999) and Hillman et al. (2000)). Thus, there is no causal relationship under this interpretation.

The second issue is that almost all variables used in such studies are endogenous. To measure whether board characteristics such as gender composition affect risk measures, researchers have to take into account the fact that risk measures could also affect gender composition. Furthermore, both sets of variables could be influenced by past risk measures as well as other board and firm characteristics, some of which cannot be measured and are therefore often omitted. Studies such as Carter et al. (2003) and Carter et al. (2010)[7] deal with these problems by using the fixed-effects estimator or simultaneous equations techniques such as two-stage or three-stage least squares with lagged variables as instruments. However, the fixed effects estimator only yields consistent estimates when the residuals and the regressors are independent across time periods. Similarly, simultaneous equation techniques provide accurate results only when the lagged variables in the first-stage equation are uncorrelated with the residuals in the main equation. This is unlikely to be the case in board studies where both dependent and independent variables are influenced by their past values. This issue is discussed in great detail by Wintoki et al. (2012). Adams and Ferreira (2009) attempt to mitigate this issue by using female connection of male directors as an exogenous instrument variable. However, the fact that all other board and firm characteristics are also endogenous means that they can also affect the coefficient estimates. Wintoki et al. (2012) propose dynamic panel GMM as a way to consistently estimate the relationship between board characteristics and performance measures. Berger et al. (2012) investigate directly into the appointment process and use the matching difference-in-difference estimator to measure the impact of new director appointments on bank risks.

4 Hypothesis development

We model the relationship between gender diversity and firms' risk measures according to the diagram depicted in Figure 1.

[Figure 1 about here]

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[7] These examples investigate the relationship between board diversity and firm performance. For studies that use similar methodologies to estimate the relationship between other board characteristics and firm performance, see Bhagat and Black (1999) and Coles *et al.* (2008).

If gender diversity matters in regards to risk-related corporate decisions, the impact of those decisions should be reflected in stock price. As prior evidence is inconclusive, we state all the hypotheses in the null form. The first hypothesis is as follows.

> H_0^1: Female boardroom representation has no impact on equity risk measures.

To test this null hypothesis, we explore various risk measures based on the perspective of equity holders: total risk, systematic risk and idiosyncratic risk. These key risk measures and how they are constructed is explained in Section 5.

Both theoretical and empirical evidence suggests that a firm's risk may also impact the gender of the directors being appointed. This bi-directional relationship can affect the reliability of the estimations as it means that the gender variable is endogenous through reverse causality. Therefore, the results from this investigation do not only allow us to better understand the relationship between gender diversity and risk, but they also allow us to check the reliability of the inference we made in regards to the first hypothesis. The investigation is done on both the impact of a firm's risk measures on female board representation and the impact of risk on the actual appointment process. The two null hypotheses are as follows.

> H_0^2: Equity risk does not have any impact on female representation on the board.

> H_0^3: Equity risk does not have any impact on the gender of the director being appointed.

Next we investigate the potential channels on which female directors may have an influence. The first channel is compensation structure, which can be used to incentivize managers to increase corporate risk. The second channel is based on the control function of corporate boards. If female directors have a different level of risk appetite compared to male directors, boards with more female representation may act differently in terms of project approvals and overseeing of risk-taking policies. Hence, we test for two further hypotheses.

> H_0^4: Female boardroom representation has no impact on CEO compensation.

> H_0^5: Female boardroom representation has no impact on corporate risk-taking policy.

We use the sensitivity of CEO remuneration package to the risk of firm's equity to measure CEO's incentives to take risk. Corporate risk-taking policy is measured through various proxies, including investment policy in terms of research and development expenditures and investment in plants, properties and equipment. We also look at corporate leverage and diversification policies. The description of these variables is presented in the data section.

5 Data, description of variables and univariate analysis

We obtain 18,395 observations (firm-years) of 2,429 firms between 1996-2012 from the following data sources. To construct board-level variables, we obtain director-level data from the RiskMetrics database, which covers Standard & Poor's (S&P) 500, S&P MidCaps and S&P SmallCap firms. We obtain financial accounting information from the S&P Capital IQ Compustat database. The variables concerning the chief executive officers (CEOs) and their remuneration are obtained from the

Execucomp database. Risk measures are calculated from stock price data obtained from the Center for Research in Security Prices (CRSP). Following prior literature, financial service and utility firms are excluded from our sample.

[Table 1 about here]

The descriptive statistics in Table 1 reveal that about 61% of observations in our sample have at least one female director. The key variable that measures gender diversity (%FemaleDir) is defined as the number of female directors divided by the number of all directors. On average, 10% of directors in a firm are female. An average board consists of nine directors (BoardSize) in which 69% are independent directors (%BoardIndep)[8].

Firm characteristics are calculated from financial accounting variables obtained from the S&P Capital IQ Compustat database to serve as proxies for firm risk-taking behaviors and control variables. R&D is measured as the research and development expenditure adjusted by the book value of total assets. As in other studies, R&D is set to zero when the value is missing from Compustat. CapEx is capital expenditure net of sales of property, plant and equipment and divided by total assets. Leverage is the total book value of debt divided by total assets. To proxy for the level of firm diversification, we use firm's number of business segments (#Segments) and the Herfindahl-Hirschman Index, which is the sum of squared segment sales divided by the square of total sales. Profitability is measured as the return on total assets (ROA). We proxy for growth opportunity and size using the market-to-book ratio (MTB) and TotalAssets respectively.

We use three variables to measure for equity risk: total risk (TotalRisk), systematic risk (SysRisk) and idiosyncratic risk (IdioRisk). TotalRisk is calculated as the standard deviation of daily stock returns. SysRisk is the coefficient of the stock market portfolio from a market-model regression. CRSP NYSE/AMEX/Nasdaq/Arca Equally-weighted Index is used as a proxy for the stock market portfolio. IdioRisk is the standard deviation of the residuals from the market model regression. Returns excluding dividends are used for these calculations. To annualize total and idiosyncratic standard deviations, we multiply TotalRisk and IdioRisk by a square root of 250.

We also obtain variables concerning CEO characteristics and compensation. Vega is the dollar change in CEO compensation per 0.01 unit increase in firm's stock return standard deviation. Delta is defined as the dollar change in compensation per 1% increase in stock return. These two measures proxy for take risk and generate value respectively. To proxy for CEO power, we also collect the dollar amount of their cash compensation (CashComp) and tenure (CEOTenure).

[Table 2 about here]

In Table 2, we tabulate the mean of board and firm characteristics by number of female directors. The majority of the firms in our sample (94.83%) have no more than two female directors. It appears in the cross-section that firms with greater numbers of female directors tend to be larger in terms of total assets and tend to be more

[8] We define independent directors as directors who are not executives and do not have any other affiliation to the company.

diversified. More female directors are appointed in larger and more independent boards. All three measures of risk are lower in firm-years with more female directors. To evaluate whether the difference in risk measures are statistically significant, we conduct a two-sample t test with unequal variances between the risk measures of firms with different numbers of female directors. The results (untabulated) reveal that one additional female director tends to result in lower risk although the effect generally decreases in both magnitude and statistical significance with the number of female directors already on the board. On average, firms with at least one female director tend to have lower total, systematic and idiosyncratic risks compared to those firms without any female director. These results show a monotonic inverse relation between female boardroom representation and all three risk measures. However, these relations may be driven by other board and firm characteristics.

6 The relationship between gender diversity and equity risk measures

If gender matters, the variation in gender diversity should explain the variation of a firm's risk measures (Hypothesis 1). We thus estimate the following equation:

$$\mathrm{Risk}_{i,t} = \beta_0 + \beta_1 \%\mathrm{FemaleDir}_{i,t} + \mathbf{CONTROL_{i,t}\Gamma} + \varepsilon_{i,t} \qquad (1)$$

The vector $\mathrm{Risk}_{i,t}$ represents TotalRisk, SysRisk and IdioRisk. $\mathbf{CONTROL_{i,t}}$ is a matrix of control variables, which include board characteristics, CEO characteristics and firm characteristics. Board characteristics include BoardSize and the proportion of independent directors (%IndepDir). Vega and delta are introduced to the extended model to control for CEO compensation structure. CEOTenure and CashComp are included to control for CEO power. It is expected that the CEO becomes more risk averse as she stays longer on the post and has more cash as a part of her compensation. Firm characteristics include Ln(TotalAssets), MTB, R&D, CapEx and Leverage. We assume that board variables are observed at the beginning of the period whilst other variables are recorded at the end of the period; thus, the relationship is modeled as contemporaneous[9]. To account for the industry effect and time variation within the sample, we include dummy variables for industries and time periods.

[Table 3 about here]

The results displayed in Table 3 show significant and negative relationships between the proportion of female directors (%FemaleDir) and the firm's volatility as well as both its systematic and idiosyncratic components. The results are similar as we control for CEO compensation and degree of risk aversion in Models 2, 4 and 6. Looking at the control variables, it is found that returns of firms with a smaller board also tend to be less volatile, which is consistent with Wang (2012). Larger firms tend to have lower idiosyncratic risk. The results in this table confirm the findings from the univariate analysis i.e. that firms with a higher proportion of female directors on their board tend to be less risky. Despite the statistical significance, the economic impact appears modest. A 10% increase in female boardroom representation is associated with approximately 2% decrease in return standard deviation, 0.5 unit decrease in market model beta and 1.8% decrease in idiosyncratic risk measure.

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[9] We also estimate alternative models where the independent variables enter the model as lags and find that the results are not altered in any significant way.

7 The impact of risk on gender diversity

Given that reverse causality is an issue when estimating the impact of gender diversity on a firm's risk and that theoretical work such as Kanter (1977) suggests that a firm's risk may influence female boardroom participation, it is important to test whether corporate risk measures have any impact on board gender diversity (Hypothesis 2). This hypothesis is tested in two ways. First, we estimate the following model using pooled OLS with industry and year fixed effects.

$$\%\mathrm{FemaleDir}_{i,t} = \beta_0 + \mathbf{RISK_{i,t-1}\Pi} + \mathbf{CONTROL_{i,t-1}\Gamma} + \varepsilon_{i,t}$$

The matrix $\mathbf{RISK_{i,t}}$ represents the risk measures. Two specifications of this model are estimated. The first specification employs total risk as the key explanatory variables whereas the other specification employs its two components, systematic and idiosyncratic risks. Control variables in $\mathbf{CONTROL_{i,t}}$ include various board characteristics and firm characteristics. We also control for equity returns (Return) and female connection of male directors on board (%FemaleConnection). All explanatory variables are lagged by one period.

Second, we investigate the impact of risk on the actual appointment process through Probit regression using a dummy variable F_Appointed as the dependent variable. This dummy variable takes a value of one when a female director is appointed and is equal to zero when the appointed director is male. The sample is limited to those firm-year where at least one director is appointed.

$$\Pr(F\_Appointed_t = 1) = \Phi(\beta_0 + \mathbf{RISK}_{\boldsymbol{i,t-1}}\mathbf{\Pi} + \mathbf{CONTROL_{i,t-1}\Gamma} + \varepsilon_{i,t}) \qquad (4)$$

Here the probability of female director appointment is modeled as normally distributed. The cumulative probability (denoted by Φ) can be explained by risk measures $\mathbf{RISK_{i,t}}$ and a set of control variables which include board and firm characteristics. We also include the proportion of female directors in the previous period and two additional dummy variables as control variables – FemaleDeparture and MaleDeparture. FemaleDeparture (MaleDeparture) is equal to 1 when at least one female (male) director depart the firm in that period. Equity returns and %FemaleConnection are also included in these models.

[Table 4 about here]

The results for both OLS and Probit estimates are tabulated in Table 4. The OLS results in Columns 1-2 suggest that a firm's total risk measures in the previous period can explain the variation of female representation on the board and it is firms with lower systematic risk that tend to have more female directors. It is also found that there are positive links between female representation and board size and independence, which is consistent with our univariate analysis. Even after controlling for board size, large firms tend to have more female directors.

When looking at the actual appointment process, we still find a negative relation between total risk measure and the probability of female director appointment. However, the relationship is much weaker (only significant at 10% level). In addition, we cannot detect any statistically significant link between the risk components (systematic and idiosyncratic risk measures) and the gender outcome. Nonetheless, these results indicate that we cannot rule out the presence of reverse causality when investigating the impact of female boardroom participation on corporate risk. It is also important to note that the coefficients for board size and the proportion of independent directors are not significant in the Probit estimates; thus, we cannot conclude that these past board characteristics have any influence on appointment decisions. The significant coefficients found in the OLS results are likely to be due to these board characteristics being simultaneously influenced by other factors rather than the presence of causal relationship between these variables.

In this set of results, we also find some evidence of gender bias in director appointment process, which confirms prior evidence from Gregory-Smith et al. (2012) and Farrell and Hersch (2005). Firms are more likely to appoint female directors when other female directors depart the board in the previous period and that female directors are less likely to be appointed if there are already a large proportion of female directors on the board. The statistical significance of %FemaleConnection suggests that networking plays a role in the probability of board appointments for female directors. Overall, our results show that board appointment is not gender neutral and thus show some evidence of tokenism.

8 Female boardroom representation and risk variation within the firm

It is possible that the negative relationship found in our OLS results are driven by the endogenous relationship between risk measures and boardroom female representation. OLS utilizes both variations within and between the firms to identify its estimates under the assumption that both sets of variations are not correlated with the independent variables. Although we control for heterogeneity across industries and time periods, there may exist other variations between firms that influence both proportion of female directors on board and firm's risk, in which case the OLS estimates become inconsistent. An example is the influence of large shareholders. These large shareholders may sway the firm towards having a more conservative investment policy and at the same time put in place more female directors due to the belief that they are better at monitoring. It is also plausible that firms choose their level of gender diversity based on risk. Therefore, we revisit Hypothesis 1 using the fixed-effects estimator

The fixed-effects estimator (or the within estimator) exploits only within-firm variation to estimate the parameters. Intuitively, if the relation is not caused by differences between firms that are not controlled for, the change in board characteristics should be significantly related to the change in risk measures within the firm. To alleviate the concern of reverse causality, we rely on an exogenous instrumental variable that is commonly used in the literature, which is the proportion of male directors who sit on other boards on which there are female directors (%FemaleConnection). This instrumental variable is first introduced in Adams and Ferreira (2009) and has since been employed in many boardroom gender diversity studies including Gregory-Smith *et al.* (2012), Levi *et al.* (2013) and Upadhyay and Zeng (2014). For an instrumental variable to be valid, it must satisfy both exogeneity and identification assumptions; that is, it must not be correlated with the residual term (the part of risk measures that is not explained by any of the independent variables) at the same time can explain the variation in the endogeneous variable (which is %FemaleDir in this case). Adams and Ferreira suggest that their instrument is suitable based on the social connection argument; that is, if male directors on the board know more female directors, there is a higher likelihood that more female directors will be appointed. Thus, the identification assumption is satisfied. Although %FemaleConnection can be a proxy for industry effect and overall connectedness of the board, Adams and Ferreira mitigate these concerns by combining 2SLS with Fixed Effects Estimator and check for robustness by including the total number of external board seats (#ExtSeats) and total number of male external board seats (#MaleExtSeats) into the model. Through fixed effects and two-stage least squares with fixed effects, we obtain different results and we find some evidence that leads us to conclude that %FemaleConnection is not an adequate instrument when it is used to estimate the risk-gender relation.

[Table 5 about here]

In Table 5, we re-estimate Equation 1 using the fixed effects (FE) estimator (Columns 1-3) and two-stage least squares estimator with fixed effects (2SLS/FE) (Columns 4-6). The FE results show no statistically significant relationship between the proportion of female directors on board and any of the risk measures. To explain why the results differ to those from OLS estimation, we calculate the Hansen statistics to compare the estimations based on fixed effects and those based on random effects. The null hypothesis is that the random effects model, which uses both variations within and between firms, estimates the same set of parameters as the fixed effects model, which uses only variation within the firms. This is similar to the Durbin-Wu-Hausman specification test but is robust under heteroskedasticity. This null hypothesis is rejected in all three cases, suggesting that within-firm variations and between-firm variations produce statistically different sets of coefficient estimates. This leads us to conclude that the negative relationship found in the OLS results is driven by other heterogeneous factors between firms.

The 2SLS/FE results on the other hand show a negative relationship between female representation and systematic risk. If we assume that the instrumental variable is truly exogenous, we would conclude that the 2SLS/FE results are more reliable as both unobserved heterogeneity and reverse causality are controlled for. We check for the strength of identification by calculating the Kliebergen-Paap Wald statistic and obtain the value of 6.838, which reveals that the instrument is weak (it is only marginally higher than the 20% critical value of 6.66). In addition, we do not control for overall connectedness of the board and thus the instrument could still be correlated with the residuals. We therefore re-estimate the equation and include the proxy for overall connectedness into the model.

[Table 6 about here]

We control for overall connectedness of the board through two variables, total number of external board seats (#ExtSeats) and total number of external board seats held by male directors (#MaleExtSeats). These two measures are highly correlated with a correlation coefficient of 0.96. Surprisingly, we find that using these two similar proxies of board connectedness lead to two different conclusions. The results are tabulated in Table 6. On one hand, when we use #ExtSeats (Columns 1-4) we do not find any significant relationship between female representation and risk measures and the Kleibergan-Papp statistic suggests that the instrument is weak. On the other hand, we find that the instrument is very strong (Kleibergen-Papp statistic equals to 88.78 compared to the 10% critical value of 16.38) and that the relationship is significantly negative when we use #MaleExtSeats as a proxy for board connectedness (Columns

5-8). Although the coefficients for %FemaleDir are not significant in Columns 2-4, they are negative and very large in magnitude, suggesting that the estimator has a negative bias in finite sample[10], which is in the same direction as the bias in our OLS results. Thus, even if the instrument was exogenous, these results cannot be relied upon. Moreover, finding that the strength of the instrumental variable depends on the included variable casts further doubts on whether the instrument is valid. These findings motive us to conduct futher tests in regards to the exogeneity of the instrument.

The fixed effect estimator relies on the strict exogeneity assumption; that is, the exogenous variable must not be correlated with the residuals in both the contemporaneous period and any other period. Therefore, to check whether the instrument satisfies the strict exogenity assumption, we conduct a test of strict exogeneity according to Wooldridge (2010). Intuitively, if a variable is strictly exogenous, its future values should not be correlated with the residuals from the fixed effect estimation. This effectively rules out feedback from risk to future values of the "exogenous" variable. Therefore, we use FE to estimate the following model.

$$\mathrm{Risk}_{i,t} = \beta_0 + \beta_1 \%\mathrm{FemaleDir}_{i,t} + \mathbf{CONTROL_{i,t}\Gamma} + \gamma_i z_{i,t+1} + \alpha_i + \eta_{i,t} \qquad (2)$$

Here, $z_{i,t+1}$ represents the future value of the variable we suspect to be endogenous. The results (displayed in Table 7) show that the residuals from the Fixed Effect regression can explain the future value of %FemaleConnection and thus verify our suspicion that the instrumental variable is endogenous[11]. Surprisingly, we find no evidence that the future proportion of female directors on board can be explained by the current value of risk measures after controlling for the current value of board and firm characteristics; thus, if all the other explanatory variables are exogeneous then the fixed effect results are reliable and there is no relationship between female boardroom representation and risk measures. However, we also find that board size is not a strictly exogenous variable as past values of risk can influence current value of board structure. Theoretical work suggests there are factors that can be driven by past performance and in turn can influence the optimal board structure (see for example, Raheja (2005) and Harris and Raviv (2008)). These factors include the level of communication among board members and firm's profit potential. Wintoki et al. (2012) shows the impact of this dynamic two-way causality on the estimated relation between board structure and firm performance. As firms choose projects according to their net present value, firm performance is then evaluated based not only on profitability but also on risk. Thus, the same argument for the dynamic relation between board structure and profitability can be applied to this case where the effect of board structure on risk is evaluated. Not only does this dynamic relation affect board characteristics, it can also affect other control variables[12]. Fama and Jensen (1982) suggest that characteristics of organizations contribute to their survival, implying that firms adjust their characteristics to optimize their values in order to survive. The signals used to optimize future values would be from past values which

[10] The two-stage least squares estimator is consistent but biased in the finite sample; that is, the bias converges towards zero when the sample size is large. When the instrumental variable is weak, the convergence can occur at a slower rate.
[11] Table 7 only shows the results when Ln(TotalRisk) is used as the risk measures. The results from using SysRisk and Ln(IdioRisk) lead to the same conclusion.
[12] We find past values of risk to affect other control variables such as firm size, market-to-book ratio and return on assets (results not tabulated).

are influenced by both their past profitability and past risk. Thus, firm characteristics such as size and leverage can also be considered endogenous. Therefore, treating the control variables as if they are exogenous means that the estimated coefficients, including the coefficient for %FemaleDir, are inconsistent.

[Table 7 about here]

Dynamic Panel GMM estimator treats all dependent variables as endogenous and uses their lags as instrument variables. This methodology is developed over a series of studies including Anderson and Hsiao (1982), Holtz-Eakin et al. (1988) and Arellano and Bond (1991). The variant implemented here is suggested by Arellano and Bover (1995) and Blundell and Bond (1998). Past values of risk measures are included in the model to reduce their impact on the coefficient estimates. Intuitively, if past risk measures can affect their current values as well as current values of board and firm characteristics, then these past values belong in the model. The effect of other time-invariant heterogeneity is removed through first differencing; then, all independent variables are treated as endogenous and the past values of these independent variables beyond included lags are used as instrument variables. As first differencing can reduce the variation in all the variables, cause weak identification problem and amplify the measurement errors, we employs the dynamic panel system GMM estimation by simultaneously estimate the model both in first-differences and in levels. Lagged variables at levels are used as instrumental variables in the differenced equation whereas lagged differenced variables are used as instruments in the level equation (These issues are discussed in Griliches and Hausman (1986), Beck et al. (2000), and Wintoki et al. (2012)).

The results from the dynamic panel system GMM estimation are reported in Table 8. There is no evidence in this table that supports the notion that the presence of female directors reduces equity risk. The coefficients are also much smaller in magnitude compared to prior estimations. In this table we also report two sets of specification tests. First, we test for first and second order serial correlations in the residuals from the differenced equation. We fail to reject the null hypothesis of no second order serial correlation for all models. The second test is Hansen test for overidentifying restriction. The null hypothesis is that all instrument variables are jointly exogenous. We reject this null hypothesis for the models in which CEO characteristics are not controlled for (models 1, 3 and 5) whereas in models 2, 4 and 6 we find no evidence that the exogeneity assumption is violated. Therefore, the results are more reliable when we control for CEO remuneration sensitivity, tenure and cash compensation. Nonetheless, the estimated coefficients from both sets of estimations are similar and, in particular, we can confirm that, after controlling for heterogeneity between firms, the negative relationship is driven by the instrument and thus is likely to be spurious.

[Table 8 about here]

9 Alternative Identification Strategy – DID Matching Estimator

There is a possibility that the failure to detect any relationship gender-risk relationship is due to the proportion of female directors on board not being an appropriate measure. Figure 2 shows a line plot of proportion of female directors on board over time. Here we observe that the changes in female boardroom representation come from two sources of variation. First is the increase in number of female directors on board and second is the decrease in overall board size. It is evident that an average board decreases in size at a faster rate than the increment in the number of female directors. This phenomenon can also be illustrated in Figure 3, which plots the percentage of firms that changes their board size, number of female directors and proportion of female directors over time. What can be observed here is that the change in the proportion of female directors on board is mainly driven by the change in board size whereas the addition and termination of female directors constitute changes of about 10% of firms each year. Therefore, in this section we explore an alternative identification strategy, a difference-in-difference matching estimator.

The difference-in-difference matching estimator (DDM) is a combination of the difference-in-difference estimator (DID) and the matching estimator. DID exploits the "parallel trends" assumption; that is, two similar firms are likely to follow the same change without any treatment. Therefore, if the treatment has any impact on the outcome, the impact should be reflected in the difference between the changes of the two firms (Roberts & Whited 2011). The DID estimator can be implemented by estimating the following equation.

$$\begin{aligned}\mathrm{Risk}_{i,t} = {} & \beta_0 + \beta_1 \mathrm{FemaleAppointed}_{i,t} + \beta_2 \mathrm{post}_{i,t} \\ & + \beta_3 \mathrm{FemaleAppointed}_{i,t} \times \mathrm{post}_{i,t} + \mathbf{CONTROL_{i,t}\Gamma} + \varepsilon_{i,t}\end{aligned} \tag{3}$$

where $\mathrm{FemaleAppointed}_{i,t}$ is a dummy variable which takes the value of one when the firm is in the treatment group and zero when the firm is in the control group. Another dummy variable, $\mathrm{post}_{i,t}$, takes the value of zero in the time period before the treatment and one in the post-treatment period. Other board, firm and CEO characteristics are also included as control variables.

Often, change in board structure reflects other changes in the organization such as corporate restructuring, merger and acquisition, or a large shift in strategy. All these changes are likely to have impact on corporate risk. Therefore, we carefully select our treatment group such that it contains only 'exogenous' changes in board gender composition. To be included in the treatment group, the firm must only appoint one female director in that year to replace a departing male director. In addition, we require that the departing director must be older than 60 years. With these stringent criteria, we are able to identify 180 exogenous female director appointments for our treatment group. These are matched with the control observations, which are firms that do not experience any change in board composition (these firms do not appoint any new director nor do they have any director departing their boards in the treatment year). Our matching criteria require that the firms must be in the same industry and year. Additionally, their size, as measured by the level of TotalAssets must be within 10% of those of the treatment observations. We are able to match 130 observations in the treatment group with those in the control group. According to the results in Table 9, we find that the average difference in risk measures across two periods of firms with female directors appointments is not statistically different from those of firms that do not experience any change in board structure (we fail to reject the null hypothesis that the coefficients for $\mathrm{FemaleAppointed} \times \mathrm{Treated}$ are statistically different from zero).

[Table 9 about here]

Overall, although we find in the sample that on average firms with a larger proportion of female directors on board have lower equity risk measures, the empirical evidence does not lend any support to the notion that a more gender-balanced board leads to lower firm risk. However, the risk measures employed so far in this study are based on stock price information. It is possible that investors do not perceive the variation in gender diversity to have any impact on stock price and thus no linkage can be established. These risk measures, similar to firm performance measures, are also functions of many other factors than board, CEO and firm characteristics. The relationship, even if it exists, may be difficult to detect (Hermalin & Weisbach 2003). The limitations of stock price information as a proxy for risk motivate us to consider corporate risk-taking actions that are reflected in accounting information.

10 Gender diversity, CEO incentives and firm's risk-taking policy

Although there is no evidence in the data that links boardroom gender diversity to equity risk, the gender difference in risk appetite may be reflected at the policy level. That is, a more gender-balanced board may act differently from a male-dominated board in terms of risk-taking behaviors that cannot be detected in stock volatility. Therefore, we explore various corporate risk-taking policies and investigate their relationship to boardroom gender diversity.

One function of the board is to set the remuneration structure to align CEO's incentives with the company's goals, which involves the level of risk appetite. If female CEOs are different from male CEOs in term of risk-taking behaviors, the effect may be revealed in the compensation structure. Therefore, we investigate the link between gender diversity and CEO incentives (Hypothesis 4). The relation is estimated through the following equation.

$$\text{CEO Incentive} = \beta_0 + \beta_1 \%\text{FemaleDir}_{i,t-1} + \mathbf{CONTROL_{i,t-1}\Gamma} + \varepsilon_{i,t}$$

CEO incentives are proxied by Ln(1+Vega) and Ln(1+Delta), which measure the sensitivity of compensation to the outcomes. Delta measures the sensitivity of compensation to the value-generating outcome (change in compensation per 1% increase in stock return) whereas vega measures the sensitivity of compensation to risk taking (change in compensation per 0.01 unit increase in stock return standard deviation). We also investigate the ratio of vega and delta which can be interpreted as the trade-off between risk-taking incentives and value-generating incentives. The control variables include board size, board independence, CEO tenure, CEO interlock, firm size, market-to-book ratio, return on asset and total risk. We hypothesize that incentives are set at the beginning of the period; therefore, all explanatory variables enter the equation as lags. We also investigate the relation between gender diversity and various corporate risk-taking policies (Hypothesis 5). This is equivalent to estimating the following equation.

$$\text{RiskTaking}_{i,t} = \beta_0 + \beta_1 \%\text{FemaleDir}_{i,t} + \mathbf{CONTROL_{i,t}\Gamma} + \varepsilon_{i,t}$$

Three sets of risk-taking policies are investigated: investment, debt and diversification policies. The more firms invest in research and development (R&D), the more they are considered risky, particularly when they also have lower investment in properties, plants and equipment (CapEx). Having high leverage is also considered a risky behavior. Leverage is measured by debt-to-equity ratio. Lastly, a narrow range of revenue sources means a firm's turnover is likely to be more sensitive to economic conditions. Thus, more diversified firms are considered less risky. We use the logarithm of the number of business segments, Ln(#Segments), and the Herfindahl-Hirschman Index of revenue concentration to measure the degree of diversification.

Control variables for these estimation closely follow prior literature (see for example Coles et al. (2006)).

[Table 10 about here]

The results are shown in Table 10. In Columns 1-2, we cannot reject the null hypothesis that there is no relationship between value generating component (Delta) or risk inducing component (Vega) of the CEO compensation (Hypothesis 4). We also explore the relationship between CEO compensation and the proportion of female directors on compensation committee and find no evidence that female representation can affect compensation.

The rest of Table 10 shows the estimated relation between gender diversity and various risk-taking policy meaures. Female boardroom representation cannot explain the variation in any risk-taking policy apart from the level of capital expenditure. The coefficient for %FemaleDir is 0.062, which is modest – a 10% increase in female representation is associated with 0.62% decrease in the proportion of capital expenditure scaled by total assets. As the average level of capital expenditure is 11%, this translates to approximately 5% increase in the level of capital expenditure. Overall, female boardroom representation does not appear to have much impact on corporate risk taking behaviours.

11 Robustness

For OLS and Fixed Effects specifications (Table 3 and Columns 1-3 of Table 5), we replace the proportion of female directors variable (%FemaleDir) with two variables, proportion of female executive directors and proportion of female non-executive directors, as the former group is also involved in managing the firm and thus has a different principal-agent relationship from the latter. We only find a significant and negative relationship between risk measures and the proportion of female non-executive directors. However, this relationship also disappears when estimated using Fixed Effects.

As the results from DDM estimator (Table 9) can be sensitive to how the observations are matched, we explore alternative matching criteria and matching distance. In addition to size, industry and year, we match the treatment observations with those which also have similar risk profiles (as measured by total return standard deviation or market model beta). We also adjust matching distance to 20% and 5%, instead of 10% in Table 9. Another matching method employed is Propensity Score Matching (PSM). We match firms in the treatment groups with those that have the same propensity to appoint a female director but instead appoint a male director. The propensity of female being appointed is estimated as per Models 3 and 4 on Table 4. The matching distances employed for PSM is 2%, 1% and 0.05%. All specifications confirm our results that female director appointment has no impact on corporate risk measures.

In Columns 1-2 of Table 10, we obtain the same findings using Delta and Vega instead of Ln(1+Delta) and Ln(1+Vega). Using the proportion of female directors on the compensation committee instead of the whole board also leads to the same conclusion.

12 Conclusion, policy discussion and limitations

Similar to those in other countries, US firms are under pressure, both regulatory and social, to embrace gender diversity in the boardroom. Although there is no mandatory gender quota, the SEC disclosure rule and pressure from stakeholders is likely to lead to US firms appointing more female directors over time. As the level of female participation on boards of directors increases, the current literature provides only limited and inconsistent evidence regarding the potential economic impact that higher female representation might bring to the firm. Drawing in 17 years of data of more than 2,000 firms, our study contributes to the debate by investigating the relationship between boardroom gender diversity and corporate equity risk. Our results show that although firms with more female directors tend to have lower equity risk, there is no robust evidence in the data that can lead to the conclusion that gender diversity influences a firm's equity risk or vice versa. The negative relationship disappears when we investigate the variation within the firm or when we evaluate the impact of female director appointment on risk measures. In addition, firm policies that concern risk taking are largely not affected by female boardroom representation. It is likely that the discovered relationship between gender diversity and risk through the Pooled OLS estimator is driven by other heterogeneous firm-specific factors that influence both gender composition of the board and the firm's risk measures, and that what is observed in the data may be the equilibrium state of gender diversity and risk as suggested by Hermalin and Weisbach (2003). In addition, like most of the studies, we only look at a limit range of government mechanisms, it is possible that the increase (decrease) of female boardroom representation as a monitoring mechanism may lead to a decrease (increase) in other mechanisms and thus we do not observe a change in outcomes.

The advocacy for gender diversity on corporate boards is driven by a sense of both fairness and good business. The lack of strong evidence on the relationship between gender diversity and risk does not mean that gender diversity in itself is not desirable. The evidence found in our results, as well as in those of Farrell and Hersch (2005) and Gregory-Smith et al. (2012), suggests the existence of gender discrimination in the director appointment process and this issue is potentially more appropriate as the area of focus for policymakers. However, a clear link between gender diversity and risk, similar to performance, cannot be established. As a result, it cannot be concluded with confidence that regulating female representation on corporate boards will affect firms' level of risk. Our results, combined with recent findings on gender-performance relation, mean there is no clear evidence on the link between gender diversity and firm value. However, we cannot reject the notion that firm's existing board characteristics are already optimal considering firm's internal and external environments. As such, regulations in the form of a diversity quota could lead to deviation from optimality and may cause an adverse impact on a firm's value, as shown by Ahern and Dittmar (2012). If this was the case, we argue that regulations around diversity disclosure and diversity demand from stakeholders, as implemented in the United States, are more appropriate as vehicles to encourage firms to bring gender diversity to their boardrooms.

This study only investigates the diversity-risk relationship from the perspective of equity holders; in particular, we look at risk in equity returns and corporate risk-taking actions. Gender diversity may impact corporate risk in other ways. One obvious area for future research is to look at risk concerning other stakeholders such as debt holders or taxpayers. It is also imperative to investigate the interaction between board diversity and other governance mechanisms. Although managerial incentives are considered in this study, other mechanism such as block holding or regulations may also impact risk taking. As we seek to understand how corporate governance affects firm value, influenced by both return and risk, this paper aims to identify risk as an outcome variable of interest, particularly in the debate on boardroom gender diversity.

References

Adams, R., Ferreira, D., 2004. Diversity and incentives in teams: Evidence from corporate boards. Working paper from Stockholm School of Economics

Adams, R., Ragunathan, V., 2013. Lehman Sisters.

Adams, R.B., Ferreira, D., 2009. Women in the boardroom and their impact on governance and performance. Journal of Financial Economics 94, 291-309

Adams, R.B., Funk, P., 2012. Beyond the glass ceiling: Does gender matter? Management Science 58, 219-235

Ahern, K.R., Dittmar, A.K., 2012. The changing of the boards: The impact on firm valuation of mandated female board representation. The Quarterly Journal of Economics 127, 137-197

Anderson, T.W., Hsiao, C., 1982. Formulation and estimation of dynamic models using panel data. Journal of Econometrics 18, 47-82

Arellano, M., Bond, S., 1991. Some tests of specification for panel data: Monte Carlo evidence and an application to employment equations. The Review of Economic Studies 58, 277-297

Arellano, M., Bover, O., 1995. Another look at the instrumental variable estimation of error-components models. Journal of Econometrics 68, 29-51

Barber, B.M., Odean, T., 2001. Boys will be boys: Gender, overconfidence, and common stock investment. The Quarterly Journal of Economics 116, 261-292

Beck, T., Levine, R., Loayza, N., 2000. Finance and the sources of growth. Journal of Financial Economics 58, 261-300

Berger, A., Kick, T., Schaeck, K., 2012. Executive board composition and bank risk taking. Bangor Business School Research Paper

Bernasek, A., Shwiff, S., 2001. Gender, risk, and retirement. Journal of Economic Issues, 345-356

Bhagat, S., Black, B.S., 1999. The uncertain relationship between board composition and firm performance. Business Lawyer 54, 921-963

Blundell, R., Bond, S., 1998. Initial conditions and moment restrictions in dynamic panel data models. Journal of Econometrics 87, 115-143

Burgess, Z., Tharenou, P., 2002. Women Board Directors: Characteristics of the Few. Journal of Business Ethics 37, 39-49

Byrnes, J.P., Miller, D.C., Schafer, W.D., 1999. Gender differences in risk taking: A meta-analysis. Psychological bulletin 125, 367

Campbell, K., Minguez-Vera, A., 2008. Gender diversity in the boardroom and firm financial performance. Journal of Business Ethics 83, 435-451

Carter, D.A., DSouza, F., Simkins, B.J., Simpson, W.G., 2010. The gender and ethnic diversity of US boards and board committees and firm financial performance. Corporate Governance: An International Review 18, 396-414

Carter, D.A., Simkins, B.J., Simpson, W.G., 2003. Corporate governance, board diversity, and firm value. Financial Review 38, 33-53

Cheng, S., 2008. Board size and the variability of corporate performance. Journal of Financial Economics 87, 157-176

Coles, J.L., Daniel, N.D., Naveen, L., 2006. Managerial incentives and risk-taking. Journal of Financial Economics 79, 431-468

Coles, J.L., Daniel, N.D., Naveen, L., 2008. Boards: Does one size fit all? Journal of

Financial Economics 87, 329-356
Croson, R., Gneezy, U., 2009. Gender differences in preferences. Journal of Economic Literature, 448-474
Erhardt, N.L., Werbel, J.D., Shrader, C.B., 2003. Board of director diversity and firm financial performance. Corporate Governance: An International Review 11, 102-111
Fairfax, L.M., 2011. Board diversity revisited: New rationale, same old story? North Carolina Law Review 89, 854-885
Fama, E.F., 1980. Agency problems and the theory of the firm. Journal of Political Economy 88, 288-307
Fama, E.F., Jensen, M.C., 1982. Agency problems and residual claims. Journal of Law & Economics 26, 327-349
Farrell, K.A., Hersch, P.L., 2005. Additions to corporate boards: the effect of gender. Journal of Corporate Finance 11, 85-106
Fehr-Duda, H., de Gennaro, M., Schubert, R., 2006. Gender, Financial Risk, and Probability Weights. Theory and Decision 60, 283-313
Gregory-Smith, I., Main, B.G., O'Reilly III, C.A., 2012. Appointments, Pay and Performance in UK boardrooms by Gender.
Griliches, Z., Hausman, J.A., 1986. Errors in variables in panel data. Journal of Econometrics 31, 93-118
Harris, M., Raviv, A., 2008. A Theory of Board Control and Size. Review of Financial Studies 21, 1797-1832
Hermalin, B.E., Weisbach, M.S., 2003. Boards of directors as an endogenously determined institution: a survey of the economic literature. Federal Reserve Bank of New York Economic Policy Review 9, 7-26
Hillman, A.J., Cannella, A.A., Paetzold, R.L., 2000. The Resource Dependence Role of Corporate Directors: Strategic Adaptation of Board Composition in Response to Environmental Change. Journal of Management Studies 37, 235-256
Hillman, A.J., Shropshire, C., Cannella, A.A., 2007. Organizational predictors of women on corporate boards. Academy of Management Journal 50, 941-952
Hinz, R.P., McCarthy, D.D., Turner, J.A., 1997. Are women conservative investors? Gender differences in participant-directed pension investments. In: Gordon MS, Mitchell OS & Twinney MM (eds.)University of Pennsylvania Press, Philadelphia, PA.
Holmström, B., 1999. Managerial incentive problems: A dynamic perspective. The Review of Economic Studies 66, 169-182
Holtz-Eakin, D., Newey, W., Rosen, H.S., 1988. Estimating vector autoregressions with panel data. Econometrica: Journal of the Econometric Society, 1371-1395
Kang, H., Cheng, M., Gray, S.J., 2007. Corporate governance and board composition: diversity and independence of Australian boards. Corporate Governance: An International Review 15, 194-207
Kanter, R.M., 1977. Men and women of the corporation. Basic Books, New York, NY.
Kaplan, S.N., Klebanov, M.M., Sorensen, M., 2012. Which CEO characteristics and abilities matter? The Journal of Finance 67, 973-1007
Leland, H.E., 1998. Agency Costs, Risk Management, and Capital Structure. The Journal of Finance 53, 1213-1243
Levi, M., Li, K., Zhang, F., 2013. Mergers and acquisitions: The role of gender. Available at SSRN 1123735
Levin, I.P., Snyder, M.A., Chapman, D.P., 1988. The interaction of experiential and situational factors and gender in a simulated risky decision-making task. The Journal of Psychology 122, 173-181
Linck, J.S., Netter, J.M., Yang, T., 2008. The determinants of board structure. Journal of Financial Economics 87, 308-328
Nakano, M., Nguyen, P., 2012. Board size and corporate risk taking: further evidence from Japan. Corporate Governance: An International Review 20, 369-387
Pathan, S., 2009. Strong boards, CEO power and bank risk-taking. Journal of Banking & Finance 33, 1340-1350

Pelled, L.H., Eisenhardt, K.M., Xin, K.R., 1999. Exploring the black box: An analysis of work group diversity, conflict and performance. Administrative science quarterly 44, 1-28

Powell, M., Ansic, D., 1997. Gender differences in risk behaviour in financial decision-making: An experimental analysis. Journal of Economic Psychology 18, 605-628

Raheja, C.G., 2005. Determinants of board size and composition: A theory of corporate boards. The Journal of Financial and Quantitative Analysis 40, 283-306

Roberts, M.R., Whited, T.M., 2011. Endogeneity in Empirical Corporate Finance. SSRN Electronic Journal

Rose, C., 2007. Does female board representation influence firm performance? The Danish evidence. Corporate Governance: An International Review 15, 404-413

Sunden, A.E., Surette, B.J., 1998. Gender differences in the allocation of assets in retirement savings plans. American Economic Review 88, 207-211

Upadhyay, A., Zeng, H., 2014. Gender and ethnic diversity on boards and corporate information environment. Journal of Business Research

Wang, C.-J., 2012. Board size and firm risk-taking. Review of Quantitative Finance and Accounting 38, 519-542

Westphal, J.D., 1999. Collaboration in the boardroom: Behavioral and performance consequences of CEO-board social ties. Academy of Management Journal 42, 7-24

Wilson, N., Altanlar, A., 2011. Director characteristics, gender balance and insolvency risk: an empirical study. Gender Balance and Insolvency Risk: An Empirical Study (September 22, 2009)

Wintoki, M.B., Linck, J.S., Netter, J.M., 2012. Endogeneity and the dynamics of internal corporate governance. Journal of Financial Economics 105, 581-606

Wooldridge, J.M., 2010. Econometric analysis of cross section and panel data. MIT Press.

Wright, P., Ferris, S.P., Sarin, A., Awasthi, V., 1996. Impact of Corporate Insider, Blockholder, and Institutional Equity Ownership on Firm Risk Taking. The Academy of Management Journal 39, 441-463

Figure 1: Hypothesized relationship between gender diversity, CEO compensation, corporate risk-taking policies and risk measures

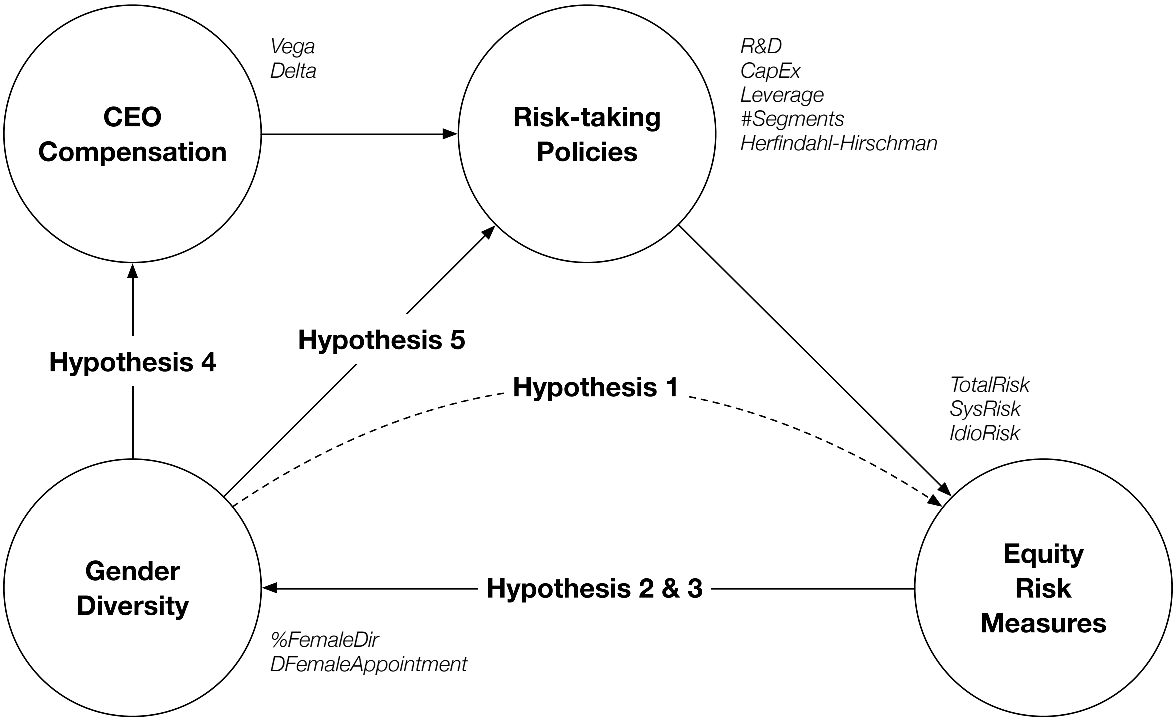

Figure 2: Board characteristics by year

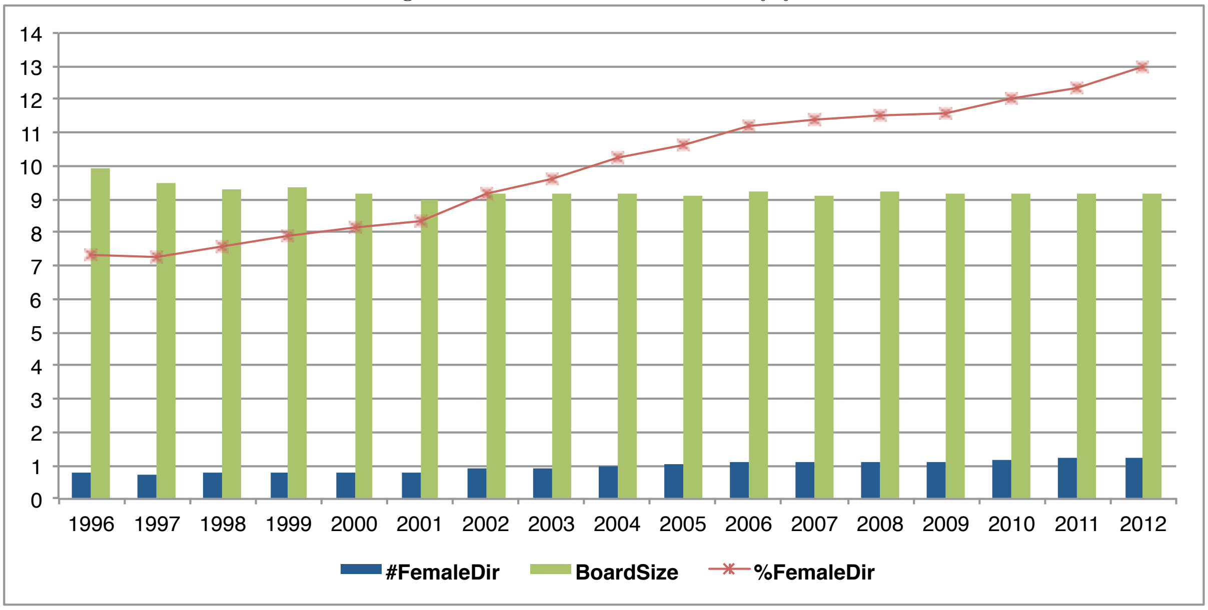

Figure 3: Percentage of firms that change their board characteristics by year

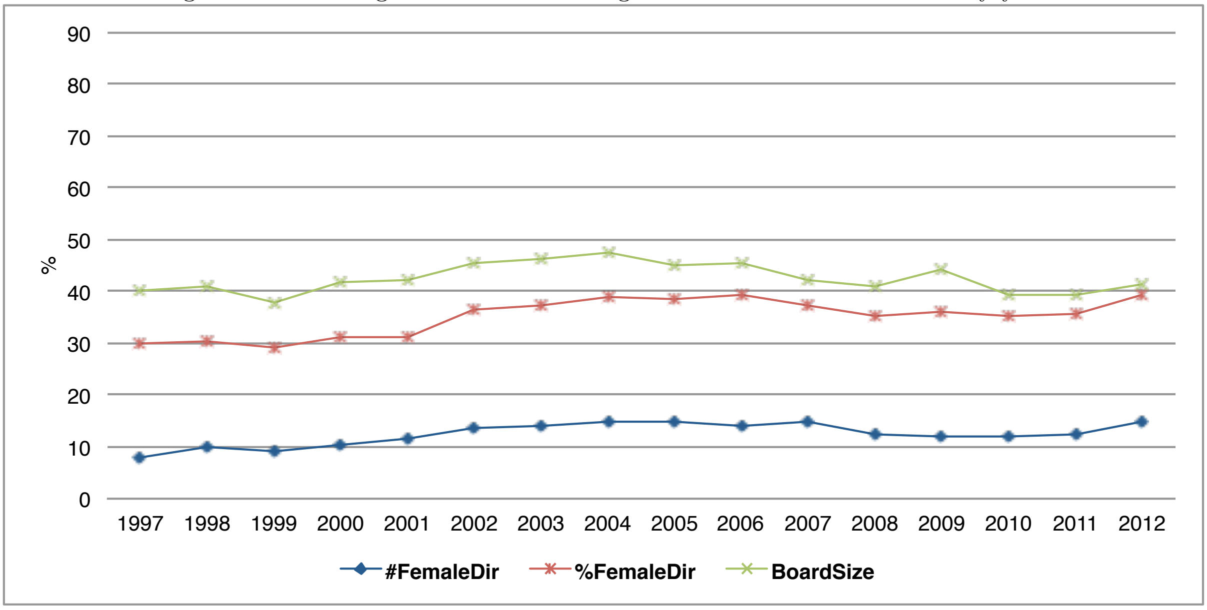

Table 1: Summary Statistics

The full sample comprises 18,395 observations (firm-year) from 2,429 firms between 1996-2012. Board characteristics are obtained from the RiskMetrics database. DFemaleDir is a dummy variable being equal to 1 when there is at least one female director on board and zero otherwise. #FemaleDir and %FemaleDir represent the number and proportion of female directors on board respectively. Firm characteristics are obtained from Compustat. Risk measures are calculated from daily prices obtained from the Center for Research in Security Prices. TotalRisk is the standard deviation of daily stock returns. SysRisk and IdioRisk are the market return coefficient and the standard deviation of the residuals from the market model regression. CRSP NYSE/Amex/NASDAQ equally-weighted market index is used as the market portfolio.

Variable	N	Mean	StDev	p25	p50	p75
Panel A: Board Characteristics						
DFemaleDir	18395	0.61	0.49	0	1	1
#FemaleDir	18395	0.92	0.93	0	1	1
%FemaleDir	18395	0.10	0.09	0	0.10	0.14
BoardSize	18395	9.01	2.37	7	9	10
%IndepDir	18395	0.69	0.18	0.57	0.71	0.83
Panel B: Firm Characteristics						
R&D	18395	0.08	1.84	0.00	0.00	0.05
CapEx	18395	0.11	3.28	0.02	0.04	0.07
Leverage	18395	0.22	0.19	0.06	0.21	0.33
#Segments	18395	2.89	2.05	1	3	4
Herfindahl	18395	0.71	0.38	0.45	0.73	1.00
ROA	18395	0.04	0.18	0.02	0.05	0.09
MTB	18395	2.05	1.66	1.23	1.61	2.29
TotalAssets ($mil.)	18395	5735	17224	544	1336	3966
Panel C: Risk Measures						
TotalRisk	18395	0.45	0.22	0.30	0.40	0.54
SysRisk	18395	1.29	0.65	0.85	1.20	1.61
IdioRisk	18395	0.39	0.20	0.26	0.34	0.47
Panel D: CEO Characteristics						
Vega ('000s)	13778	155	309	22	63	165
Delta ('000s)	13778	1249	12252	95	245	646
CashComp ('000s)	13778	1273	1619	605	924	1434
CEOTenure	13778	6.93	7.52	2	5	10

Table 2: Key variables by number of female directors

Variable	Number of female directors 0	1	2	3	4-7	>0
Panel A: Board Characteristics						
BoardSize	7.67	9.32	10.51	11.16	12.26	9.86
%IndepDir	0.64	0.70	0.74	0.77	0.76	0.72
Panel B: Firm Characteristics						
R&D	0.13	0.06	0.04	0.02	0.02	0.05
CapEx	0.18	0.07	0.06	0.04	0.05	0.06
Leverage	0.20	0.22	0.24	0.24	0.27	0.23
#Segments	2.49	2.90	3.46	3.90	3.80	3.15
Herfindahl	0.76	0.71	0.63	0.62	0.64	0.68
ROA	0.02	0.05	0.05	0.06	0.06	0.05
MTB	2.09	2.01	2.04	1.98	1.91	2.02
TotalAssets ($mil.)	1631	5368	11180	19701	18723	8321
Panel C: Risk Measures						
TotalRisk	0.52	0.43	0.39	0.36	0.36	0.41
SysRisk	1.44	1.24	1.14	1.03	1.02	1.19
IdioRisk	0.45	0.37	0.33	0.31	0.30	0.35
#Obs.	7111	6906	3426	712	240	11284

Table 3: Risk measures on gender diversity (OLS)

This table reports the OLS regression results of risk measures on the proprotion of female directors on board. Within-cluster heteroskedasticity and serial correlation robust standard errors are reported in parentheses. All specifications include industry (based on two-digit NAICS code) and year fixed effects. Intercepts not reported. * p < 0.10, ** p < 0.05, *** p < 0.01.

	Ln(TotalRisk)		SysRisk		Ln(IdioRisk)	
	(1)	(2)	(3)	(4)	(5)	(6)
FemaleDir	−0.207***	−0.217***	−0.476***	−0.521***	−0.175***	−0.179***
	(0.056)	(0.056)	(0.084)	(0.093)	(0.059)	(0.057)
BoardSize	−0.026***	−0.026***	−0.045***	−0.045***	−0.025***	−0.025***
	(0.002)	(0.003)	(0.004)	(0.004)	(0.002)	(0.003)
IndepDir	−0.077***	−0.062*	−0.083*	−0.068	−0.073**	−0.058*
	(0.029)	(0.032)	(0.050)	(0.056)	(0.029)	(0.032)
Ln(TotalAssets)	−0.071***	−0.066***	−0.003	0.009	−0.086***	−0.081***
	(0.004)	(0.005)	(0.007)	(0.009)	(0.004)	(0.005)
MTB	0.008***	0.008***	0.055***	0.056***	0.006**	0.005**
	(0.002)	(0.003)	(0.006)	(0.007)	(0.002)	(0.003)
ROA	−0.512***	−0.561***	−0.947***	−0.962***	−0.502***	−0.549***
	(0.056)	(0.086)	(0.084)	(0.132)	(0.057)	(0.086)
R&D	0.002	0.011	−0.001	0.002	0.002	0.014
	(0.002)	(0.012)	(0.003)	(0.019)	(0.002)	(0.013)
CapEx	0.001***	−0.010	0.004***	−0.001	0.001**	−0.012
	(0.000)	(0.012)	(0.001)	(0.019)	(0.001)	(0.013)
Leverage	0.082***	0.019	−0.150***	−0.225***	0.114***	0.052
	(0.029)	(0.033)	(0.045)	(0.056)	(0.030)	(0.034)
Vega ($'000)		−0.000		−0.000***		−0.000
		(0.000)		(0.000)		(0.000)
Delta ($'000)		0.000		0.000		0.000
		(0.000)		(0.000)		(0.000)
CEOTenure		−0.000		0.001		−0.000
		(0.001)		(0.001)		(0.001)
CashComp ($'000)		0.000		−0.000		0.000
		(0.000)		(0.000)		(0.000)
Constant	−0.368***	−0.498***	1.531***	1.104***	−0.344***	−0.398***
	(0.083)	(0.141)	(0.124)	(0.176)	(0.083)	(0.149)
#Obs.	18395	13778	18395	13778	18395	13778
R^2	0.532	0.544	0.266	0.274	0.546	0.543

Table 4: Determinants of gender in director appointments

Columns 1-2 report OLS regression of the proportion of female directors on risk measures and control variables. Columns 3-4 report Probit regressions of the director appointment process. F_Appointed is a dummy variable which is equal to one when there is at least one female director appointed to the board in that firm-year. Within-cluster heteroskedasticity and serial correlation robust standard errors are reported in parentheses. All specifications include industry (based on two-digit NAICS code) and year fixed effects. Intercepts not reported. * p < 0.10, ** p < 0.05, *** p < 0.01.

	%FemaleDir		F_Appointed	
	(1)	(2)	(3)	(4)
Ln(TotalRisk)	−0.014***		−0.109*	
	(0.005)		(0.057)	
SysRisk		−0.009***		−0.063
		(0.002)		(0.038)
Ln(IdioRisk)		−0.002		−0.027
		(0.006)		(0.070)
BoardSize	0.005***	0.005***	0.011	0.011
	(0.001)	(0.001)	(0.009)	(0.009)
%IndepDir	0.064***	0.064***	0.029	0.028
	(0.009)	(0.009)	(0.110)	(0.110)
Ln(TotalAssets)	0.006***	0.007***	0.090***	0.094***
	(0.001)	(0.001)	(0.016)	(0.016)
MTB	0.001*	0.002**	0.024**	0.026**
	(0.001)	(0.001)	(0.011)	(0.011)
Leverage	−0.004	−0.006	−0.134	−0.145
	(0.009)	(0.009)	(0.101)	(0.102)
R&D	0.001	0.001	0.055*	0.053
	(0.002)	(0.002)	(0.033)	(0.033)
CapEx	−0.001	−0.001	−0.197	−0.185
	(0.002)	(0.002)	(0.120)	(0.119)
ROA	0.004	0.002	0.142	0.125
	(0.007)	(0.007)	(0.158)	(0.158)
Return	−0.004**	−0.003*	0.064	0.068
	(0.002)	(0.002)	(0.045)	(0.045)
%FemaleCon	0.057***	0.057***	0.209**	0.211**
	(0.008)	(0.008)	(0.089)	(0.089)
FemaleDeparture			0.729***	0.729***
			(0.057)	(0.057)
MaleDeparture			−0.049	−0.050
			(0.035)	(0.035)
%FemaleDir			−2.452***	−2.465***
			(0.295)	(0.294)
N	15489	15489	7886	7886
R^2 $[Pseudo-R^2]$	0.240	0.241	[0.060]	[0.060]

Table 5: Risk Measures on Gender Diversity (Fixed Effect and Fixed Effect 2SLS)

This table reports the regression results of risk measures on the proportion of female directors on board. Columns 1-3 report the Fixed Effect Estimator results. Also reported is the Hansen chi-square statistics testing the null hypothesis that the parameters estimated from Fixed and Random Effect estimators are statistically equivalent. Columns 5-7 report the results from the Fixed Effect 2SLS estimation where %FemaleDir is treated as endogenous (the first-stage regression is displayed in Column 4). Kleibergen-Paap rk Wald statistics under the null hypothesis that the instrument is weak and Stock-Yogo (2005) critical values for critical values for maximal IV size distortion are also reported. All specifications include year fixed effects. Intercepts not reported. * p<0.10, ** p<0.05, *** p<0.01.

	Fixed Effects			2SLS with Fixed Effects			
	Ln(TotalRisk) (1)	SysRisk (2)	Ln(IdioRisk) (3)	FemaleDir (4)	Ln(TotalRisk) (5)	SysRisk (6)	Ln(IdioRisk) (7)
%FemaleDir	0.008	−0.081	0.039		−3.484*	−6.919*	−2.770
	(0.066)	(0.120)	(0.066)		(2.039)	(3.897)	(1.844)
BoardSize	−0.010***	−0.024***	−0.009***	0.001	−0.008**	−0.021***	−0.008***
	(0.003)	(0.005)	(0.003)	(0.001)	(0.003)	(0.007)	(0.003)
%IndepDir	−0.045	−0.044	−0.043	0.064***	0.188	0.412	0.144
	(0.032)	(0.064)	(0.032)	(0.008)	(0.139)	(0.266)	(0.127)
Ln(TotalAssets)	−0.107***	−0.023	−0.124***	0.002	−0.098***	−0.006	−0.117***
	(0.012)	(0.022)	(0.011)	(0.003)	(0.014)	(0.027)	(0.013)
MTB	0.006**	0.051***	0.000	0.000	0.006**	0.052***	0.001
	(0.002)	(0.009)	(0.002)	(0.001)	(0.003)	(0.008)	(0.002)
ROA	−0.229***	−0.404***	−0.223***	0.002	−0.222***	−0.391***	−0.218***
	(0.034)	(0.063)	(0.036)	(0.005)	(0.040)	(0.063)	(0.041)
R&D	−0.008*	−0.024	−0.006	−0.002	−0.016*	−0.040	−0.013*
	(0.005)	(0.017)	(0.005)	(0.002)	(0.009)	(0.026)	(0.007)
CapEx	0.010**	0.026	0.008	0.002	0.018**	0.041	0.015**
	(0.005)	(0.018)	(0.005)	(0.002)	(0.009)	(0.026)	(0.007)
Leverage	0.171***	0.044	0.210***	−0.003	0.160***	0.022	0.201***
	(0.037)	(0.073)	(0.037)	(0.007)	(0.042)	(0.080)	(0.040)
FemaleCon				0.015**			
				(0.006)			
				Kleibergen-Paap = 6.838			
	Hansen (FE vs RE)			Stock-Yogo (2005) critical values:			
	227.231***	245.575***	170.184***	16.38 (10%), 8.96 (15%), 6.66 (20%), 5.53 (25%)			
#Obs.	18395	18395	18395	18395	18106	18106	18106
R^2	0.567	0.141	0.568	0.159	0.305	−0.390	0.407

Table 6: Risk Measures on Gender Diversity (Fixed Effect and Fixed Effect 2SLS)

This table reports the results from the Fixed Effect 2SLS estimation where the %FemaleDir is treated as endogenous and %FemaleCon is used as the instrumental variable (the first-stage regression is displayed in Column 1 and 5). #ExtSeats is the number of external board seats of all directors and #MaleExtSeats is the number of external board seats of all male directors. Kleibergen-Paap rk Wald statistics under the null hypothesis that the instrument is weak are also reported. The Stock & Yogo (2005) critical values for maximal IV size distortion are 16.38 (10%), 8.96 (15%), 6.66 (20%), 5.53 (25%). All specifications include year fixed effects. Intercepts not reported. * p<0.10, ** p<0.05, *** p<0.01.

	%FemaleDir (1)	Ln(TotalRisk) (2)	SysRisk (3)	Ln(IdioRisk) (4)	%FemaleDir (5)	Ln(TotalRisk) (6)	SysRisk (7)	Ln(IdioRisk) (8)
%FemaleDir		−9.360	−18.971	−8.979		−0.925**	−2.424***	−0.882**
		(9.611)	(19.590)	(9.227)		(0.398)	(0.809)	(0.390)
BoardSize	0.000	−0.006	−0.015	−0.005	0.001	−0.010***	−0.023***	−0.009***
	(0.001)	(0.008)	(0.016)	(0.008)	(0.001)	(0.003)	(0.005)	(0.002)
%IndepDir	0.064***	0.560	1.175	0.537	0.067***	0.025	0.125	0.024
	(0.008)	(0.621)	(1.264)	(0.596)	(0.008)	(0.042)	(0.084)	(0.042)
Ln(TotalAssets)	0.002	−0.087***	0.016	−0.106***	0.003	−0.103***	−0.014	−0.121***
	(0.003)	(0.030)	(0.061)	(0.029)	(0.002)	(0.011)	(0.021)	(0.011)
MTB	0.000	0.008	0.055***	0.002	0.000	0.006***	0.051***	0.000
	(0.001)	(0.005)	(0.012)	(0.005)	(0.001)	(0.002)	(0.008)	(0.002)
ROA	0.002	−0.210***	−0.366***	−0.205***	0.002	−0.227***	−0.400***	−0.222***
	(0.005)	(0.064)	(0.104)	(0.065)	(0.005)	(0.034)	(0.058)	(0.036)
R&D	−0.002	−0.030	−0.068	−0.027	−0.002	−0.010*	−0.029	−0.008*
	(0.002)	(0.028)	(0.062)	(0.026)	(0.002)	(0.005)	(0.019)	(0.005)
CapEx	0.002	0.033	0.071	0.030	0.002	0.012**	0.031	0.010**
	(0.002)	(0.028)	(0.063)	(0.026)	(0.002)	(0.005)	(0.019)	(0.005)
Leverage	−0.003	0.141*	−0.018	0.181**	−0.003	0.168***	0.036	0.207***
	(0.007)	(0.077)	(0.152)	(0.075)	(0.007)	(0.035)	(0.068)	(0.035)
%FemaleCon	0.008				0.073***			
	(0.008)				(0.008)			
#ExtSeats	0.006	0.071	0.145	0.075				
	(0.005)	(0.088)	(0.180)	(0.085)				
#MaleExtSeats					−0.047***	−0.032*	−0.056*	−0.024
					(0.005)	(0.017)	(0.032)	(0.017)
#Obs.	18395	18106	18106	18106	18395	18106	18106	18106
Kleibergen-Paap		1.077	1.077	1.077		88.783	88.783	88.783

Table 7: Test of Strict Exogeneity

This table reports the Fixed Effects regressions of Ln(TotalRisk) on comtemporaneous board and firm characteristics (denoted by t) and forward values of board characteristics (denoted by $t+1$). Within-cluster heteroskedasticity and serial correlation robust standard errors are reported in parentheses. All specifications include year fixed effects. Intercepts not reported. * p<0.10, ** p<0.05, *** p<0.01.

	Dependent Variable = Ln(TotalRisk)$_t$				
	(1)	(2)	(3)	(4)	(5)
%FemaleDir$_t$	0.057	0.018	0.013	0.016	0.053
	(0.061)	(0.071)	(0.071)	(0.071)	(0.061)
BoardSize$_t$	−0.010***	−0.010***	−0.006**	−0.011***	−0.006**
	(0.003)	(0.003)	(0.002)	(0.003)	(0.002)
%IndepDir$_t$	−0.032	−0.023	−0.033	−0.009	−0.007
	(0.034)	(0.034)	(0.034)	(0.029)	(0.029)
Ln(TotalAssets)$_t$	−0.094***	−0.093***	−0.091***	−0.094***	−0.089***
	(0.013)	(0.013)	(0.013)	(0.013)	(0.013)
MTB$_t$	0.009***	0.009***	0.009***	0.009***	0.009***
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
ROA$_t$	−0.290***	−0.290***	−0.289***	−0.291***	−0.288***
	(0.048)	(0.048)	(0.048)	(0.048)	(0.048)
R&D$_t$	−0.016***	−0.016***	−0.017***	−0.016***	−0.016***
	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)
CapEx$_t$	0.019***	0.019***	0.019***	0.019***	0.019***
	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)
Leverage$_t$	0.152***	0.152***	0.153***	0.152***	0.152***
	(0.042)	(0.042)	(0.042)	(0.042)	(0.042)
%FemaleDir$_{t+1}$	−0.072				−0.056
	(0.059)				(0.059)
%FemaleCon$_{t+1}$		−0.075***			−0.075***
		(0.028)			(0.028)
BoardSize$_{t+1}$			−0.009***		−0.009***
			(0.002)		(0.002)
%IndepDir$_{t+1}$				−0.043	−0.032
				(0.032)	(0.032)
#Obs.	15489	15489	15489	15489	15489
R^2	0.572	0.573	0.573	0.572	0.574

Table 8: Risk Measures on Gender Diversity (Dynamic Panel GMM)

This table reports the results from Arellano-Bover/Blundell-Bond Dynamic Panel GMM estimation of risk measures on the proportion of female directors on board and other control variables. Lag 1-2 of the dependent variables are included in all models. All independent variables are treated as endogenous except the year dummy variables. Lags 3-4 of the dependent variables and lags 2-3 of the independent variables are used as instrument variables. AR(1) and AR(2) are test statistics for the null hypothesis that there is no serial correlation of order 1 and 2 in the residuals of the differenced equations. The null hypothesis for the Hansen test is that all instruments are exogenous. Intercepts not reported. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

	Ln(TotalRisk)		SysRisk		Ln(IdioRisk)	
	(1)	(2)	(3)	(4)	(5)	(6)
%FemaleDir	−0.134	−0.100	0.041	−0.149	−0.135	−0.024
	(0.119)	(0.137)	(0.217)	(0.252)	(0.133)	(0.155)
BoardSize	0.011	0.009	0.016	−0.012	0.014	0.013
	(0.010)	(0.009)	(0.016)	(0.018)	(0.013)	(0.011)
%IndepDir	−0.044	−0.114	0.006	−0.189	−0.006	−0.161
	(0.142)	(0.140)	(0.224)	(0.226)	(0.185)	(0.174)
Ln(TotalAssets)	−0.016	0.002	−0.013	0.005	−0.020	−0.028
	(0.014)	(0.019)	(0.033)	(0.037)	(0.019)	(0.025)
MTB	−0.002	0.009	0.010	−0.003	0.011	0.010
	(0.014)	(0.017)	(0.023)	(0.030)	(0.030)	(0.027)
ROA	−0.309	−0.289	0.185	0.257	−0.637	−0.461
	(0.214)	(0.198)	(0.271)	(0.231)	(0.481)	(0.375)
R&D	0.028**	0.043**	−0.047	−0.009	0.042**	0.040**
	(0.013)	(0.018)	(0.046)	(0.033)	(0.020)	(0.017)
CapEx	−0.395**	−0.442***	0.227	0.019	−0.633	−0.485***
	(0.169)	(0.129)	(0.402)	(0.292)	(0.397)	(0.184)
Leverage	−0.104	−0.076	−0.303**	−0.341**	−0.046	−0.037
	(0.068)	(0.067)	(0.126)	(0.143)	(0.086)	(0.077)
L1	0.994***	0.797***	0.844***	0.793***	0.844***	0.721***
	(0.142)	(0.117)	(0.144)	(0.111)	(0.195)	(0.165)
L2	−0.156	−0.002	−0.016	−0.005	−0.106	−0.014
	(0.113)	(0.101)	(0.121)	(0.095)	(0.132)	(0.117)
Hansen	30.904*	34.348	40.539***	32.752	37.776**	32.304
AR(1)	−4.997***	−4.760***	−3.905***	−4.721***	−3.874***	−3.951***
AR(2)	1.698*	0.501	0.889	1.053	1.340	0.733
CEO Variables	N	Y	N	Y	N	Y
#Obs.	13028	9890	13028	9890	13028	9890

Table 9: Effect of Female Director Appointment on Risk Measures

This table reports the effect of female director appointment (FemaleAppointed) on risk measures using the Difference-in-Difference Matching Estimator. Treatment firm-years are matched with the control observations in the same industry and year. In addition, their level of TotalAssets must be within 10% of each other (130 out of 180 treatment observations are matched). Post is a dummy variable, which is equal to one in the post-treatment period (when a female director is appointed) and zero otherwise. Within-cluster heteroskedasticity and serial correlation robust standard errors are reported in parentheses. All specifications include industry (based on two-digit NAICS code) and year fixed effects. Intercepts not reported. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

	Ln(TotalRisk) (1)	SysRisk (2)	Ln(IdioRisk) (3)
FemaleAppointed × Post	−0.008	0.002	−0.003
	(0.022)	(0.043)	(0.024)
FemaleAppointed	−0.058**	−0.080	−0.064**
	(0.029)	(0.050)	(0.030)
Post	−0.005	−0.002	−0.010
	(0.011)	(0.021)	(0.012)
BoardSize	−0.035***	−0.067***	−0.032***
	(0.006)	(0.011)	(0.006)
%IndepDir	0.022	0.057	0.041
	(0.070)	(0.135)	(0.070)
Ln(TotalAssets)	−0.058***	0.048**	−0.086***
	(0.010)	(0.020)	(0.010)
MTB	0.013***	0.041***	0.012***
	(0.004)	(0.011)	(0.004)
R&D	0.315***	0.655***	0.343***
	(0.081)	(0.214)	(0.082)
CapEx	0.286	0.418	0.267
	(0.177)	(0.342)	(0.186)
Leverage	0.021	−0.420***	0.067
	(0.066)	(0.113)	(0.069)
ROA	−1.091***	−1.814***	−1.061***
	(0.124)	(0.252)	(0.125)
#Obs.	1492	1492	1492
R^2	0.545	0.313	0.547

Table 10: CEO Compensation and Risk Taking Policies on Gender Diversity

This table reports the Fixed-Effects regressions of firm's compensation, investment, diversification and debt policies on the proprotion of female directors and other control variables. The dependent variables are indicated in each of the columns. Within-cluster heteroskedasticity and serial correlation robust standard errors are reported in parentheses. All specifications include year fixed effects. Intercepts not reported. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

	Compensation		Investment		Diversification		Debt
	Ln(1+Delta)	Ln(1+Vega)	R&D	CapEx	Ln(#Segments)	HHI	Leverage
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
%FemaleDir	0.029	0.262	−0.043	−0.062***	0.138	−0.007	−0.013
	(0.246)	(0.303)	(0.027)	(0.022)	(0.121)	(0.068)	(0.028)
BoardSize	−0.058***	−0.006	0.000	−0.000	0.000	−0.002	−0.001
	(0.010)	(0.012)	(0.001)	(0.001)	(0.005)	(0.002)	(0.001)
%IndepDir	0.081	0.492***	0.069	0.054	0.090	−0.061*	−0.022
	(0.130)	(0.154)	(0.054)	(0.048)	(0.070)	(0.035)	(0.016)
Ln(TotalAssets)	0.632***	0.540***	−0.015	0.015*	0.071***	−0.031***	0.021***
	(0.050)	(0.050)	(0.012)	(0.008)	(0.021)	(0.009)	(0.007)
MTB	0.197***	0.017	0.001	0.000	−0.004	0.002	−0.007***
	(0.053)	(0.010)	(0.006)	(0.003)	(0.005)	(0.002)	(0.002)
ROA	0.755***	0.429***					−0.114***
	(0.234)	(0.152)					(0.026)
Leverage	−0.815***	−0.466***	−0.010	−0.012	0.126**	−0.015	
	(0.152)	(0.168)	(0.043)	(0.025)	(0.063)	(0.026)	
Ln(TotalRisk)	−0.202***	−0.509***					
	(0.059)	(0.064)					
CEOTenure	0.062***	0.000					
	(0.004)	(0.005)					
SurplusCash			−0.138	0.027	−0.053	0.050	
			(0.118)	(0.067)	(0.087)	(0.045)	
Ln(SalesGrowth)			0.003	0.003	−0.001	0.002	
			(0.005)	(0.003)	(0.005)	(0.002)	
Return			−0.013	−0.025***	−0.002	−0.005	
			(0.010)	(0.009)	(0.010)	(0.005)	
NetPP&E							0.005
							(0.035)
R&D							−0.000
							(0.000)
#Obs.	13778	14350	13472	13472	13461	13472	18360
R^2	0.341	0.185	0.005	0.009	0.236	0.107	0.062