Women on board: Does boardroom gender diversity affect firm risk?

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Abstract

We investigate the relationship between boardroom gender diversity and firm risk. To identify a causal effect of gender on risk, we use a dynamic model that controls for reverse causality and for gender and risk being influenced by unobservable firm factors. We find no evidence that female boardroom representation influences equity risk. We also show that findings of a negative relationship between the two variables are spurious and driven by unobserved between-firm heterogeneous factors.

JEL classification: G10, G34
Keywords: board of directors, gender diversity, equity risk, endogeneity

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1. Introduction

A substantial and growing literature links the composition of the board of directors to observable firm outcomes. We contribute to this literature by examining whether the gender composition of a board affects firm risk. This is an important research question. Recently, various firms have come under public pressure to increase the gender diversity on their boards[1], and a number of European countries (among them Belgium, France, Norway and Italy) have passed legislation mandating more female board representation for certain firms. However, the economic consequences of more female directors are not well understood. While studies in economics and psychology find that women have less risk appetite than men (Hinz, McCarthy, and Turner, 1997; Byrnes, Miller, and Schafer, 1999; Barber and Odean, 2001), it is unclear whether greater female board representation means that firms engage in less risk-taking. If firms that appoint more female board members were to make less risky policy choices and investment decisions, these firms could ultimately become less competitive players in their industries. Additionally, boards of directors now face heightened expectations regarding their role in risk oversight[2]. The gender diversity of a board could therefore also be important for effective risk oversight.

This paper examines whether gender diversity affects firm risk using a sample of US firms from 1996-2010. To date, the literature has examined how the gender of the CEO and other senior executives affects risk (Berger, Kick, and Schaeck, 2014; Huang and Kisgen, 2013; Faccio, Marchica, and Mura, 2014) and how board diversity in banks affects bank risk (Adams and Ragunathan, 2013). However, the extant literature has not examined the risk implications of gender diversity on the boards of non-financial firms, which is the focus of this study. Sapienza, Zingales, and Maestripieri (2009) find women who enter the financial

[1] For instance, Twitter came under fire in the media over its exclusively male board of directors. Although the company's CEO replied that the director appointment process should be more than just "checking a box", the company still responded by appointing Marjorie Scardino as its first female director in December 2013. See 'Twitter has taken a good step forward, but needs more than one female director', Forbes, September 12, 2013.

[2] See Securities and Exchange Commission's Regulation S-K 407(h).

industry to be less risk averse than women entering other industries. This suggests that the findings from the banking sector on the gender-risk link may not apply to other sectors and calls for a more general enquiry into the risk implications of greater gender diversity on the boards of non-financial firms.

Establishing a causal relationship between gender diversity and risk is challenging. Board characteristics are not exogenous random variables. They are endogenously chosen by firms to suit their operating and contracting environment (Adams and Ferreira, 2007; Coles, Daniel, and Naveen, 2008; Harris and Raviv, 2008). Two sources of endogeneity are particularly likely to bias our estimates of how gender affects firm risk.

First, omitted unobservable firm characteristics (both fixed and time-varying) may simultaneously affect both the director appointment process and firm risk. Empirical models cannot possibly capture all the determinants of firm risk. There will be other factors, observable and unobservable, that influence both the director appointment process and risk. An example of an unobservable driver of firm risk is a firm's attitude towards corporate social responsibility (CSR)[3]. Both theory and empirical evidence from a board literature on CSR suggest that a firm's engagement with its stakeholders reduces both systematic and idiosyncratic risk (Freeman, 1984; Waddock and Graves, 1997; Godfrey, 2005). At the same time, a firm's compliance with a CSR agenda may influence both the demand and supply of women to the board of directors. On the demand side, gender diversity is one of the social responsibility dimensions on which the firm is evaluated by its stakeholders[4] CSR-compliant firms will thus have a higher demand for women directors. On the supply side, CSR-compliant firms may attract women directors as evidence shows that women directors care more than

[3]Whilst quantitative and thus measurable indicators of social performance exist (e.g. ESG Research Data from Thomson Reuters or KLD rating data from Kinder, Lydenberg, Domini and Co.), these measures are based on public data and in some cases voluntary disclosure by firms. Therefore, social performance data tend to only be available for a subset of firms. Furthermore, social responsibility itself could be determined by other institutional factors such as the presence of monitoring by certain institutions, institutionalized norms and engagement with stakeholders (Campbell, 2007). These factors cannot be readily observed and thus are generally omitted from empirical models.

[4]For example, Coca-Cola communicates its boardroom gender diversity policy through its corporate social responsibility report.

men about self-transcendence values (universalism and benevolence) and may thus identify better with, and offer their services to, socially responsible firms (Chatman, 1989; Turban and Greening, 1997; Adams and Funk, 2012). In these circumstances, omitted unobservable variables such as corporate attitudes towards CSR could cause us to report a negative but non-causal relationship between female boardroom representation and firm risk.

Second, the direction of causality between firm risk and appointment decisions is unclear ex-ante. Rather than appointments affecting firm risk, firm risk may affect appointment decisions. For instance, female directors may self-select into lower risk firms, possibly as a result of their widely-documented higher risk aversion (Farrell and Hersch, 2005). Therefore, reverse causality could explain a negative relationship between female board representation and firm risk. Additionally, Wintoki, Linck, and Netter (2012) and Cicero, Wintoki, and Yang (2013) demonstrate that reverse causality issues around board characteristics are *dynamic*. For our study, this means that current female boardroom representation is likely to be influenced by past realizations of firm risk.

A common empirical strategy to deal with endogeneity is to identify an instrumental variable that explains gender representation on the board but is exogenous to the firm outcomes being investigated. However, it is challenging to find a truly exogenous instrumental variable for gender diversity. For instance, we present some evidence in this paper that a variable commonly employed as a source of exogenous variation in gender diversity (the number of female connections of male directors) is not truly exogenous in our data set.

Taking into account (i) these endogeneity issues, (ii) the dynamic nature of these endogeneity issues and (iii) the challenges around identifying a suitable instrument, we employ a dynamic panel system GMM estimator to estimate a dynamic model of equity risk. We find no evidence that female boardroom representation affects any of the measures of equity risk we analyze (total, systematic and idiosyncratic risk). Our findings hold in various GMM specifications. The results are also robust to us using difference-in-difference estimators, an operating performance measure of risk (the standard deviation of a firm's return on assets) and a range of firm policy measures of risk. The results of the various tests and robustness tests presented all point to the same conclusion. A board with a higher proportion of female directors is no more or less risk-taking than a more male-dominated board.

We also shed some light on the different sources of endogeneity and how they affect the reported gender-risk relationship. Our results offer some support for reverse causality concerns. We find that firm risk is negatively related to the probability that a female director is appointed. However, this effect is small in magnitude and therefore unlikely to drive any spurious relationship between gender and risk. Instead, the main sources of endogeneity that would cause us to report a negative but spurious relationship between gender diversity and risk are unobservable firm-level factors. We show that unobserved between-firm heterogeneous factors are important drivers of board gender diversity and risk, and that not controlling for these factors leads to a spurious negative effect of gender diversity on risk.

Our paper makes the following contributions to the literature. First, we extend the literature that investigates the link between gender diversity and risk in banks (Adams and Ragunathan, 2013; Berger et al., 2014) by providing the first study that examines the gender-risk link for a cross-industry sample. We also contribute to a broader literature that has documented the relations between firm risk-taking and other corporate governance characteristics, including CEO gender, financial expertise, ownership, compensation and the presence of institutional investors (e.g. Faccio et al., 2014; Wahal and McConnell, 2000; Minton, Taillard, and Williamson, 2014; Coles, Daniel, and Naveen, 2006; Kim and Lu, 2011). Ahern and Dittmar (2012) and Matsa and Miller (2013) investigate the relationship between the presence of female directors and debt policy.

Second, our paper contributes more generally to the literature on the hitherto inconclusive debate over director gender and firm value. While female board representation is linked to a range of arguably desirable firm outcomes such as board attendance, lower M&A bid premiums and less risky business decisions (e.g. Levi, Li, and Zhang, 2013; Adams and

Ragunathan, 2013), evidence linking gender diversity to firm performance is less conclusive (e.g. Adams and Ferreira, 2009; Liu, Wei, and Xie, 2014). Many studies that examine the gender-performance link use operating performance measures, which are not risk-adjusted (e.g. ROA, ROE or other accounting variables)[5]. These studies can only reveal part of the story, because two firms with identical cash flows can exhibit different levels of risk. Therefore, even when gender does not affect operating performance it may still have an effect on firm risk[6]. We contribute to this literature by confirming that risk is not a channel through which gender affects firm value.

Finally, we illustrate the impact of endogeneity on the estimated relationship between gender diversity and firm risk by showing that the negative gender-risk relationship is largely driven by between-firm variations. Our findings add to previous studies that document different relationships between board and performance variables depending on the choice of estimator (Adams and Ferreira, 2009; Wintoki et al., 2012).

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 value in order to generate returns for shareholders. As firm value can be viewed as the sum of future cash flows discounted by an appropriate rate of return that accounts for risk, it is appropriate that both risk and return are considered by managers. Agency theory suggests that managers are risk averse due to concerns about their own undiversified human capital (Fama, 1980; Holmström, 1999) and the literature investigates

[5]Some of these studies also examine Tobin's Q, which is measured as the market-to-book ratio and is a proxy for a firm's growth opportunities. Although Tobin's Q is a risk-adjusted measure (it is based on a firm's market value), Wintoki et al. (2012) argue that this measure is more likely to be a cause rather than a consequence of a firm's governance structure. This argument is supported by theoretical works such as Raheja (2005) and Harris and Raviv (2008). Various empirical works including Boone, Field, Karpoff, and Raheja (2007) and Linck, Netter, and Yang (2008) also find evidence that supports this argument.

[6]Other studies use risk-adjusted measures of performance changes, but reach conflicting conclusions. Ahern and Dittmar (2012) document a decline in equity prices following the introduction of a gender quota in Norway, while Adams, Gray, and Nowland (2011) find that appointments of female directors result in higher stock market performance than male director appointments.

how managers can be induced to make risky choices through various corporate governance mechanisms. These mechanisms include both external mechanisms such as monitoring by shareholders and internal mechanisms such as risk-rewarding remuneration (Leland, 1998; Coles et al., 2006). One governance mechanism believed to have a particularly large impact on risk is the board of directors.

2.1. Board characteristics and firm risk-taking behavior

Existing literature suggests that boards matter for firm risk-taking. Studies have attempted to identify the influence of board characteristics on firm risk. Cheng (2008) finds that firms with smaller boards have higher performance variability and accounting accruals, and participate more frequently in mergers and acquisitions. Pathan (2009) finds a negative relationship between board size and stock return volatility. However, the directors in these studies are treated as a homogenous group without controlling for personal characteristics such as gender, ethnicity, qualifications, personalities and beliefs. Variations in these characteristics, and gender in particular, may be able to explain the difference in risk-taking choices amongst firms.

2.2. Do female directors affect firm risk?

Studies in both the psychology and economics literature find that women tend to be more averse to risk than men. A meta-analysis of 150 studies on risk-taking behavior reports 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 (e.g. Levin, Snyder, and Chapman, 1988; Fehr-Duda, de Gennaro, and Schubert, 2006). Further, women are more conservative in making investment decisions (e.g. Sunden and Surette, 1998; Bernasek and Shwiff, 2001). Croson and Gneezy (2009) provide an overview of the literature in this area.

However, these studies investigate the risk attitudes of women in the general population. In their sample of economics, finance and business students, Deaves, Lüders, and Luo (2009) do not find women to be less overconfident than men. They postulate that women who are attracted to 'male' disciplines may be different from those in the general population. In the context of our study, it is plausible that female directors possess characteristics that have helped them to climb the corporate ladder and become directors. Adams and Funk (2012), for instance, hypothesize that the degree of risk aversion in women may vanish once they have broken through the glass ceiling and have adapted to a male-dominated culture. In a Swedish sample, they find that female directors are more risk-seeking than their male counterparts. Nonetheless, if one accepts that there are general differences in risk attitude between the genders, it is possible that the gender composition of the board may explain variation in corporate risk-taking behavior.

At the board level, gender diversity may also impact the process and quality of decision-making (Hoogendoorn, Oosterbeek, and van Praag, 2013). On the one hand, board diversity may result in more board scrutiny and improved decision-making. On the other hand, diversity could cause conflict and, as a result, consensus may be more difficult to achieve. The risk implications of this are difficult to gauge ex-ante. More scrutiny can potentially lead to less extreme outcomes (i.e. lower risk), whilst risk may increase if it is more time-consuming for directors to reach decisions.

2.3. Empirical studies on board gender diversity

There are a limited number of studies on the impact of female board representation on firm risk-taking behavior. Wilson and Altanlar (2011) find insolvency risk to be negatively related to the proportion of female directors. Levi et al. (2013) find that firms with more male-dominated boards are more likely to participate in M&A activities and pay higher acquisition premiums. Beck, Behr, and Guettler (2013) find that repayment of loans made by female officers are less likely to fall into arrears. However, greater female boardroom representation is not always associated with less risky behavior. Matsa and Miller (2013) find no change in firm leverage after the introduction of a female boardroom representation quota in Norway. The authors posit that 'risk aversion may not be a distinctive part of women's approach to corporate decision-making' (p. 161). By contrast, Berger et al. (2014) find that an increase in the proportion of female bank directors results in increased portfolio risk.

Most of the research in the area of gender diversity on boards of directors focuses on profitability and, so far, there is no consensus in the literature on the relationship between female representation and performance. Some studies find that board diversity leads to better performance while others find no such relationship (e.g. Carter, Simkins, and Simpson, 2003; Gregory-Smith, Main, and O'Reilly, 2014).

Another strand of the literature looks at the determinants of boards appointing female directors and firm risk is found to be one of the determinants of female board appointments. 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 with reference to Kanter's (1977) argument that group homogeneity (i.e. a male-dominated board) is essential in environments where uncertainty is high. Similarly, Farrell and Hersch (2005) find that the probability of female director appointments is higher in less risky and better performing firms. The authors argue that female directors self-select into these firms due to demand for gender diversity.

Farrell and Hersch (2005) also find that female directors are more likely to be appointed to boards with fewer female directors or to replace female directors on the board. Gregory-Smith et al. (2014) find similar results for UK firms. However, they cannot establish a relation between firm risk and the gender of directors being appointed. Overall, the results of both Farrell and Hersch (2005) and Gregory-Smith et al. (2014) confirm that neither a director's gender nor the proportion of female directors on the board are exogenous random variables, and that reverse causality is likely to be an issue when investigating the impact of gender diversity and firm risk.

3. Methodology

This section begins by discussing why the relationship between female boardroom representation and firm risk could be endogenous. It then discusses an empirical specification that takes into account the two sources of endogeneity that are of concern in board studies – unobserved heterogeneity and reverse causality. Lastly, we introduce a dynamic model between female boardroom representation and risk and propose the dynamic panel system generalized method of moments estimator (DPS-GMM, hereafter) as a suitable estimator that allows us to test whether female boardroom representation impacts on firm risk.

3.1. Endogeneity issues in estimating the relationship between female boardroom representation and risk measures

There is a general consensus in the literature that board characteristics are not exogenous random variables. Instead, they are endogenously chosen by firms to suit their own operating and information environments and the bargaining power of various stakeholders in the firm. Amongst others, Fama and Jensen (1983) and Coles et al. (2008) argue that board characteristics are affected by the scope and complexity of the firm. Equally, the level of information asymmetry prevailing between insiders and outsiders could affect board characteristics if board characteristics are chosen such that insiders are incentivized to reveal sufficient private information for the board to fulfil its monitoring and advisory functions (Adams and Ferreira, 2007; Harris and Raviv, 2008; Linck et al., 2008)[7].

[7] This view is formally explained in theoretical models by Raheja (2005), Adams and Ferreira (2007), and Harris and Raviv (2008). Linck et al. (2008) finds that board size and independence are negatively associated with growth opportunities, R&D expenditure and R&D volatility, suggesting that these types of firms may not require intensive monitoring.

The prospect that gender diversity is a choice that firms make has to be taken into account when estimating the gender-risk relationship. To accurately test whether female boardroom representation affects firm risk, at least two alternative explanations must be considered: that the gender-risk relationship is driven by omitted unobserved factors or by reverse causality.

3.1.1. Omitted unobserved factors

The first explanation is that omitted unobservable firm characteristics (both fixed and variable across time) may affect both the selection of particular directors and firm risk. For example, a firm's desire to act as a responsible corporate citizen could be linked to both risk and gender diversity. There is evidence consistent with this from a broad literature on corporate social responsibility.

Most prominently, stakeholder theory (Freeman, 1984) has a number of risk-relevant implications for the relationship between a firm and its various stakeholders[8]. For instance, maintaining good relationships with stakeholders increases firm legitimacy while reducing firm-specific risk factors such as legal prosecutions, regulatory sanctions, customer boycotts, and labor-related problems (Waddock and Graves, 1997). Additionally, socially responsible firms may be perceived as better managed and, as a result, less risky (McGuire et al., 1988). Similarly, investors may be less likely to react negatively to adverse firm-specific events (Godfrey, 2005). These explanations suggest that socially responsible firms are associated with lower firm-specific risk.

In addition to lower firm-specific risk, being socially responsible can also reduce systematic risk. Albuquerque, Durnev, and Koskinen (2014) present a theoretical model where social responsibility decreases the sensitivity of firm profitability to economic conditions

[8]An alternative view is advanced in the form of slack resource theory and states that only firms with abundant resources participate in socially responsible activities (see McGuire, Sundgren, and Schneeweis, 1988; McGuire, 1990) and that corporate social responsibility is the result of agency conflicts within the firm (Masulis and Reza, 2015). Both stakeholder and slack resource theories predict a positive relation between corporate social responsibility and profitability. However, the relationship between CSR and risk is unclear under the slack resource view.

through increased customer loyalty.

The theoretical evidence presented above is supported by empirical work that shows a negative relation between corporate social responsibility (CSR) and both systematic and idiosyncratic risk measures (Spicer, 1978; Orlitzky and Benjamin, 2001; Oikonomou, Brooks, and Pavelin, 2012; Lee and Faff, 2009).

At the same time, CSR can be positively related to gender diversity either through a greater willingness to appoint women directors (the demand side) or through an increased pool of women candidates for board positions (the supply side). On the demand side, socially responsible firms may be more likely to appoint women to the boardroom, because female director appointments are arguably one way through which firms seek legitimacy (Carleton, Nelson, and Weisbach, 1998; Agrawal and Knoeber, 2001). Incidentally, boardroom gender diversity is one of the various elements firms are formally evaluated on in terms of social responsibility[9]; it also forms part of some firms' internal CSR agenda. For example, Coca-Cola Enterprises explicitly state in their 2013-2014 Corporate Responsibility and Sustainability Report[10] that the company aims for greater representation of women in top positions. Empirical studies generally show a positive association between gender diversity and corporate social performance (see e.g. Johnson and Greening, 1999; Boulouta, 2012).

On the supply side, firms with a CSR agenda may be more attractive to women directors (Turban and Greening, 1997). Social identity theory suggests that people define who they are based on their group memberships (Chatman, 1989; Dutton, Dukerich, and Harquail, 1994). Adams and Funk (2012) find in their sample of directors that women care more than men about self-transcendence values (such as universalism and benevolence[11]).

[9]Boardroom gender diversity is included in the environmental, social and governance factors that are used by asset managers who screen for socially responsible firms. It is also one of the criteria of many social investment indices such as Dow Jones Sustainability Indices, in which the scoring methodology explicitly includes gender diversity as a relevant dimension. See http://www.sustainability-indices.com/images/CSA_2014_Annual_Scoring_Methodology_Review.pdf.

[10]See https://www.cokecce.com/corporate-responsibility-sustainability/.

[11]Schwartz, Melech, Lehmann, Burgess, Harris, and Owens (2001) define benevolence as 'preservation and enhancement of the welfare of people with whom one is in frequent personal contact' and universalism as 'understanding, appreciation, tolerance and protection for the welfare of all people and for nature'.

Whilst the literature uses some quantitative measures to proxy for the level of a firm's CSR performance[12], these measures largely rely on voluntary disclosure by firms and may therefore be poor indicators of a firm's actual engagement with a CSR agenda (Ullmann, 1985). CSR scores are also only available for a subset of firms. Furthermore, social responsibility itself could be endogenous and determined by other institutional factors (e.g. the presence of monitoring organizations, institutionalized norms and the level of engagement by their stakeholders; see Campbell, 2007). The factors determining a firm's CSR agenda cannot be readily observed and thus are generally omitted from empirical models.

Another example of omitted unobserved factors in the risk equation is managerial ability. CEOs of high ability may be more effective in terms of managing firm risk (such that firms have lower risk for a given level of profits), whilst also having more influence over director appointment decisions (Hermalin and Weisbach, 1988)[13]. While these powerful managers may well appear to be indifferent with regards to the gender of board appointees, it is conceivable that powerful managers are in a position to appoint directors who are less likely to hold them to account. Existing empirical evidence suggests that female directors are more likely to be effective monitors of CEOs[14] and it is therefore possible that unobserved managerial ability and CEO preferences for a less effective board would be correlated with gender diversity.

Under either of these explanations, we would observe a statistical relation between female boardroom representation and firm risk measures, even in the absence of a causal relationship

[12] Examples are environmental, social and corporate governance (ESG) data from Thomson Reuters and Kinder, Lydenberg, Domini and Co. (KLD).

[13] Prior evidence shows that CEOs have influence over the selection of board candidates (e.g. Shivdasani and Yermack, 1999). Although NYSE and NASDAQ listing rules have reduced the influence of CEOs in the nomination process, they are, at the very least, still able to approve the list of director candidates and these candidates are often voted in by shareholders (Cai, Garner, and Walking, 2009; Coles, Daniel, and Naveen, 2014).

[14] Adams and Ferreira (2009) observe that women directors allocate more effort to monitoring compared to male directors. Furthermore, Adams and Funk (2012) find that female directors are more independently minded. Women directors in their sample care less than men about tradition, conformity and security and are more open to change. Ferreira (2014) argues that the female boardroom representation may better represent the level of board independence than the nominal measure of independence (i.e. the proportion of outside directors).

between the two variables. While the literature generally deals with unobservable variables by using a fixed effects estimator, this is insufficient due to a second possible explanation, reverse causality.

3.1.2. Reverse causality

The second explanation is that risk influences appointment decisions. Hermalin and Weisbach (1988) suggest that the intensity with which a board monitors increases when the board finds it more difficult to judge CEO ability. If this is the case in risky firms (where volatile market indicators make for noisy signals of CEO ability), boards may decide to increase monitoring by hiring more female directors (who have a reputation for better monitoring; see Adams and Ferreira, 2009). Alternatively, female directors may simply self-select into lower risk firms due to their higher risk aversion Farrell and Hersch (2005). In either case, one would observe a positive relationship between the proportion of female directors and firm risk.

Further, we rely on the insight of Wintoki et al. (2012) that reverse causality issues in governance research tend to be of a dynamic nature. For the purposes of our study, this means that current female boardroom representation is influenced by past realizations of firm risk. Intuitively, this is because the appointment decision is made before the next risk realization becomes observable. Therefore, only past risk measures would be in the information set considered by the existing board when making appointment decisions. This insight allows us to introduce a dynamic model in the next section that allows for the possibility of unobserved heterogeneity and the influence of past risk on female boardroom representation.

3.2. Identification strategy

To accurately measure the influence of female boardroom representation on firm risk, we require an empirical model that takes into account the influence of unobserved heterogeneity and past realizations of risk on the choice of director gender and current risk. In this section, we introduce a dynamic model that takes these issues into account. We then argue that the commonly used ordinary least squares (OLS) and fixed effects estimators cannot produce reliable inferences for models of this type. Finally, we propose the DPS-GMM as an appropriate estimator.

We have established in the previous section that the proportion of female directors on boards is a choice variable and that it can be influenced by board and firm characteristics, other unobserved factors and past realizations of risk. This can be formally written as:

$$\text{Proportion of Women}_{i,t} = f(\mathbf{X}_{i,t}, \text{Risk}_{i,t-1}, \text{Risk}_{i,t-2}, \ldots, \text{Risk}_{i,t-p}, \eta_i) \tag{1}$$

The matrix $\mathbf{X}_{i,t}$ represents other determinants of director gender such as other board and firm characteristics. The variables $\text{Risk}_{i,t-1}, \text{Risk}_{i,t-2}, \ldots, \text{Risk}_{i,t-p}$ represent past risk measures at lag 1, 2, ..., p respectively and η_i is time invariant unobserved heterogeneity (e.g. corporate behavior and CEO ability). These variables are not only determinants of the current level of female boardroom representation; they are also likely to be correlated with the current level of risk. Thus, to accurately estimate a relationship between female boardroom representation and the risk measure, these variables need to be included, resulting in a model as follows.

$$\text{Risk}_{i,t} = \alpha + \beta\text{Proportion of Women}_{i,t} + \mathbf{X}_{i,t}\mathbf{\Gamma} + \sum_{s=1}^{p} \delta_s \text{Risk}_{i,t-s} + \{\eta_i + \varepsilon_{i,t}\} \tag{2}$$

This dynamic model with fixed effects means that current firm risk is affected by both unobserved heterogeneity (through η_i) and by past realizations of risk (through $\text{Risk}_{i,t-1}$, $\text{Risk}_{i,t-2}, \ldots, \text{Risk}_{i,t-p}$).

The relationship between firm risk and female boardroom representation is captured by β. To consistently estimate β using the OLS estimator, the proportion of women on the board must not be correlated with the residual term (which in this case is $\eta_i + \varepsilon_{i,t}$ in Equation 2). This is not a realistic assumption. As stated previously, female boardroom representation and other board characteristics are choices made by firms, and these choices may well be influenced by unobservable factors such as CEO ability and corporate culture (captured by η_i). If so, the residual term would be correlated with the proportion of women and the OLS estimates of β would be inconsistent.

Nor would the fixed effects estimator yield consistent estimates in our sample. An implicit assumption underlying the fixed effects estimator is that all independent variables are uncorrelated with contemporaneous, past and future residual terms (the strict exogeneity assumption). In the presence of a dynamic relationship between risk and female boardroom representation, this assumption is violated by construction. This is because firm risk is highly correlated across time. The only situation where this estimator is consistent is when the effect of past risk on current risk weakens over time and the time dimension of the panel sample is large. While the former is a reasonable assumption, it is difficult to obtain a panel with a sufficiently long time dimension.

Considering these limitations, our identification relies on the assumption that firms choose a certain proportion of female directors to target a certain level of risk. In order to choose that level of female representation, the CEO and existing directors rely on information available to them at the time of the appointment. The information set used to make appointment decisions includes past values of realized risk as well as existing board and firm characteristics[15]. In essence, appointment decisions are made based on an expected level of future firm risk. Therefore, once actual firm risk has materialized, the unexpected component of the risk equation (i.e. the error term) can be assumed to be uncorrelated with the current information set. This rationale is consistent with the generalized method of moments orthogonality conditions (Hansen and Singleton, 1982). Because past realizations of variables in the information set underlying appointment decisions are not correlated with the unexpected component in the error term, these variables are candidates for instrumental variables for appointment decisions. This intuition allows us to use DPS-GMM to estimate

[15]This is consistent with the weak-form rational expectation theory of Muth (1961) and Lovell (1986).

the relationship between female boardroom representation and risk.

In this study, we use the dynamic panel system GMM estimator proposed by Arellano and Bover (1995) and Blundell and Bond (1998). As a system GMM estimator, the model is estimated simultaneously in both levels and first differences. This improves the efficiency of our estimator and the power of hypothesis tests by allowing more instrumental variables to be included in the estimation (Roodman, 2009). In line with the rationale above that past variables in the information set explaining appointments are not correlated with the unexpected component of risk, our identification assumes that past endogenous variables in levels are not correlated with the current residual terms in first differences ($\Delta\varepsilon_{i,t}$) and that past variables in first differences are not correlated with the residual terms in levels ($\varepsilon_{i,t}$).

The DPS-GMM estimator is accompanied by two tests that can be used to detect potential misspecification. The first test is a test of second order autocorrelation. Valid inferences from DPS-GMM rely on the assumption that the model is dynamically complete (i.e. that sufficient number of lags have been included). Therefore, no serial correlation should remain in the error term[16]. Second, under DPS-GMM, more than one lag of past variables can be used as instrumental variables. Therefore, we can use the test of overidentifying restrictions (Hansen and Singleton, 1982) to test the null hypothesis that all instrumental variables are jointly valid.

It is important to note that our identification strategy relies on one strong assumption: that all time-varying factors that can influence female boardroom representation and risk measures are included in the model or that their influence on female boardroom representation is channeled through past risk. Arguably, a better strategy is to identify the relationship using a truly exogenous instrumental variable for female boardroom representation. However, it is widely accepted that finding a truly exogenous instrumental variable is challenging. Section 5.3 shows some evidence that an instrumental variable that is commonly used in the gender literature (the number of female connections of male directors) is not truly exoge-

[16]We look at the *second* order autocorrelation in the residuals at first difference as $\Delta\varepsilon_{i,t} = \varepsilon_{i,t} - \varepsilon_{i,t-1}$ is correlated with its first lag, $\Delta\varepsilon_{i,t-1} = \varepsilon_{i,t-1} - \varepsilon_{i,t-2}$, by construction (through $\varepsilon_{i,t-1}$).

nous to firm risk. In the absence of a truly exogenous instrument, we identify the gender-risk relationship using DPS-GMM.

4. Data and Variable Definitions

Our sample of US firms is derived from the RiskMetrics, Compustat, Execucomp and CRSP databases. Our sample contains 13,581 observations (firm-years) of 1,960 firms between 1996-2010. To avoid survivorship bias, we do not require a balanced panel. Following prior literature, financial services and utility firms are excluded from our sample[17].

As dependent variables, we use three measures of equity risk: total risk, systematic risk and idiosyncratic risk. Total risk is calculated as the standard deviation of daily stock returns over the last year. Systematic risk is the coefficient on the stock market portfolio from a market-model regression using the CRSP NYSE/AMEX/Nasdaq/Arca equally-weighted index. Idiosyncratic risk is the standard deviation of the residuals from the market model regression. All returns used for these calculations exclude dividends. To annualize total and idiosyncratic standard deviations, we multiply total and idiosyncratic risk by the square root of 250.

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 then consolidate the data into firm-level variables. The proportion of women is defined as the number of female board members on the board divided by the number of all board members.

As our empirical estimation assumes that the unobserved factors that influence both female boardroom representation and risk are constant across time, we rely on prior literature to identify a comprehensive list of control variables in our risk equation. This minimizes the chance that our findings are driven by time-variant omitted variable bias. All variables are defined in Table A1. We control for board size as decisions made by a large board can lead to compromises and, as a result, less risky outcomes (Sah and Stiglitz, 1986, 1991).

[17] We analyze a sample of bank holding companies separately in Section 5.6.

We control for board independence as the presence of independent directors can result in a more shareholder-focused board (Fama and Jensen, 1983), which could lead to higher risk-taking. For directors to be classified as independent, they cannot be executives (formerly or presently) and cannot have any other affiliation to the company. We also control for the level of director connectedness (or "busyness"), as proxied by the total number of additional directorships held by all directors. On one hand, multiple outside directorships may inhibit a director's ability to monitor (e.g. Fich and Shivdasani, 2007). On the other hand, having other directorships is a signal of director ability (e.g. Masulis and Mobbs, 2014). Both explanations suggest a relation between board connectedness and firm value, and one channel through which connectedness may affect value is firm risk.

We also control for various proxies of CEO risk incentives. Firm risk could be responsive to the risk sensitivity of CEO compensation; thus, we control for CEO vega as well as delta. Vega is the dollar change in CEO compensation per 0.01 unit increase in a firm's standard deviation of stock returns. Delta is defined as the dollar change in compensation per 1% increase in stock return. The calculation of vega and delta follows Core and Guay (2002) and Coles et al. (2006). These two measures proxy for CEO pay incentives to take risk and generate value, respectively. To control for CEO risk aversion, we also collect the length of CEO tenure and the dollar amount of CEO cash compensation. Berger, Ofek, and Yermack (1997) suggest that longer tenure entrenches CEOs and leads to less risk-taking. A higher amount of cash compensation allows CEOs to more easily diversify their wealth outside the firm and potentially makes them less risk averse (Guay, 1999). Compensation variables are calculated using Execucomp data.

Additionally, we control for a number of firm-level characteristics using financial accounting variables obtained from Compustat. Firms with larger investment opportunity sets and growth options may take more risk Guay (1999); therefore, we include the market-to-book ratio, research and development expenditure (divided by total assets), capital expenditure (divided by total assets) and sales growth (in log form) as proxies for investment and growth opportunities.

The existing literature suggests that board characteristics are chosen based on the scope and complexity of the firm, its monitoring needs and the bargaining power of the CEO (e.g. Hermalin and Weisbach, 1998; Coles et al., 2008; Boone et al., 2007; Linck et al., 2008). Therefore, we also control for the complexity and life stage of the firm using firm size (as measured by the logarithm of the book value of total assets), firm age (in log form) and revenue diversification (as measured by the Herfindahl-Hirschman index of revenue concentration). Firm leverage is also a proxy for firm complexity and also a determinant of risk. On one hand, higher leverage may lead managers to take more risk as it incentivizes them to transfer wealth from bondholders to shareholders (Leland, 1998). On the other hand, a higher probability of facing financial distress may curb the firm's tendency to engage in risky activities (Friend and Lang, 1988).

We also include profitability and surplus cash as proxies for CEO bargaining power and agency cost (Hermalin and Weisbach, 1998; Jensen, 1986). To alleviate the effect of outliers, all control variables are winsorized at the 1st and 99th percentile values of the sample.

[**Tables 1 about here**]

Descriptive statistics of all variables are provided in Table 1. About 63% of firms in our sample have at least one female director. On an average board of nine directors, one director is a woman, resulting in an average of 10% female boardroom representation. We observe a high variation in firm and CEO characteristics, particularly in total assets and CEO delta.

To analyze the association between female boardroom representation and these variables, Table 1 also calculates the mean values of our variables by the number of female board members. We find that female directors are more prevalent on larger and more independent boards. This is expected as most female directors are appointed as independent directors. We also find that firms with female directors are older, larger and have lower market-to-book values, suggesting that mature firms are more likely to appoint female directors. We also observe differences in CEO compensation with CEOs on more gender-diverse boards receiving pay that is higher in vega, delta and cash.

We also observe negative monotonic relations between the number of female directors and all three risk measures. 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. However, 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 risk compared to firms with no female directors. Again, the univariate results cannot rule out the possibility that the relationship between female boardroom representation and risk are influenced by other board and firm characteristics.

Empirical specifications that only exploit within-firm variations such as DPS-GMM and fixed effects may lead to hypothesis tests that are extremely underpowered if there is little time-series variation in the data. In Table 2, we show the proportion of firms in our sample that change their board composition each year. On average, about 11% of sample firms experience a change in the number of female directors each year. Over the whole sample period, about 40% of firms experience a change in the number of women directors at least once. This variation is higher when examining the proportion of women directors, which is the measure we use in our GMM and fixed effects results. More than half the sample firms (55%) change their level of gender diversity at least once during the sample period, and nearly one in three firms experience a change in gender diversity each year. As a point of reference, Table 2 also shows that the percentage of firms that experience a change in board size and board independence each year is 40% and 53%, respectively. This suggests that there is enough time-series variation in our key variables to effectively employ methodologies that exploit within-firm variation such as DPS-GMM.

[Tables 2 about here]

5. Results

5.1. Does risk affect the appointment of female directors?

We argue that the dynamic model presented in this paper is suitable for estimating the relationship between female boardroom representation and risk due to the presence of both unobserved heterogeneity and the influence of past risk on the gender of appointed directors. To confirm that this is indeed the case, we focus on the firm-year observations where at least one director is appointed and conduct a Probit estimation as per Equation 3 below.

$$Pr(\text{Female Appointment}_{i,t} = 1) = \mathbf{\Phi}(\alpha_0 + \alpha_1 \text{Risk}_{i,t-1} + \mathbf{X}_{i,t-1}\mathbf{\Gamma} + \varepsilon_{i,t}) \tag{3}$$

The dependent variable, *female appointment*, is a dummy variable which is set to 1 when the appointed director is a women and 0 otherwise. The probability of a female director appointment is modeled as normally distributed. The cumulative probability (denoted by Φ) is explained by past risk measures and a number of other variables as guided by prior literature. For instance, lack of access to what are predominantly all-male networks is widely seen as one reason for the low number of female directors (Medland, 2004; Adams and Ferreira, 2009). On each board, we measure the extent of connectedness between male directors and female directors in other firms. We control for the proportion of male directors with board connections to women (i.e. the proportion of male directors who sit on the same board as at least one female director in other firms). The more male directors have experience working with female directors in other firms, the higher the likelihood that women would be brought onto the board that male directors currently sit on. On average, 29% of male directors sit on the same board as female directors in other firms.

To measure the tendency of firms to maintain the status quo in regards to gender diversity, we include two additional dummy variables in the model – *women departing the board* and *men departing the board*. We also include the proportion of women already on the board.

Similar to Farrell and Hersch (2005) and Gregory-Smith et al. (2014), we control for board size and board independence. We also include firm-level determinants of board structure as documented by prior literature (Linck et al., 2008; Coles et al., 2008).

[**Table 3 about here**]

Focusing on those firm-years in which at least one director is appointed, we obtain 7,101 observations. Table 3 displays the results. There is some evidence that firm risk influences the gender of board appointments. The coefficient on the logarithm of the standard deviation of stock returns is negative and significant at the 5% level.

The negative coefficient in our results suggests that riskier firms are less likely to appoint female directors. This is consistent with the group homogeneity argument of Kanter (1977) that male-dominated boards are more prevalent in high-uncertainty environments. It is also consistent with the possibility that female directors prefer to work for less risky firms Farrell and Hersch (2005).

However, the economic impact of risk on the probability of appointing a female director is small. For an average firm, a doubling in total risk is associated with a 4.50% decrease in the probability that a female director is appointed. In addition, when examining systematic and idiosyncratic risk, there is no evidence that these two risk components affect the probability that a female director is appointed. Overall, our evidence is only suggestive of the possibility that risk affects the gender of appointees to the board. Nonetheless, the presence of some relationship between firm risk and the gender of board appointees means we cannot rule out reverse causality issues when testing whether female boardroom representation affects firm risk.

To rule out the possibility that the relation between risk and appointment is caused by other time-invariant factors not included in the model, we also estimate Models 1 and 2 using a linear probability model with firm-level fixed effects and find that the coefficient for total risk remains significant. The coefficient for idiosyncratic risk also becomes significant but only at 10% level.

The results in Table 3 also show that there is a gender bias in the director appointment process. We find that firms are less likely to appoint female directors if they already have a high proportion of female directors on their board. Further, women are more likely to be appointed when female directors have recently vacated a board position. Finally, board networks also play a role as postulated by Adams and Ferreira (2009). The presence of male directors who are more connected with female directors in other firms is associated with a higher probability that a female director is appointed. Overall, our results demonstrate that board appointments are not gender neutral and show some evidence consistent with tokenism whereby boards seek to maintain a certain representation of women on boards.

5.2. Does female boardroom representation affect firm risk?

5.2.1. Dynamic panel GMM estimation

Considering the evidence that past risk influences the choice of selecting women into the boardroom, we proceed with the estimation of the dynamic model in Equation 2. In our baseline results, we include two lags of risk measures in the model.

The results using DPS-GMM are reported in Table 4. We find no evidence in support of the view that female directors reduce equity risk. None of the coefficients on the proportion of women on a board are statistically significant. In addition, these coefficients are too small to have any economic impact. For example, a 10% increase in female boardroom representation, which is approximately equivalent to appointing one female director to an average-sized board of nine directors, would lead to a 0.0031 unit increase in stock return beta. This is very small considering that the average systematic risk in our sample is 1.276.

Table 4 also reports the results of the two specification tests – the Hansen test of overidentifying restrictions and the autocorrelation test. The results of the Hansen test suggest that all orthogonality conditions specified in the model are valid; that is, past values of board characteristics, firm characteristics and risk measures are exogenous. The AR(2) tests also suggest no evidence of second-order autocorrelation in the residuals. Overall, the specification tests reveal no evidence that the instruments used in identifying the relationship between female boardroom representation and all three risk measures are endogenous.

[**Table 4 about here**]

5.2.2. Robustness checks

Our baseline results include two lags of the risk measures in the model and use two further lags of risk measures and other variables as the instruments. The choice of lag length is made as a result of a trade-off between exogeneity and identification. On the one hand, the included number of lags must be high enough to ensure that the model is dynamically complete such that further information in the past is not related to the expectational error in the data. On the other hand, information too far in the past may not be sufficiently relevant to identify the parameters. As robustness checks, we estimate models that include one, three and four lags instead of two and still find no significant relation between the proportion of women and our risk measures. Additionally, our results continue to hold when we use the data sampled every two years instead of one. The results are presented in Table A2.

5.2.3. Identifying the sources of endogeneity

The inferences from DPS-GMM suggest no relationship between female boardroom representation and any of the three equity risk measures. However, the summary statistics suggest that female directors are more prevalent in lower risk firms. We further analyze why this is the case. There are three alternative explanations: (i) The inverse relationship is driven by other observable factors such as board size, firm size or the level of CEO compensation (ii) the relationship is driven by other unobservable factors such as corporate culture or managerial ability and (iii) risk influences female boardroom representation (reverse causality).

We distinguish between these three sources of endogeneity by estimating a static model between female boardroom representation and risk using two estimators: OLS and a fixed effects estimator. Both estimators would yield biased estimates under the presence of unobserved heterogeneity and/or reverse causality. However, they can be useful in identifying what causes the negative relation observed in the data. On one hand, if the relationship is driven by other factors that we can observe in the sample, OLS estimates would yield no significant relation between the proportion of women and risk measures once we include these observable factors. On the other hand, if unobservable factors influence the relation, their influences should be captured by the fixed effects. While results obtained from the fixed effects estimator would still be asymptotically biased by past risk, the magnitude of the resulting estimation bias would depend on how strong the influence of past risk on current gender diversity is.

[**Table 5 about here**]

Table 5 reports the OLS and fixed effects results. The OLS results (Columns 1-3) show negative and significant relationships between the proportion of women on boards and total risk as well as systematic risk. The coefficients are also much larger in magnitude compared to the DPS-GMM results in Table 4. In the case of systematic risk for example, a 10% increase in female boardroom representation is associated with a 0.035 unit decrease in the market model beta. The statistically significant relation remains even after controlling for the determinants of equity risk.

The fixed effects results (Columns 4-6), on the other hand, show no significant relationship between the proportion of women and any of the three risk measures. All three coefficients are much closer to zero compared to the OLS results, whereas the standard errors remain similar for both sets of results. A comparison between the OLS and the fixed effects results suggests that the negative relationships come from unobservable sources of firm heterogeneity. The fixed effects estimator, which relies on within-firm variation to identify the parameters, are not susceptible to unobserved differences between the firms. Therefore, the fixed effects estimates are not subject to the same bias that drives the negative and significant coefficients of the OLS estimator.

To analyze this further, we conduct Sargan-Hansen tests to compare the estimations based on fixed effects and those based on random effects. The null hypothesis of the Sargan-Hansen test is that the random effects model, which uses variation both within and between firms, estimates the same set of parameters as the fixed effects model, which uses only variation within firms. This is similar to the Durbin-Wu-Hausman specification test but is robust under heteroskedasticity. The χ^2-distributed test statistics (with 32 degrees of freedom) are 432.696, 319.687 and 380.950 for the estimation of total, systematic and idiosyncratic risk, respectively. We reject the null hypothesis in all three cases, suggesting that within-firm variation and between-firm variation produce statistically different sets of coefficient estimates. This leads us to conclude that the negative relationship found in the OLS results is indeed driven by time-invariant factors between firms.

As noted previously, the fixed effects estimator is not robust to the influence of past risk on female boardroom representation. In this case, we find that, despite the influence of risk on the gender of new appointees, the fixed effects results yield the same results as DPS-GMM. That is, there is no significant relationship between female boardroom representation and risk. A joint reading of the results above leads us to conclude the following. Although we find that low risk firms tend to have a higher proportion of female directors on their boards, there is no robust evidence suggesting that higher female boardroom representation leads to lower equity risk. There is suggestive evidence that firms take their existing risk profile into account when deciding on the gender of new director appointments. However, any negative association between female directors and firm risk can most likely be attributed to other unobserved factors in a firm's contracting environment such as corporate culture or managerial ability. These unobserved factors may cause researches to report a spurious negative relationship between gender and risk as these factors simultaneously influence firm risk and the proportion of female directors on the board.

5.3. Is 'female connections of male directors' a valid instrument?

Adams and Ferreira (2009) propose the proportion of male directors with external connections to female directors[18] as an instrument for gender diversity on the board. The economic rationale behind this instrument is that one reason for small numbers of women on boards is that many women lack the type of professional network that male directors have access to. The instrument has been used widely in boardroom gender diversity studies (e.g. Adams and Ferreira, 2009; Levi et al., 2013; Gregory-Smith et al., 2014). In this section, we present evidence that this instrument is not valid in our examination of firm risk. We do so in two steps. First, we show that the statistical significance of both the instrument and the proportion of female directors critically depend on the control variables included in our models. Second, we cast doubt on the exogeneity of the instrument using formal tests in an overidentified model.

We start the analysis in this section by presenting two-stage least squares results with fixed effects and one variation in the controls[19]. Since the instrumental variable estimation is inconsistent if an omitted explanator that belongs in the model is correlated with the instrumental variable, we have been careful to control for the connectedness of the board in our main analysis. However, there are other ways to proxy for board connectedness and therefore we include an alternative measure in our regressions.

[**Table 6 about here**]

The results are presented in Table 6. We note that the control variables in Panel A are the same as in the baseline model. In Panel B, we replace director connectedness with *male* director connectedness, which is defined as the total number of external board seats held by male directors. We find that the conclusions critically depend on the employed measure of board connectedness[20]. Despite a high correlation of 0.968 between the two measures

[18] This variable is constructed by computing the proportion of male directors who are connected to female directors. Male directors are connected if they sit on other boards and one of these boards has at least one female director. This variable is assumed to be exogenous because the fact that male directors know women from their other directorships should not have any relation to firm performance or risk. At the same time, if male directors on the board know more female directors, there is a higher likelihood that more female directors will be appointed. Thus, they argue that the identification assumption is satisfied.

[19] As the estimation may not be consistent due to unobserved factors that are present in both the first and second stage equations (Cornwell, Schmidt, and Wyhowski, 1992), we time-demean all the variables including the instrument in both stages to remove unobserved time-invariant factors.

[20] We also re-estimate our GMM results using male director connectedness as a control variable. The

of board connectedness, Panel A does not report a significant relationship between female representation and risk measures, but Panel B reports that female board representation reduces risk (significant at 5% level)[21]. These findings provide a first indication that female connections of male directors is not a suitable instrument in our study of firm risk and motivate us to conduct further tests in regards to the exogeneity of the instrument.

Exactly identified models posit a challenge to testing the validity of the instrument because the standard way to test for instrument exogeneity, i.e. the Hansen test for overidentifying restrictions, requires that the number of instruments is larger than the number of endogenous variables[22]. Therefore, we purposefully overidentify our model by using a second proxy for female networks that was also proposed by Adams and Ferreira (2009): the proportion of male directors' board seats in other firms with female directors. While the first instrument centers around the number of directors with any female connections (i.e. the number of male directors with external connection to women divided by the number of directors), the second instrument centers around the number of connections (i.e. the number of male directors' external board seats in firms with female directors divided by the total number of external board seats). The correlation coefficient between the two instruments is 0.604.

Under the null hypothesis of the overidentification test, the instruments are jointly exogenous and therefore should estimate similar coefficients for the endogenous variable. Rejecting the null hypothesis implies that at least one of the instrumental variables is not exogenous. We exploit the fact that this test is weak when instruments bias the results in the same direction. Specifically, because similar instruments lead to similar coefficients for the endogenous variables, a rejection of the validity of these similar instruments would be a strong

results (in Panel F of Table A2) are consistent with our other results.

[21] In addition, the strength of the instrument in the first stage also depends on the included variable. The instrument enters the model significantly only when male director connectedness is used as a control variable (Panel B). The Kleibergen-Papp Wald statistic also suggests that the instrument is weak in Panel A (1.986 against the 25% critical value of 5.53).

[22] For example, although in unreported results we find that female board connections enters the risk regression significantly in both OLS and fixed effects (a valid instrument cannot be itself an explanatory variable), a standard t-test is invalid given that the residuals are biased.

indicator against strict exogeneity (Murray, 2006). Additionally, because the instruments are similar, the rejection of the null would also provide evidence against the exogeneity of both instruments.

[**Table 7 about here**]

Table 7 presents some evidence against instrument exogeneity. In Panel A, we estimate models using the alternative instrument only (i.e., the models are exactly-identified). We find that the relationship between gender and risk in the second-stage regressions flips signs and is now positive. Finding the opposite results when using a related alternative instrument casts further doubt on the validity of female connections of male directors as an instrument for female board participation. We then combine the two instruments in overidentified models in Panel B. We find that the relation between gender and risk is not statistically significant in any of the models. Additionally, the Hansen test statistics lead us to reject the null hypothesis that the instruments are jointly exogenous.

Taken together, our results indicate that the connections of male directors to other women directors is not a valid instrument, at least in our setting where risk measures are used as the dependent variable.

5.4. Alternative identification strategy – DID matching estimator

One possible explanation for not detecting an effect of gender diversity on firm risk could be that the proportion of female directors is not an appropriate metric to identify gender diversity. Figure 1 shows a line plot of the proportion of female board members over time. We observe that changes in female boardroom representation come from two sources of variation: first, an increase in the number of female directors on boards and, second, a decrease in overall board size. It is evident from Figure 1 that during our sampling period average board size has decreased faster than the rate at which the number of female directors has increased. Similarly, Table 2 also shows that changes in the proportion of female board members is mainly driven by changes in board size with turnover of female directors affecting about 10% of firms each year. Therefore, this section demonstrates that our results are robust to an alternative identification of the effects of gender diversity on risk. We employ a difference-in-difference matching estimator and exploit changes in gender diversity that come from female director appointments to identify whether female directors affect risk.

[Figures 1 about here]

The difference-in-difference matching estimator 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 and Whited, 2011). The DID estimator can be implemented by estimating the following equation.

$$\begin{aligned}\text{Risk}_{i,t} = \alpha_0 + \alpha_1 (\text{Female Appointment})_{i,t} \times (\text{Post Period})_{i,t} \\ + \alpha_2 (\text{Female Appointment})_{i,t} + \alpha_3 (\text{Post Period})_{i,t} \\ + \mathbf{CONTROL}_{i,t}\mathbf{\Gamma} + \varepsilon_{i,t}\end{aligned} \tag{4}$$

The variable *female appointment* is a dummy variable that takes the value of one when the firm is in the treatment group and zero when the firm is in the control group. *Post period* takes the value of one in the post-treatment period (and zero before treatment).

We select our treatment group such that it excludes director appointments that are likely to result from a change in strategy and which may themselves affect firm risk. To be included in the treatment group, the firm must appoint only one female director in that year to replace a departing male director. We require that the departing director must be older than 60[23]. Applying these criteria, we are able to identify 153 female director appointments for our treatment group.

[23]This ensures that director turnover is more likely to be caused by retirement than by shareholders forcing out a director over dissatisfaction with the firm.

Further, we match treatment firms to similar control firms. We identify 737 control observations that appoint one male director in that year to replace another departing male director. The departing director in our control firms also must be older than 60. We then match treatment and control firms using their propensity to replace a departing male director with a female director[24].

In addition to propensity score matching, we also employ the nearest-neighbor matching method in order to include all our treatment firms in the estimation. We use the matching procedure of Abadie, Drukker, Herr, and Imbens (2004) and use variables from Model 1 in Table 3 as our matching covariates. We match each treatment firm with its four nearest neighbors.

The difference-in-difference results using both matching techniques are reported in Table 8. The coefficients on (Female Appointment)$_{i,t}\times$(Post Period)$_{i,t}$ are not statistically different from zero. Therefore, the difference in risk of firms with female director appointments is not statistically different from firms without female appointments to the board. This result is consistent across the three risk measures and both matching procedures.

[Table 8 about here]

As robustness checks, we also run propensity-score matching DID estimations with varying levels of restrictions (see Table A4). We expand the number of matches by relaxing the propensity score restriction from 5% to 10%. We also estimate the model with the propensity score restriction set to 2%, 1% and 0.5%. The results confirm our 5% baseline finding that there is no statistically significant change in risk after a male director is replaced by a female director.

Similarly, for the nearest-neighbor matching procedure, there is a trade-off between efficiency gain from using multiple matches and including overly dissimilar firms in the estimation. Therefore, we vary the number of matches for each treatment firm from 4 to 1, 2, 3, 5

[24]The propensity scores of these observations are computed based on Model 1 in Table 3. We employ matching with replacement and require that the difference in the propensity scores of treatment and matched firms does not exceed 5%. We are able to match 103 observations in the treatment group to at least one control observation.

and 6 and confirm our baseline results. Overall, although we find in the sample that firms with a larger proportion of female directors have lower equity risk, the evidence does not support the notion that greater female boardroom representation leads to lower firm risk.

However, the risk measures employed so far in this study are based on stock price information. Market-based risk measures, similar to profitability measures, are also functions of many other factors than board, CEO and firm characteristics. Any relationship between board composition and firm outcomes may therefore be difficult to detect (Hermalin and 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 in the next section.

5.5. Alternative measures of firm risk

Although we find no evidence that links boardroom gender diversity to equity risk, gender difference in risk appetite may still be reflected in firm policies. That is, a more gender diverse board may act differently from a more male-dominated board in terms of risk-taking behavior even though these differences are not reflected in a firm's stock volatility. Therefore, we explore risk-taking incentives, various risk-taking corporate policies and their relationship with boardroom gender diversity.

First, we investigate the relation between gender diversity and CEO compensation. One function of the board is to determine the remuneration policies in a way that align CEO incentives with a company's objectives. If female directors were to differ in terms of risk-taking tolerance and behavior, this may also be reflected in the compensation packages that gender diverse boards offer to the CEO. Risk-taking incentive is proxied by CEO vega. In addition to other board characteristics (board size, board independence and director connectedness), we follow Coles et al. (2006) and include CEO delta, cash compensation, various firm characteristics and firm total risk as control variables.

Next, we examine whether gender diversity is related to R&D expenditure, diversification and leverage. R&D spending is considered risky as the payoffs are highly uncertain ex ante. Thus, gender diversity could have some relation to the level of R&D spending after controlling for its other determinants. Further, a less diversified range of revenue sources means a firm's turnover is likely to be more sensitive to demand for fewer products. Thus, more diversified firms are considered less risky. We use the Herfindhal-Hirschman index for revenue concentration to measure the degree of diversification[25]. Lastly, higher leverage can also be considered risky. Leverage is measured by the debt-to-equity ratio using the book value of firm equity. Control variables for these estimations follow prior literature (e.g. Coles et al., 2006) (e.g. Coles et al., 2006).

Finally, we use an alternative proxy of firm risk based on operating performance. The variable S.D.(ROA) is constructed as the standard deviation of firm return on assets in the next five years. Control variables for the S.D.(ROA) equation are the same as for our model of equity risk measures.

[**Table 9 about here**]

The first column of Table 9 shows no statistically significant relation between the proportion of women and CEO vega. We also explore the relationship between CEO compensation and the proportion of female directors on the compensation committee and find no evidence that female representation affects compensation.

The remainder of Table 9 shows the estimated relation between gender diversity and various risk-taking policy measures. Female boardroom representation cannot explain the variation in any of the risk-relevant firm policies we examine, except for the level of diversification (significant at the 10% level). We also do not find any significant relation between the proportion of women and the standard deviation of return on assets. Overall, female boardroom representation does not impact risk policies.

[25]We also use number of business segments (in log form) as a proxy for diversification and find qualitatively similar results.

5.6. *Are banks different? Evidence from bank holding companies*

In this section, we analyze a sample of bank-holding companies (BHCs), which, as customary in most governance studies, have been excluded from the main analysis. We build a sample of 138 BHCs (881 observations) with data available on RiskMetrics, Compustat, Execucomp and CRSP. This analysis allows us to compare our results with prior works on gender diversity in bank boards (e.g. Adams and Ragunathan, 2013).

Table 10 reports ordinary least squares, fixed effects and dynamic panel estimates of equity risk measures on the proportion of female directors and control variables. We include the same set of board characteristics and CEO risk-taking incentives as in our main analysis and add several BHC characteristics. We include bank size (the logarithm of total assets) to control for bank complexity. We control for (the logarithm of) asset growth (Berger et al., 2014) and charter value as proxied by Tobin's Q (Morrison and White, 2005). We also control for differences in the balance sheet and asset composition using the ratios of loans and deposits to assets and the proportion of bank loans that are non-performing. Finally, we include the tier-1 capital adequacy ratio to control for moral hazard and monitoring incentives (Keeley, 1990).

Our results regarding the effect of gender diversity on risk in BHCs are the same as those for our main sample. We find no statistically significant effect of the proportion of women directors on risk in any specification.

6. Conclusion

Many US firms are under increasing public pressure to embrace more gender diversity in the boardroom. Although there presently is no mandatory gender quota in the US, SEC disclosure rules and pressure from various firm stakeholder groups are likely to nudge US firms towards appointing a greater proportion of female directors in the near future. As the level of female participation on boards of directors increases, the current literature provides only limited and inconsistent evidence regarding the economic impact that higher female representation might bring to the firm.

Drawing on 15 years of data and almost 2,000 firms, our study contributes to this debate by investigating the relationship between boardroom gender diversity and equity risk. We show that female boardroom representation is a choice that boards make and that firm risk influences this choice. We then demonstrate that after controlling for two sources of endogeneity – unobserved heterogeneity and reverse causality – there is no evidence that female boardroom representation affects any of the equity risk measures included in this study. We also show that spurious links between gender diversity and risk are driven by unobserved firm heterogeneity that influences both the gender composition of a board and firm risk. Consistent with gender diversity not affecting firm risk, we also show that female board representation does not affect a range of policy measures or an operating measure of risk.

Our main conclusion is straightforward. A board with a higher proportion of female directors is no more or less risk-taking than a more male-dominated board. This result hinges on careful identification of the causal relationship between director gender and firm risk. A key implication of our paper, therefore, is that studies which attempt to link the demographic characteristics of corporate decision-makers to firm outcomes have to carefully consider how to causally isolate firm outcomes from between-firm heterogeneous factors that influence both the demographic characteristics in the boardroom and the firm outcomes. Empirical set-ups that are unable to distinguish between the two will lead to biased results and policy conclusions that are not empirically justified.

Ultimately, the case for greater gender diversity on corporate boards rests on a sense of fairness rather than on pure economic considerations. The lack of strong empirical evidence on the relationship between gender diversity and risk, therefore, does not make gender diversity any more or less desirable. Still, our results do point to a gender bias in the director appointment process. Discriminatory practices in the recruitment of directors should attract scrutiny by regulators. Since we find evidence of gender bias, our results at first glance support mandatory gender quotas. However, we have to consider the possibility that firms' existing board characteristics are already optimal given a firm's internal and external environments. Thus, regulations such as gender quotas could cause a deviation from optimality and adversely impact on firm value. Consistent with this, Ahern and Dittmar (2012) show value losses around the implementation of a gender quota law in Norway. Therefore, regulations around increased diversity disclosure and demands for more diversity by outside stakeholders offer a more cautious route towards encourage firms to bring more gender diversity to their boardrooms.

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Table 1: Summary Statistics

This table reports summary statistics for the full sample and subsamples by the number of women on board. The sample comprises 13,581 observations (firm-years) from 1,960 firms between 1996-2010. Board characteristics are obtained from the RiskMetrics database. CEO risk-taking incentives are computed using data from Execucomp. Firm characteristics are obtained from Compustat and risk measures are computed using price data from the Center for Research in Security Prices. CEO risk-taking incentives and firm characteristics are winsorized at the 1st and 99th percentile values. All variables are defined in Table A1.

	Full Sample					Number of Women on Board				
	Mean	S.D.	p25	p50	p75	0	1	2	3	4 – 6
Board Characteristics										
Firms with At Least One Women	0.628	0.483	0.000	1.000	1.000					
Number of Women	0.938	0.925	0.000	1.000	1.000					
Proportion of Women	0.096	0.092	0.000	0.100	0.143					
Board Size	9.098	2.386	7.000	9.000	11.000	7.665	9.392	10.638	11.251	12.506
Board Independence	0.687	0.171	0.571	0.714	0.833	0.640	0.696	0.737	0.768	0.753
Director Connectedness	5.805	5.920	2.000	4.000	8.000	2.961	6.490	8.797	9.888	10.976
Male Director Connectedness	5.040	5.119	1.000	4.000	7.000	2.961	5.755	7.080	7.279	6.792
Proportion of Male Directors with Board Connections to Women	0.290	0.243	0.111	0.250	0.444	0.168	0.327	0.405	0.464	0.479
CEO Risk-Taking Incentives										
CEO Vega	0.145	0.227	0.022	0.063	0.164	0.081	0.141	0.222	0.336	0.363
CEO Delta	0.728	1.622	0.095	0.245	0.641	0.604	0.700	0.959	0.946	1.024
CEO Tenure	6.924	7.513	2.000	5.000	10.000	8.121	6.654	5.547	5.226	5.976
CEO Cash Compensation	1.218	1.012	0.605	0.922	1.430	0.908	1.260	1.593	1.790	1.671
Firm Characteristics										
Market-to-Book	2.027	1.266	1.244	1.624	2.314	2.074	1.986	2.036	1.959	1.946
R&D Expenditure	0.046	0.091	0.000	0.004	0.050	0.064	0.041	0.030	0.022	0.019
Capital Expenditure	0.069	0.111	0.021	0.038	0.068	0.086	0.064	0.053	0.045	0.046
Leverage	0.215	0.169	0.062	0.208	0.327	0.192	0.219	0.244	0.237	0.270
Ln(Total Assets)	7.398	1.482	6.330	7.246	8.325	6.670	7.533	8.184	8.738	8.717
Return on Assets	0.044	0.098	0.020	0.054	0.091	0.033	0.047	0.054	0.059	0.058
Ln(1+Sales Growth)	0.090	0.237	0.001	0.082	0.177	0.116	0.084	0.063	0.052	0.058
Surplus Cash	0.092	0.097	0.038	0.082	0.136	0.091	0.093	0.091	0.089	0.082
Net PP&E	0.283	0.215	0.116	0.224	0.398	0.272	0.291	0.286	0.289	0.288
Dividends	0.527	0.499	0.000	1.000	1.000	0.356	0.569	0.704	0.768	0.839
Firm Age	25.975	16.170	12.000	21.000	40.000	19.537	27.329	32.751	37.456	36.589
Diversification	0.718	0.406	0.461	0.745	1.000	0.770	0.718	0.640	0.630	0.674
Risk Measures										
Total Risk	0.451	0.214	0.303	0.400	0.545	0.516	0.429	0.393	0.372	0.372
Systematic Risk	1.276	0.644	0.839	1.186	1.600	1.452	1.222	1.116	1.003	0.986
Idiosyncratic Risk	0.393	0.191	0.262	0.348	0.476	0.453	0.373	0.337	0.317	0.319
S.D.(ROA)	0.055	0.094	0.015	0.028	0.058	0.068	0.051	0.041	0.039	0.040
Observations	13,581					5,056	5,228	2,603	526	168
% of Full Sample	100%					37%	38%	19%	4%	1%

Table 2: Change in Board Variables Over Time

This table displays the proportion of firms in the sample that change their number of women on board, proportion of women on board, board size and board independence over any one-year period between 1996-2010. The results are based on a sample of 1,960 firms (13,581 firm-years) from the RiskMetrics database.

	Change in				
Year	Number of Women	Proportion of Women	Board Size	Board Independence	# Firms (Firm-Years)
1997	7.61%	29.39%	37.24%	50.23%	854
1998	9.61%	30.60%	40.69%	54.80%	843
1999	9.72%	29.86%	36.46%	51.85%	864
2000	11.58%	29.98%	38.74%	52.38%	924
2001	11.86%	30.21%	39.69%	54.02%	970
2002	11.46%	31.48%	40.25%	52.63%	969
2003	13.60%	35.38%	45.30%	60.22%	978
2004	14.24%	36.18%	45.15%	59.39%	948
2005	13.06%	36.72%	43.79%	56.00%	934
2006	12.60%	37.53%	42.82%	55.96%	738
2007	10.49%	28.54%	32.53%	46.07%	953
2008	12.63%	35.11%	41.68%	49.08%	974
2009	11.24%	34.95%	43.61%	50.62%	970
2010	10.80%	32.82%	37.35%	44.55%	972
Average	11.46%	32.77%	40.38%	52.70%	921
1997-2010					
Percentage of Firms	40.26%	54.59%	74.80%	80.36%	1,960
Percentage of Firm-Years	10.92%	31.09%	38.34%	49.97%	(13,581)

Table 3: Determinants of Gender in Director Appointments

The dependent variable, *Female Appointment*, is a dummy variable which equals one when women directors are appointed and zero otherwise. Columns 1 and 2 report results from probit regressions and Columns 3 and 4 report results from a linear probability model with firm-level fixed effects. The sample includes all firm-years where at least one director is appointed. Cluster-robust standard errors are reported in parentheses. All independent variables are lagged by one period. All specifications include year fixed effects. Columns 1 and 2 include industry fixed effects based on two-digit NAICS code. Intercepts are included but not reported. *, **, *** denote statistical significance at 10%, 5% and 1% respectively.

Dependent Variable =	Female Appointment			
	Probit		Fixed Effects	
	(1)	(2)	(3)	(4)
Total Risk	−0.168**		−0.060*	
	(0.073)		(0.035)	
Systematic Risk		−0.041		0.007
		(0.045)		(0.019)
Idiosyncratic Risk		−0.112		−0.072*
		(0.085)		(0.037)
Women Departing the Board	0.688***	0.688***	0.237***	0.237***
	(0.068)	(0.068)	(0.027)	(0.027)
Men Departing the Board	−0.049	−0.050	−0.011	−0.010
	(0.041)	(0.041)	(0.015)	(0.015)
Proportion of Male Directors with Board	0.229**	0.230**	0.037	0.037
Connections to Women	(0.104)	(0.104)	(0.056)	(0.056)
Proportion of Women	−2.721***	−2.726***	−3.401***	−3.398***
	(0.325)	(0.324)	(0.159)	(0.158)
Board Size	0.011	0.011	−0.023***	−0.023***
	(0.011)	(0.011)	(0.007)	(0.007)
Board Independence	0.156	0.156	0.110	0.111
	(0.130)	(0.130)	(0.073)	(0.073)
Ln(Total Assets)	0.079***	0.081***	0.063**	0.061**
	(0.019)	(0.019)	(0.026)	(0.026)
Market-to-Book	0.039**	0.041**	0.010	0.009
	(0.018)	(0.018)	(0.009)	(0.009)
R&D Expenditure	−0.356	−0.340	−0.162	−0.173
	(0.315)	(0.316)	(0.226)	(0.225)
Capital Expenditure	−0.311	−0.302	−0.054	−0.064
	(0.242)	(0.243)	(0.121)	(0.122)
Leverage	−0.034	−0.038	−0.089	−0.086
	(0.139)	(0.139)	(0.079)	(0.079)
Return on Assets	−0.105	−0.112	−0.110	−0.111
	(0.266)	(0.266)	(0.107)	(0.107)
Observations	7,101	7,101	7,101	7,101
R^2	0.059	0.059	0.401	0.401

Table 4: Risk Measures on Female Boardroom Representation (DPS-GMM)

This table reports two-step Dynamic Panel System GMM estimations of risk measures on the proportion of women on board and control variables. All models include year dummy variables. All independent variables are treated as endogenous except *Ln(1+Firm Age)* and year dummy variables. Endogenous variables are instrumented by two of their past values. In parentheses are finite-sample robust standard errors (Windmeijer, 2005). The null hypothesis for the Hansen test of overidentification is that all instruments are exogenous. 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 first-difference residuals. * , ** , *** denote statistical significance at 10%, 5% and 1% respectively.

Risk Measure =	Total Risk (1)	Systematic Risk (2)	Idiosyncratic Risk (3)
Proportion of Women	0.075	−0.743	0.134
	(0.157)	(0.566)	(0.168)
Board Size	0.018*	0.023	0.015
	(0.011)	(0.034)	(0.012)
Board Independence	0.169	0.482	0.062
	(0.132)	(0.403)	(0.147)
Director Connectedness	−0.004	−0.016	−0.004
	(0.004)	(0.013)	(0.004)
CEO Vega	−0.065	−0.036	−0.098
	(0.068)	(0.245)	(0.070)
CEO Delta	0.016	0.024	0.008
	(0.015)	(0.045)	(0.016)
CEO Tenure	0.002	−0.008	0.003
	(0.002)	(0.006)	(0.002)
CEO Cash Compensation	−0.036*	0.081	−0.005
	(0.022)	(0.066)	(0.022)
Market-to-Book	0.039	0.139	0.037
	(0.029)	(0.095)	(0.030)
R&D Expenditure	0.234	−0.527	0.277
	(0.419)	(0.928)	(0.424)
Capital Expenditure	−0.246	−0.090	−0.279
	(0.261)	(0.683)	(0.297)
Ln(1+Sales Growth)	0.147*	0.178	0.078
	(0.081)	(0.196)	(0.085)
Leverage	−0.232**	−0.824**	−0.201**
	(0.098)	(0.342)	(0.102)
Ln(Total Assets)	−0.039*	−0.068	−0.043**
	(0.021)	(0.053)	(0.022)
Ln(1+Firm Age)	0.046**	−0.021	0.022
	(0.021)	(0.056)	(0.023)
Diversification	0.184	−0.240	0.172
	(0.119)	(0.199)	(0.111)
Return on Assets	−1.443***	−0.326	−1.708***
	(0.409)	(0.784)	(0.438)
Surplus Cash	−0.448	−2.384**	−0.247
	(0.491)	(1.166)	(0.459)
Risk Measure (Lag 1)	0.451***	0.281	0.512***
	(0.114)	(0.178)	(0.130)
Risk Measure (Lag 2)	0.163*	0.264*	0.046
	(0.091)	(0.136)	(0.099)
Observations	8,629	8,629	8,629
Hansen (df=38)	44.032	36.489	45.202
AR(1)	−4.557***	−2.365**	−4.549***
AR(2)	−1.072	−1.029	0.124

Table 5: Risk Measures on Female Boardroom Representation (OLS and Firm-Level Fixed Effects)

This table reports ordinary least squares (OLS) and firm-level fixed effects estimations of risk measures on proportion of women and control variables. Cluster-robust standard errors are reported in parentheses. All models include year dummy variables. OLS models also include industry dummy variables based on two-digit NAICS code. Within-cluster heteroskedasticity and serial correlation robust standard errors are reported in parentheses. Intercepts are included but not reported. * , ** , *** denote statistical significance at 10%, 5% and 1% respectively.

	Panel A: Ordinary Least Squares			Panel B: Firm-level Fixed Effects		
Risk Measure =	Total Risk	Systematic Risk	Idiosyncratic Risk	Total Risk	Systematic Risk	Idiosyncratic Risk
Proportion of Women	−0.123**	−0.351***	−0.085	0.032	−0.030	0.056
	(0.052)	(0.089)	(0.053)	(0.065)	(0.121)	(0.065)
Board Size	−0.015***	−0.030***	−0.013***	−0.008***	−0.018***	−0.008***
	(0.003)	(0.004)	(0.003)	(0.003)	(0.005)	(0.003)
Board Independence	0.003	0.012	0.006	−0.017	0.006	−0.025
	(0.030)	(0.054)	(0.030)	(0.031)	(0.063)	(0.030)
Director Connectedness	−0.002**	−0.003	−0.002*	0.002	0.002	0.002*
	(0.001)	(0.002)	(0.001)	(0.001)	(0.002)	(0.001)
CEO Vega	−0.101***	−0.307***	−0.074***	−0.159***	−0.300***	−0.146***
	(0.023)	(0.044)	(0.022)	(0.024)	(0.041)	(0.023)
CEO Delta	0.012***	0.019***	0.011***	0.008**	0.005	0.009***
	(0.003)	(0.006)	(0.003)	(0.003)	(0.006)	(0.003)
CEO Tenure	−0.000	0.000	−0.000	0.001**	0.003**	0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
CEO Cash Compensation	−0.001	−0.012	0.003	−0.014***	−0.023***	−0.012***
	(0.005)	(0.008)	(0.004)	(0.004)	(0.008)	(0.004)
Market-to-Book	0.006	0.065***	0.001	0.018***	0.108***	0.006
	(0.004)	(0.010)	(0.004)	(0.004)	(0.009)	(0.004)
R&D Expenditure	0.494***	1.252***	0.486***	−0.269***	0.384	−0.357***
	(0.060)	(0.143)	(0.060)	(0.094)	(0.233)	(0.089)
Capital Expenditure	0.017	0.271***	−0.015	0.026	0.426***	−0.030
	(0.045)	(0.092)	(0.045)	(0.055)	(0.118)	(0.051)
Ln(1+Sales Growth)	0.072***	0.127***	0.082***	0.049***	0.088***	0.053***
	(0.015)	(0.028)	(0.015)	(0.014)	(0.025)	(0.014)
Leverage	−0.044	−0.306***	−0.002	0.092**	−0.019	0.130***
	(0.031)	(0.057)	(0.031)	(0.041)	(0.084)	(0.040)
Ln(Total Assets)	−0.047***	0.037***	−0.063***	−0.065***	0.050**	−0.088***
	(0.005)	(0.010)	(0.005)	(0.013)	(0.024)	(0.013)
Ln(1+Firm Age)	−0.078***	−0.076***	−0.088***	−0.336***	−0.596***	−0.262***
	(0.009)	(0.016)	(0.009)	(0.037)	(0.071)	(0.035)
Diversification	0.012	−0.020	0.023*	0.006	−0.009	0.007*
	(0.009)	(0.014)	(0.013)	(0.004)	(0.011)	(0.004)
Return on Assets	−0.993***	−1.224***	−1.007***	−0.531***	−0.610***	−0.548***
	(0.048)	(0.104)	(0.050)	(0.045)	(0.093)	(0.046)
Surplus Cash	−0.166***	−0.579***	−0.101**	−0.174***	−0.544***	−0.131***
	(0.053)	(0.131)	(0.050)	(0.040)	(0.093)	(0.041)
Observations	13,581	13,581	13,581	13,581	13,581	13,581
R^2	0.595	0.327	0.596	0.613	0.205	0.595

Table 6: Instrumental Variable Regressions with Firm-Level Fixed Effects

This table reports two-stage least squares regressions with firm-level fixed effects of firm equity risk measures on the proportion of women on board and control variables. Proportion of women is treated as endogenous and is instrumented using the proportion of male directors with board connections to female directors. Director connectedness is defined as the average number of external board seats held by a director. Male director connectedness is defined as the average number of external board seats held by a male director. Other control variables are defined in Table A1. All dependent and independent variables are time-demeaned in both first-stage and second-stage regressions. All models include year dummy variables. Within-cluster heteroskedasticity and serial correlation robust standard errors are reported in parentheses. Intercepts are included but not reported. * , ** , *** denote statistical significance at 10%, 5% and 1% respectively.

	(A) Including Director Connectedness				(B) Including Male Director Connectedness			
	Proportion of Women	Total Risk	Systematic Risk	Idiosyncratic Risk	Proportion of Women	Total Risk	Systematic Risk	Idiosyncratic Risk
Proportion of Women		−6.734	−9.885	−6.780		−1.063**	−1.880**	−1.076**
		(5.352)	(8.729)	(5.320)		(0.479)	(0.946)	(0.473)
Board Size	0.000	−0.008	−0.018**	−0.009	0.003***	−0.005*	−0.014***	−0.006**
	(0.001)	(0.006)	(0.009)	(0.006)	(0.001)	(0.003)	(0.006)	(0.003)
Board Independence	0.066***	0.432	0.660	0.428	0.068***	0.065	0.141	0.059
	(0.008)	(0.360)	(0.584)	(0.358)	(0.008)	(0.047)	(0.092)	(0.047)
CEO Vega	0.005	−0.124**	−0.249***	−0.110**	0.002	−0.155***	−0.292***	−0.141***
	(0.006)	(0.054)	(0.085)	(0.054)	(0.006)	(0.024)	(0.042)	(0.024)
CEO Delta	0.000	0.009	0.007	0.010	0.000	0.008**	0.005	0.009**
	(0.001)	(0.007)	(0.011)	(0.007)	(0.001)	(0.004)	(0.006)	(0.004)
CEO Tenure	−0.000	0.000	0.001	−0.000	−0.000	0.001	0.003**	0.001
	(0.000)	(0.002)	(0.003)	(0.002)	(0.000)	(0.001)	(0.001)	(0.001)
CEO Cash Compensation	0.000	−0.013	−0.022	−0.011	0.000	−0.013***	−0.022***	−0.011**
	(0.001)	(0.008)	(0.013)	(0.008)	(0.001)	(0.005)	(0.008)	(0.005)
Market-to-Book	0.000	0.021**	0.113***	0.009	0.001	0.019***	0.110***	0.007
	(0.001)	(0.008)	(0.015)	(0.008)	(0.001)	(0.004)	(0.010)	(0.004)
R&D Expenditure	−0.050**	−0.604*	−0.104	−0.695**	−0.052**	−0.322***	0.295	−0.411***
	(0.024)	(0.324)	(0.531)	(0.327)	(0.023)	(0.097)	(0.235)	(0.095)
Capital Expenditure	−0.015	−0.075	0.280	−0.131	−0.016*	0.006	0.394***	−0.050
	(0.009)	(0.119)	(0.208)	(0.116)	(0.009)	(0.057)	(0.123)	(0.053)
Ln(1+Sales Growth)	−0.000	0.045**	0.082**	0.049**	−0.001	0.048***	0.085***	0.052***
	(0.002)	(0.021)	(0.033)	(0.022)	(0.002)	(0.014)	(0.025)	(0.015)
Leverage	−0.002	0.076	−0.043	0.113	−0.002	0.089**	−0.024	0.126***
	(0.009)	(0.075)	(0.123)	(0.076)	(0.009)	(0.042)	(0.085)	(0.041)
Ln(Total Assets)	0.001	−0.060***	0.058	−0.082***	0.002	−0.063***	0.054**	−0.085***
	(0.003)	(0.022)	(0.036)	(0.023)	(0.003)	(0.013)	(0.025)	(0.013)
Ln(1+Firm Age)	0.013	−0.252***	−0.473***	−0.177*	0.022**	−0.310***	−0.556***	−0.236***
	(0.009)	(0.096)	(0.155)	(0.096)	(0.009)	(0.039)	(0.074)	(0.038)
Diversification	−0.003	−0.012	−0.035	−0.011	−0.002	0.002	−0.014	0.003
	(0.002)	(0.019)	(0.033)	(0.018)	(0.002)	(0.005)	(0.013)	(0.004)
Return on Assets	−0.011	−0.602***	−0.714***	−0.620***	−0.013	−0.546***	−0.635***	−0.564***
	(0.009)	(0.096)	(0.161)	(0.097)	(0.009)	(0.047)	(0.097)	(0.048)
Surplus Cash	−0.004	−0.203***	−0.587***	−0.161**	−0.004	−0.180***	−0.555***	−0.138***
	(0.010)	(0.075)	(0.127)	(0.076)	(0.010)	(0.040)	(0.092)	(0.040)
Director Connectedness	0.000	0.005	0.006	0.006				
	(0.000)	(0.004)	(0.006)	(0.004)				
Male Director Connectedness					−0.004***	−0.001	−0.003	−0.001
					(0.000)	(0.002)	(0.003)	(0.002)
Proportion of Male Directors with Board Connections to Women	0.011				0.062***			
	(0.008)				(0.008)			
Observations	13,581	13,581	13,581	13,581	13,581	13,581	13,581	13,581
Kleibergen-Paap	1.986				47.933			

Table 7: Alternative Instrumental Variable

This table reports two-stage least squares regressions with firm-level fixed effects of firm equity risk measures on the proportion of women on board and control variables. In Panel A, the proportion of women is instrumented using the proportion of male directors with board connections to female directors. In Panel B, the proportion of women is instrumented using the proportion of male directors with board connections and the proportion of men's other directorships with at least one female director. Other control variables are defined in Table A1. All dependent and independent variables are time-demeaned in both first-stage and second-stage regressions. All models include year dummy variables. Within-cluster heteroskedasticity and serial correlation robust standard errors are reported in parentheses. Intercepts are included but not reported. * , ** , *** denote statistical significance at 10%, 5% and 1% respectively.

	(A) Exactly Identified Model				(B) Overidentified Model			
	Proportion of Women	Total Risk	Systematic Risk	Idiosyncratic Risk	Proportion of Women	Total Risk	Systematic Risk	Idiosyncratic Risk
Proportion of Women		0.864*	1.467	0.814*		−0.116	−0.235	−0.147
		(0.468)	(0.996)	(0.461)		(0.224)	(0.434)	(0.224)
Board Size	0.002**	−0.009***	−0.020***	−0.009***	0.004***	−0.007***	−0.017***	−0.008***
	(0.001)	(0.003)	(0.006)	(0.003)	(0.001)	(0.003)	(0.005)	(0.003)
Board Independence	0.074***	−0.075	−0.102	−0.078*	0.067***	−0.004	0.022	−0.008
	(0.008)	(0.047)	(0.099)	(0.046)	(0.008)	(0.035)	(0.070)	(0.034)
Male Director Connectedness	−0.002***	0.003*	0.005	0.004**	−0.005***	0.001	0.001	0.001
	(0.000)	(0.002)	(0.003)	(0.002)	(0.000)	(0.002)	(0.003)	(0.002)
CEO Vega	0.004	−0.162***	−0.306***	−0.149***	−0.001	−0.158***	−0.299***	−0.145***
	(0.006)	(0.025)	(0.043)	(0.024)	(0.006)	(0.024)	(0.041)	(0.023)
CEO Delta	0.000	0.008**	0.005	0.008**	0.000	0.008**	0.005	0.009**
	(0.001)	(0.003)	(0.006)	(0.003)	(0.001)	(0.003)	(0.006)	(0.003)
CEO Tenure	−0.000	0.002**	0.003***	0.001*	−0.000	0.001**	0.003**	0.001
	(0.000)	(0.001)	(0.001)	(0.001)	(0.000)	(0.001)	(0.001)	(0.001)
CEO Cash Compensation	0.000	−0.014***	−0.023***	−0.012***	0.000	−0.014***	−0.022***	−0.012***
	(0.001)	(0.004)	(0.008)	(0.004)	(0.001)	(0.004)	(0.008)	(0.004)
Market-to-Book	0.001	0.018***	0.107***	0.005	0.001	0.018***	0.109***	0.006
	(0.001)	(0.004)	(0.009)	(0.004)	(0.001)	(0.004)	(0.009)	(0.004)
R&D Expenditure	−0.044*	−0.230**	0.454*	−0.321***	−0.050**	−0.277***	0.373	−0.367***
	(0.023)	(0.099)	(0.245)	(0.093)	(0.022)	(0.094)	(0.234)	(0.089)
Capital Expenditure	−0.016*	0.039	0.451***	−0.018	−0.014	0.022	0.422***	−0.034
	(0.009)	(0.056)	(0.117)	(0.052)	(0.009)	(0.055)	(0.118)	(0.051)
Ln(1+Sales Growth)	−0.001	0.050***	0.090***	0.054***	−0.001	0.049***	0.088***	0.053***
	(0.002)	(0.014)	(0.025)	(0.014)	(0.002)	(0.014)	(0.025)	(0.014)
Leverage	−0.004	0.095**	−0.015	0.131***	−0.005	0.092**	−0.019	0.129***
	(0.009)	(0.041)	(0.085)	(0.040)	(0.008)	(0.041)	(0.084)	(0.040)
Ln(1+Total Assets)	0.003	−0.067***	0.047*	−0.089***	0.003	−0.065***	0.051**	−0.087***
	(0.003)	(0.013)	(0.025)	(0.013)	(0.003)	(0.013)	(0.024)	(0.013)
Ln(1+Firm Age)	0.022**	−0.352***	−0.628***	−0.276***	0.023***	−0.331***	−0.591***	−0.255***
	(0.009)	(0.039)	(0.077)	(0.036)	(0.009)	(0.037)	(0.072)	(0.035)
Diversification	−0.003*	0.008*	−0.004	0.009**	−0.002	0.005	−0.010	0.006
	(0.002)	(0.004)	(0.010)	(0.004)	(0.002)	(0.004)	(0.011)	(0.004)
Return on Assets	−0.014	−0.520***	−0.590***	−0.538***	−0.015	−0.533***	−0.613***	−0.551***
	(0.009)	(0.045)	(0.094)	(0.047)	(0.009)	(0.045)	(0.094)	(0.046)
Surplus Cash	−0.006	−0.169***	−0.535***	−0.127***	−0.003	−0.175***	−0.545***	−0.133***
	(0.009)	(0.042)	(0.097)	(0.043)	(0.009)	(0.040)	(0.093)	(0.040)
Proportion Of Male External Board Seats with Women	−0.023***				−0.048***			
	(0.003)				(0.003)			
Proportion of Male Directors with Board Connections to Women					0.126***			
					(0.009)			
Observations	13,360	13,360	13,360	13,360	13,360	13,360	13,360	13,360
Kleibergen-Paap	62.782				130.544			
Hansen ($\chi^2 = 1$)						5.698**	3.928**	5.657**

Table 8: Effect of Female Director Appointments on Risk Measures

This table reports results from difference-in-difference estimations. Dependent variables are firm equity risk measures. Treatment observations are firms that replace a departing male director with a female director. Control observations are firms that replace a departing male director with another male director. In Panel A, treatment firms are matched with control firms of similar propensity (within 5%) of appointing a women director. Propensity scores are calculated from Model 1 in Table 3. In Panel B, treatment firms are matched with control firms using the nearest-neighbor matching methods (Abadie et al., 2004). Matching variables are the independent variables in Model 1 of Table 3. Additionally, treatment firms and matched control firms must be in the same year and industry. *Female Appointment* is a dummy variable which equals one if the firm appoints a female director and zero otherwise. *Post Period* is a dummy variable which equals one in the period after the appointment and zero in the period before. Control variables are defined in Table A1. Within-cluster heteroskedasticity and serial correlation robust standard errors are reported in parentheses. Intercepts are included but not reported. *, **, *** denote statistical significance at 10%, 5% and 1% respectively.

	Panel A: Propensity Score Matching			Panel B: Nearest Neighbor Matching		
Dependent Variable =	Total Risk	Systematic Risk	Idiosyncratic Risk	Total Risk	Systematic Risk	Idiosyncratic Risk
Female Appointment	−0.007	0.020	−0.002	−0.005	0.01	−0.005
× Post Period	(0.038)	(0.066)	(0.039)	(0.021)	(0.042)	(0.022)
Female Appointment	−0.054*	−0.093*	−0.056*	−0.032	−0.056	−0.031
	(0.028)	(0.050)	(0.029)	(0.024)	(0.045)	(0.024)
Post Period	−0.003	−0.003	−0.007	−0.003	0.004	−0.003
	(0.015)	(0.029)	(0.016)	(0.013)	(0.024)	(0.013)
Board Size	−0.032***	−0.072***	−0.029***	−0.024***	−0.046***	−0.020**
	(0.004)	(0.007)	(0.004)	(0.008)	(0.014)	(0.009)
Board Independence	−0.064	−0.119	−0.103*	−0.059	−0.067	−0.064
	(0.052)	(0.102)	(0.053)	(0.084)	(0.153)	(0.082)
Director Connectedness	0.034**	0.053*	0.039**	0.022	0.112**	0.006
	(0.017)	(0.032)	(0.017)	(0.030)	(0.053)	(0.029)
CEO Vega	−0.000***	−0.000***	−0.000***	−0.180***	−0.469***	−0.134**
	(0.000)	(0.000)	(0.000)	(0.067)	(0.108)	(0.063)
CEO Delta	0.000*	0.000	0.000	0.009	0.02	0.007
	(0.000)	(0.000)	(0.000)	(0.009)	(0.016)	(0.008)
CEO Tenure	0.002***	0.002	0.002**	0.001	0.001	0.001
	(0.001)	(0.002)	(0.001)	(0.002)	(0.003)	(0.002)
CEO Cash Compensation	−0.000	0.000	−0.000	0.005	−0.019	0.01
	(0.000)	(0.000)	(0.000)	(0.011)	(0.019)	(0.011)
Market-to-Book	0.044***	0.117***	0.039***	0.015	0.064**	0.012
	(0.007)	(0.016)	(0.007)	(0.017)	(0.032)	(0.017)
R&D Expenditure	0.118*	0.259**	0.116*	0.690***	1.336***	0.730***
	(0.065)	(0.111)	(0.063)	(0.221)	(0.481)	(0.219)
Capital Expenditure	0.102	0.298*	0.036	0.098	0.277	0.076
	(0.080)	(0.169)	(0.081)	(0.140)	(0.316)	(0.132)
Ln(Sales Growth)	−0.565***	−1.188***	−0.446***	0.052	0.094	0.056
	(0.111)	(0.217)	(0.109)	(0.047)	(0.103)	(0.045)
Leverage	−0.045	−0.285***	−0.004	−0.116	−0.302*	−0.086
	(0.051)	(0.097)	(0.052)	(0.093)	(0.168)	(0.094)
Ln(Total Assets)	−0.013	0.070***	−0.030***	−0.045***	0.023	−0.058***
	(0.009)	(0.017)	(0.008)	(0.017)	(0.029)	(0.016)
Ln(1+Firm Age)	−0.078***	−0.087***	−0.091***	−0.065***	−0.093**	−0.067***
	(0.013)	(0.025)	(0.013)	(0.025)	(0.040)	(0.025)
Diversification	0.004	−0.063	0.011	0.056	0.064	0.074
	(0.035)	(0.072)	(0.034)	(0.051)	(0.091)	(0.051)
Return on Assets	−0.775***	−1.251***	−0.756***	−1.206***	−1.297***	−1.233***
	(0.130)	(0.212)	(0.125)	(0.158)	(0.332)	(0.165)
Surplus Cash	0.038	−0.012	0.076***	−0.506**	−1.216***	−0.406**
	(0.028)	(0.052)	(0.028)	(0.196)	(0.346)	(0.205)
Observations	1,781	1,781	1,781	2,448	2,448	2,448
R^2	0.565	0.373	0.557	0.65	0.435	0.651

Table 9: Other Measures of Firm Risk

This table reports fixed effects estimation of CEO Vega, research and development Expenditure, Herfindahl-Hirschman index of firm diversification and the standard deviation of firm's return on assets on proportion of women on board and control variables. *Stock Returns* is average daily returns multiplied by 250. *Dividends* is a dummy which equals one if the firm pays dividends. *Net PP&E* is the net value of firm's property, plant and equipment scaled by total assets. Other control variables are defined in Table A1. All models include year dummy variables. Within-cluster heteroskedasticity and serial correlation robust standard errors are reported in parentheses. Intercepts are included but not reported. *, **, *** denote statistical significance at 10%, 5% and 1% respectively.

Dependent Variable =	CEO Vega (1)	R&D (2)	Diversification (3)	Leverage (4)	S.D.(ROA) (5)
Proportion of Women	0.032	−0.004	−0.085*	−0.006	0.006
	(0.045)	(0.004)	(0.044)	(0.028)	(0.025)
Board Size	−0.003*	−0.000	−0.003*	−0.001	0.001
	(0.002)	(0.000)	(0.002)	(0.001)	(0.001)
Board Independence	0.020	0.001	−0.039	−0.010	0.022***
	(0.021)	(0.002)	(0.026)	(0.015)	(0.007)
Director Connectedness	−0.007	0.001	−0.008	−0.004	−0.006*
	(0.012)	(0.001)	(0.010)	(0.006)	(0.004)
CEO Vega		0.004**	0.025	−0.033***	−0.002
		(0.002)	(0.017)	(0.010)	(0.006)
CEO Delta	0.022***	−0.000	−0.001	−0.001	0.002
	(0.005)	(0.000)	(0.002)	(0.001)	(0.002)
CEO Tenure		−0.000	−0.001*	0.000	−0.000
		(0.000)	(0.000)	(0.000)	(0.000)
CEO Cash Compensation	0.029***	−0.001***	0.011***	−0.007***	−0.000
	(0.006)	(0.000)	(0.003)	(0.002)	(0.001)
Ln(Total Assets)	0.062***	−0.001	−0.048***	0.036***	0.017**
	(0.008)	(0.001)	(0.009)	(0.007)	(0.007)
Market-to-Book	−0.010**	−0.001***	0.007**	−0.011***	0.004
	(0.004)	(0.000)	(0.003)	(0.002)	(0.002)
Return on Assets	0.058***		0.086***	−0.240***	0.022
	(0.021)		(0.026)	(0.021)	(0.025)
R&D Expenditure	0.345**			0.008	0.150
	(0.147)			(0.112)	(0.149)
Capital Expenditure	0.043*				0.061*
	(0.024)				(0.033)
Leverage	−0.066***	0.008**	−0.004		−0.044**
	(0.022)	(0.003)	(0.024)		(0.021)
Diversification					0.007
					(0.009)
Ln(1+Sales Growth)		−0.005***	0.013*		0.014**
		(0.001)	(0.008)		(0.006)
Surplus Cash		−0.001			−0.032
		(0.005)			(0.036)
Total Risk	−0.051***				
	(0.008)				
Stock Returns		−0.001*	−0.013***		
		(0.000)	(0.004)		
Dividends			−0.007		
			(0.011)		
Net PP&E				−0.016	
				(0.033)	
Observations	13,581	13,581	13,581	13,581	8,379
R^2	0.199	0.037	0.143	0.108	0.044

Table 10: Women on Boards and Bank Risk

The sample comprises 794 observations from 130 bank holding companies (BHCs) with data available on RiskMetrics, Compustat, Execucomp and CRSP. Ln(1+Asset Growth) is the logarithm of current year's total assets divided by previous year's total assets. Deposit ratio is total deposit divided by total assets. Capital adequacy ratio is the sum of tier-1 and tier-2 capital ratio. Charter value is the market value divided by the book value of firm's total assets. Loan ratio is total loan divided by total assets. Non-performing loan ratio is non-performing loan scaled by total loan. All models include year dummy variables. Bank-level cluster-robust standard errors are reported for ordinary least squares and fixed effects models. Finite-sample robust standard errors (Windmeijer, 2005) are reported for dynamic panel system GMM. Intercepts are included but not reported. * , ** , *** denote statistical significance at 10%, 5% and 1% respectively.

	Ordinary Least Squares			Fixed Effects			Dynamic Panel System GMM		
Dependent Variable =	Total Risk	Systematic Risk	Idiosyncratic Risk	Total Risk	Systematic Risk	Idiosyncratic Risk	Total Risk	Systematic Risk	Idiosyncratic Risk
Proportion of Women	0.258	0.266	0.287	0.258	0.109	0.272	0.721	0.218	0.052
	(0.181)	(0.222)	(0.208)	(0.222)	(0.282)	(0.257)	(1.237)	(1.731)	(1.229)
Board Size	−0.008*	−0.011*	−0.008*	−0.002	−0.012*	−0.001	−0.004	0.006	0.004
	(0.003)	(0.004)	(0.003)	(0.004)	(0.006)	(0.004)	(0.014)	(0.030)	(0.015)
Board Independence	−0.038	−0.002	−0.046	−0.082	−0.194	−0.065	−0.352	−0.455	−0.660*
	(0.095)	(0.122)	(0.104)	(0.113)	(0.156)	(0.117)	(0.387)	(0.623)	(0.394)
Director Connectedness	0.004*	0.005*	0.004*	0.003	0.006	0.003	0.005	0.016	0.003
	(0.002)	(0.003)	(0.002)	(0.003)	(0.004)	(0.003)	(0.011)	(0.016)	(0.012)
CEO Vega	−0.184*	−0.317*	−0.187*	−0.198*	−0.338*	−0.194*	−0.042	−0.426	−0.046
	(0.091)	(0.143)	(0.086)	(0.086)	(0.137)	(0.080)	(0.258)	(0.477)	(0.282)
CEO Delta	0.012***	0.018***	0.013***	−0.002	−0.004	−0.001	0.000	0.010	0.000
	(0.003)	(0.005)	(0.003)	(0.004)	(0.008)	(0.004)	(0.012)	(0.021)	(0.012)
CEO Tenure	0.001	0.002	0.000	−0.003	−0.004	−0.003	0.007	0.004	0.012
	(0.002)	(0.003)	(0.002)	(0.002)	(0.003)	(0.002)	(0.008)	(0.013)	(0.008)
CEO Cash Compensation	0.010	0.024*	0.006	−0.007	−0.008	−0.008	0.012	−0.004	0.003
	(0.008)	(0.011)	(0.009)	(0.006)	(0.009)	(0.007)	(0.035)	(0.057)	(0.036)
Ln(Total Assets)	−0.025	0.016	−0.028*	−0.004	0.078	0.003	−0.012	0.057	0.021
	(0.016)	(0.022)	(0.017)	(0.048)	(0.073)	(0.051)	(0.058)	(0.113)	(0.070)
Ln(1+Asset Growth)	−0.124*	−0.220***	−0.120*	−0.216***	−0.287***	−0.245***	−1.112***	−0.840*	−1.340***
	(0.063)	(0.084)	(0.071)	(0.065)	(0.104)	(0.068)	(0.403)	(0.455)	(0.456)
Deposit Ratio	0.016	0.092	0.008	0.643*	0.676*	0.809***	−0.131	1.712	−0.206
	(0.170)	(0.227)	(0.180)	(0.279)	(0.384)	(0.283)	(0.682)	(1.424)	(0.835)
Capital Adequacy Ratio	−0.363	−0.352	−0.366	0.999*	2.504***	0.755	−2.593	−1.914	−2.372
	(0.569)	(0.716)	(0.609)	(0.490)	(0.803)	(0.561)	(2.272)	(4.611)	(2.260)
Charter Value	−0.225*	−0.176	−0.267*	−0.145	−0.117	−0.169	0.693	1.872*	0.762
	(0.127)	(0.203)	(0.146)	(0.115)	(0.262)	(0.127)	(0.625)	(1.117)	(0.469)
Loan Ratio	−0.324***	−0.421***	−0.268*	−0.174	0.069	−0.185	0.271	−0.384	0.409
	(0.118)	(0.152)	(0.129)	(0.183)	(0.273)	(0.184)	(0.557)	(0.791)	(0.519)
Non-performing Loan Ratio	2.601*	2.404	3.110*	2.223	2.457	2.515	2.287	6.171	4.070
	(1.375)	(1.532)	(1.544)	(1.455)	(1.508)	(1.682)	(5.329)	(9.657)	(5.228)
Risk Measure (Lag 1)							0.407	0.003	0.283
							(0.260)	(0.136)	(0.220)
Risk Measure (Lag 2)							−0.128	0.111	0.041
							(0.270)	(0.177)	(0.270)
Observations	881	881	881	881	881	881	632	632	632
R^2	0.819	0.537	0.770	0.881	0.610	0.853			
Hansen (df=29)							25.947	26.392	25.964
AR(1)							−2.294**	−2.152**	−2.495**
AR(2)							0.026	−1.436	−0.139

Table A1: Definition of Variables

Variable	Definition
Board Characteristics (Source: RiskMetrics)	
Proportion of Women	Number of female directors divided by number of directors.
Board Size	Number of directors on board.
Board Independence.	Number of independent directors (as defined by RiskMetrics) divided by number of directors.
Director Connectedness	Total number of external board seats held by all directors.
Male Director Connectedness	Total number of external board seats held by all male directors.
Proportion of Male Directors with Board Connections to Women	Number of male directors with board connections to women divided by number of male directors on board. Male directors are defined as having board connections to women when they sit on at least one other board on which there are female directors.
Proportion off Male External Board Seats with Women	Number of outside directorships of male directors that have at least one female directors divided by total number of outside directorships.
CEO Risk-Taking Incentives (Source: Execucomp)	
CEO Vega	Dollar change in CEO compensation per 0.01 unit increase in a firm's standard deivation of stock returns ($million).
CEO Delta	Dollar change in CEO compensation per 1% increase in stock returns ($million).
CEO Tenure	The duration (years) the current CEO has been in post.
CEO Cash Compensation	Dollar amount of CEO cash compensation ($million).
Firm Characteristics (Source: Compustat)	
Market-to-Book	Market value of total assets divided by the book value of total assets. Market value of total assets is defined as the book value of total assets minus the book value of total equity plus share price times the number of shares outstanding.
R&D Expenditure	Research and development expenditure divided by the book value of total assets or zero if the data is missing.
Capital Expenditure	Capital expenditure minus sale of property divided by total assets.
Leverage	Total liabilities divided by the book value of equity
Ln(Total Assets)	Logarithm of the book value of firm total assets
Return on Assets	Earnings before tax divided by the book value of total assets.
Ln(1+Sales Growth)	Logarithm of current year's sales minus the logarithm of previous year's sales.
Surplus Cash	Net cash flow from operating activities less depreciation and amortization plus research and development expenditure divided by the book value of total assets.
Risk Measures (Source: CRSP)	
Total Risk	Logarithm of square root of 250 times daily return standard deviation.
Systematic Risk	Coefficient of the stock market portfolio return from a market-model regression. CRSP NYSE/AMEX/NASDAQ/Arca equally-weighted index is the market portfolio proxy.
Idiosyncratic Risk	Logarithm of the square root of 250 times the residuals from the market model regression.

Table A2: Dynamic Panel System GMM Robustness Checks

This table reports two-step Dynamic Panel System GMM estimations of risk measures on the proportion of women on board and other control variables. The specifications are identical to the models presented in Table 4 except Panels A, B and C include one, three and four lags of the dependent variable as control variables instead of two lags. Panel D shows two-lag estimations based on a subsample of data from 1996, 1998, ... 2008 and 2010. Panel E uses male director connectedness as a control variable instead of director connectedness. All independent variables are treated as endogenous except *Ln(1+Firm Age)* and year dummy variables. Endogenous variables are instrumented by two of their past values. In parentheses are finite-sample robust standard errors (Windmeijer, 2005). The null hypothesis for the Hansen Overidentification test is that all instruments are exogenous. 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 first-difference residuals. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

	(A) One Lag of Risk Measures			(B) Three Lags of Risk Measures		
Risk Measure =	Total Risk	Systematic Risk	Idiosyncratic Risk	Total Risk	Systematic Risk	Idiosyncratic Risk
Proportion of Women	−0.064	−0.164	−0.145	0.123	−0.323	0.097
	(0.119)	(0.242)	(0.127)	(0.361)	(0.554)	(0.392)
Board Size	−0.002	0.008	−0.007	0.005	0.007	−0.000
	(0.008)	(0.016)	(0.008)	(0.018)	(0.034)	(0.020)
Board Independence	0.096	0.311	−0.021	−0.256	0.031	−0.606***
	(0.092)	(0.192)	(0.094)	(0.215)	(0.372)	(0.222)
Director Connectedness	−0.001	−0.010*	0.002	−0.009	−0.013	−0.004
	(0.003)	(0.006)	(0.003)	(0.007)	(0.012)	(0.008)
CEO Vega	−0.163***	−0.331***	−0.155***	−0.259*	−0.196	−0.357**
	(0.051)	(0.098)	(0.052)	(0.147)	(0.243)	(0.167)
CEO Delta	0.012	0.031	0.012	0.057*	0.036	0.057
	(0.009)	(0.021)	(0.009)	(0.034)	(0.050)	(0.035)
CEO Tenure	0.000	0.000	0.000	0.000	−0.007	0.005
	(0.001)	(0.003)	(0.001)	(0.004)	(0.007)	(0.004)
CEO Cash Compensation	0.003	0.029	0.017	0.042	0.076	0.051
	(0.015)	(0.037)	(0.014)	(0.031)	(0.057)	(0.035)
Market-to-Book	0.086***	0.117***	0.078***	0.043	0.192*	0.034
	(0.016)	(0.034)	(0.017)	(0.046)	(0.104)	(0.044)
R&D Expenditure	−0.829**	−0.684	−0.911**	0.980*	0.295	1.164*
	(0.405)	(0.802)	(0.441)	(0.574)	(1.101)	(0.603)
Capital Expenditure	0.123	1.000**	−0.040	−0.234	−0.197	−0.783
	(0.191)	(0.413)	(0.209)	(0.432)	(0.663)	(0.527)
Leverage	0.168**	−0.022	0.194**	−0.427*	−0.892**	−0.425
	(0.079)	(0.153)	(0.081)	(0.229)	(0.365)	(0.261)
Ln(Total Assets)	−0.039**	−0.014	−0.040**	−0.052	−0.058	−0.033
	(0.016)	(0.033)	(0.018)	(0.036)	(0.054)	(0.043)
Return on Assets	−1.624***	−2.459***	−1.303***	−0.261	1.000	−0.307
	(0.314)	(0.840)	(0.325)	(0.506)	(1.059)	(0.523)
Ln(1+Sales Growth)	0.040	−0.078	0.014	0.018	0.167	−0.016
	(0.043)	(0.086)	(0.047)	(0.116)	(0.230)	(0.125)
Surplus Cash	0.332	1.187	−0.157	−1.460**	−3.669**	−1.884***
	(0.343)	(0.972)	(0.332)	(0.600)	(1.622)	(0.578)
Diversification	−0.031	−0.015	−0.047	−0.124	−0.370*	−0.147
	(0.024)	(0.063)	(0.030)	(0.144)	(0.217)	(0.116)
Ln(1+Firm Age)	−0.006	0.056	−0.044**	0.066*	−0.009	0.017
	(0.018)	(0.038)	(0.020)	(0.037)	(0.062)	(0.039)
Risk Measure (Lag 1)	0.557***	0.655***	0.541***	0.294*	0.237	0.103
	(0.041)	(0.051)	(0.046)	(0.164)	(0.162)	(0.138)
Risk Measure (Lag 2)				−0.101	0.204	−0.032
				(0.164)	(0.129)	(0.157)
Risk Measure (Lag 3)				0.414***	0.059	0.453***
				(0.143)	(0.111)	(0.156)
Observations	10,859	10,859	10,859	6,802	6,802	6,802
Hansen	71.059***	76.001***	61.855***	46.860	36.113	46.882
AR(1)	−13.517***	−12.920***	−13.564***	−3.945***	−3.535***	−4.110***
AR(2)	2.193**	4.067***	2.723***	1.458	−0.642	0.843

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(Table A2 continued)

Risk Measure =	(C) Four Lags of Risk Measures Total Risk	 Systematic Risk	 Idiosyncratic Risk	(D) Sample from 1996,1998,..., 2010 Total Risk	 Systematic Risk	 Idiosyncratic Risk
Proportion of Women	−0.031	−0.150	−0.020	0.048	−0.871	0.040
	(0.367)	(0.500)	(0.401)	(0.405)	(0.804)	(0.422)
Board Size	0.016	0.020	0.010	−0.018	−0.009	−0.031
	(0.019)	(0.032)	(0.021)	(0.020)	(0.045)	(0.021)
Board Independence	−0.308	0.136	−0.557**	−0.555**	−0.163	−0.780***
	(0.217)	(0.349)	(0.233)	(0.250)	(0.509)	(0.256)
Director Connectedness	−0.008	−0.012	−0.003	0.003	−0.030*	0.008
	(0.007)	(0.012)	(0.008)	(0.007)	(0.016)	(0.008)
CEO Vega	−0.156	−0.224	−0.243	−0.276*	−0.707**	−0.268
	(0.150)	(0.219)	(0.170)	(0.149)	(0.321)	(0.164)
CEO Delta	0.054	0.037	0.060	0.035	0.049	0.030
	(0.035)	(0.045)	(0.038)	(0.039)	(0.069)	(0.036)
CEO Tenure	0.001	−0.002	0.006	−0.005	−0.010	−0.006
	(0.004)	(0.006)	(0.004)	(0.004)	(0.009)	(0.004)
CEO Cash Compensation	0.048	0.047	0.058*	0.017	0.082	0.026
	(0.029)	(0.050)	(0.035)	(0.037)	(0.077)	(0.038)
Market-to-Book	0.046	0.107	0.025	0.124***	0.324***	0.079*
	(0.041)	(0.087)	(0.042)	(0.044)	(0.087)	(0.045)
R&D Expenditure	0.775	0.169	0.913*	1.921**	4.687***	1.948**
	(0.501)	(0.969)	(0.530)	(0.754)	(1.732)	(0.795)
Capital Expenditure	−0.405	−0.135	−0.903	−0.279	0.431	−0.467
	(0.464)	(0.656)	(0.571)	(0.475)	(1.047)	(0.509)
Leverage	−0.480**	−0.806**	−0.418	−0.183	0.245	−0.081
	(0.235)	(0.335)	(0.264)	(0.281)	(0.576)	(0.297)
Ln(Total Assets)	−0.076**	−0.057	−0.064	−0.061	0.017	−0.047
	(0.035)	(0.049)	(0.041)	(0.042)	(0.084)	(0.042)
Return on Assets	−0.419	0.428	−0.580	0.148	0.800	−0.018
	(0.582)	(0.772)	(0.619)	(0.539)	(1.101)	(0.546)
Ln(1+Sales Growth)	0.056	0.232	0.036	0.305**	0.713**	0.299*
	(0.106)	(0.230)	(0.117)	(0.139)	(0.290)	(0.158)
Surplus Cash	−1.564***	−1.731	−1.845***	−1.702***	−3.694***	−1.598***
	(0.559)	(1.074)	(0.530)	(0.530)	(1.042)	(0.533)
Diversification	−0.112	−0.325*	−0.108	−0.111	−0.355	−0.063
	(0.136)	(0.178)	(0.118)	(0.129)	(0.286)	(0.148)
Ln(1+Firm Age)	0.050	0.051	0.004	0.075	0.131	0.031
	(0.044)	(0.062)	(0.046)	(0.047)	(0.099)	(0.048)
Risk Measure (Lag 1)	0.280*	0.404***	0.057	0.324***	0.334***	0.316**
	(0.151)	(0.143)	(0.134)	(0.104)	(0.084)	(0.128)
Risk Measure (Lag 2)	−0.064	0.066	0.090	0.044	−0.112	0.019
	(0.166)	(0.137)	(0.160)	(0.109)	(0.113)	(0.121)
Risk Measure (Lag 3)	0.435***	−0.013	0.461***			
	(0.133)	(0.105)	(0.149)			
Risk Measure (Lag 4)	−0.106	0.144*	−0.135			
	(0.121)	(0.082)	(0.128)			
Observations	5,296	5,296	5,296	3,087	3,087	3,087
Hansen	46.554	39.420	46.580	47.623	48.087	39.203
AR(1)	−3.955***	−3.309***	−3.525***	−4.480***	−4.462***	−4.070***
AR(2)	1.421	−0.092	0.017	−0.996	0.448	−0.605

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(Table A2 continued)

Risk Measure =	(E) Sample from 1997, 1999, ..., 2009 Total Risk	Systematic Risk	Idiosyncratic Risk	(F) Male Director Connectedness Total Risk	Systematic Risk	Idiosyncratic Risk
Proportion of Women	0.400	0.830	0.306	0.054	−0.865	0.115
	(0.605)	(1.170)	(0.621)	(0.161)	(0.586)	(0.172)
Board Size	0.021	−0.111	0.028	0.017	0.022	0.013
	(0.034)	(0.072)	(0.031)	(0.011)	(0.034)	(0.012)
Board Independence	−0.104	−0.989	0.037	0.152	0.498	0.041
	(0.409)	(0.753)	(0.367)	(0.130)	(0.409)	(0.144)
Director Connectedness	0.018	0.045**	0.020	−0.004	−0.016	−0.004
	(0.012)	(0.022)	(0.013)	(0.004)	(0.014)	(0.004)
CEO Vega	−0.050	−0.072	−0.123	−0.061	−0.063	−0.090
	(0.212)	(0.420)	(0.206)	(0.069)	(0.253)	(0.070)
CEO Delta	−0.017	0.018	−0.012	0.017	0.021	0.009
	(0.033)	(0.073)	(0.029)	(0.015)	(0.046)	(0.016)
CEO Tenure	−0.002	−0.000	0.002	0.002	−0.008	0.003
	(0.009)	(0.016)	(0.009)	(0.002)	(0.006)	(0.002)
CEO Cash Compensation	−0.102***	−0.156**	−0.085**	−0.038*	0.076	−0.007
	(0.035)	(0.066)	(0.036)	(0.022)	(0.067)	(0.022)
Market-to-Book	0.050	−0.123	0.049	0.034	0.141	0.032
	(0.065)	(0.133)	(0.058)	(0.029)	(0.095)	(0.030)
R&D Expenditure	−0.410	0.819	−0.364	0.231	−0.601	0.282
	(0.625)	(1.507)	(0.649)	(0.419)	(0.938)	(0.430)
Capital Expenditure	0.876	0.691	0.784	−0.248	−0.141	−0.267
	(0.607)	(1.058)	(0.627)	(0.264)	(0.696)	(0.301)
Leverage	0.740**	0.455	0.822**	−0.239**	−0.794**	−0.210**
	(0.335)	(0.565)	(0.347)	(0.098)	(0.342)	(0.102)
Ln(Total Assets)	−0.052	0.039	−0.078*	−0.041*	−0.057	−0.047**
	(0.045)	(0.085)	(0.046)	(0.021)	(0.051)	(0.022)
Return on Assets	−2.070***	−4.164**	−1.419*	−1.431***	−0.344	−1.684***
	(0.733)	(1.725)	(0.789)	(0.406)	(0.782)	(0.436)
Ln(1+Sales Growth)	0.401*	0.160	0.234	0.152*	0.178	0.084
	(0.227)	(0.353)	(0.237)	(0.081)	(0.196)	(0.085)
Surplus Cash	0.359	2.736**	0.424	−0.412	−2.371**	−0.224
	(0.650)	(1.306)	(0.681)	(0.484)	(1.195)	(0.452)
Diversification	0.058	−0.062	0.062	0.193	−0.222	0.180
	(0.153)	(0.274)	(0.159)	(0.118)	(0.202)	(0.110)
Ln(1+Firm Age)	0.003	0.166**	−0.038	0.050**	−0.032	0.027
	(0.044)	(0.083)	(0.046)	(0.021)	(0.057)	(0.024)
Risk Measure (Lag 1)	0.591***	0.459***	0.550***	0.465***	0.280	0.523***
	(0.138)	(0.108)	(0.145)	(0.113)	(0.182)	(0.130)
Risk Measure (Lag 2)	0.067	0.185	0.032	0.157*	0.264*	0.041
	(0.161)	(0.122)	(0.180)	(0.091)	(0.139)	(0.099)
Observations	2,972	2,972	2,972	8,629	8,629	8,629
Hansen Overidentification	30.826	31.570	24.008	43.969	36.846	45.052
AR(1)	−3.819***	−3.408***	−3.664***	−4.567***	−2.318***	−4.557***
AR(2)	−0.117	−1.420	0.039	−1.004	−1.013	0.174

Table A3: Results with Female Board Connections of Male Director as Control

This table reports ordinary least square, fixed effects and dynamic panel system GMM regressions of equity risk measures on proportion of women and other control varialbes. Proportion of male directors with board connections to women is included as an additional control variable. All models include year dummy variables. Bank-level cluster-robust standard errors are reported for ordinary least squares and fixed effects models. Finite-sample robust standard errors (Windmeijer, 2005) are reported for dynamic panel system GMM. Intercepts are included but not reported. * , ** , *** denote statistical significance at 10%, 5% and 1% respectively.

	Ordinary Least Squares			Fixed Effects			Dynamic Panel System GMM		
Dependent Variable =	Total Risk	Systematic Risk	Idiosyncratic Risk	Total Risk	Systematic Risk	Idiosyncratic Risk	Total Risk	Systematic Risk	Idiosyncratic Risk
Prop. of Men with Board Connections to Women	−0.156***	−0.194***	−0.171***	−0.076***	−0.111**	−0.077***	0.016	−0.084	−0.062
	(0.030)	(0.055)	(0.030)	(0.028)	(0.055)	(0.028)	(0.118)	(0.386)	(0.118)
Proportion of Women	−0.094*	−0.315***	−0.053	0.036	−0.025	0.059	0.088	−0.407	0.154
	(0.052)	(0.090)	(0.054)	(0.065)	(0.121)	(0.065)	(0.154)	(0.520)	(0.167)
Board Size	−0.017***	−0.033***	−0.016***	−0.009***	−0.020***	−0.010***	0.021*	−0.037	0.017
	(0.003)	(0.005)	(0.003)	(0.003)	(0.006)	(0.003)	(0.012)	(0.032)	(0.012)
Board Independence	0.023	0.036	0.027	−0.013	0.012	−0.021	0.172	0.154	0.074
	(0.030)	(0.055)	(0.030)	(0.031)	(0.063)	(0.030)	(0.132)	(0.352)	(0.147)
Director Connectedness	0.002*	0.003	0.003***	0.004***	0.005*	0.005***	−1.427***	−0.005	−1.697***
	(0.001)	(0.002)	(0.001)	(0.002)	(0.003)	(0.002)	(0.409)	(0.797)	(0.440)
CEO Vega	−0.095***	−0.300***	−0.068***	−0.157***	−0.297***	−0.143***	0.213	0.822	0.225
	(0.023)	(0.044)	(0.021)	(0.024)	(0.041)	(0.023)	(0.406)	(1.307)	(0.415)
CEO Delta	0.011***	0.019***	0.010***	0.008**	0.005	0.009**	−0.241	0.940	−0.278
	(0.003)	(0.006)	(0.003)	(0.003)	(0.006)	(0.003)	(0.259)	(0.829)	(0.301)
CEO Tenure	−0.000	0.000	−0.001	0.001**	0.003**	0.001	−0.233**	−0.390	−0.189*
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.099)	(0.321)	(0.102)
CEO Cash Compensation	−0.001	−0.013	0.003	−0.014***	−0.023***	−0.012***	−0.039*	−0.035	−0.042**
	(0.005)	(0.008)	(0.004)	(0.004)	(0.008)	(0.004)	(0.020)	(0.057)	(0.021)
Market-to-Book	0.007*	0.066***	0.001	0.018***	0.108***	0.006	−0.072	−0.101	−0.102
	(0.004)	(0.009)	(0.004)	(0.004)	(0.009)	(0.004)	(0.068)	(0.210)	(0.069)
R&D Expenditure	0.482***	1.237***	0.473***	−0.262***	0.394*	−0.350***	0.003	−0.004	0.004*
	(0.060)	(0.143)	(0.060)	(0.093)	(0.232)	(0.088)	(0.002)	(0.007)	(0.002)
Capital Expenditure	0.010	0.262***	−0.023	0.025	0.425***	−0.030	−0.036*	−0.014	−0.007
	(0.045)	(0.091)	(0.045)	(0.055)	(0.118)	(0.051)	(0.021)	(0.057)	(0.022)
Ln(1+Sales Growth)	0.068***	0.122***	0.077***	0.049***	0.087***	0.053***	0.144*	0.306	0.060
	(0.015)	(0.028)	(0.015)	(0.014)	(0.025)	(0.014)	(0.082)	(0.207)	(0.084)
Leverage	−0.039	−0.300***	0.002	0.092**	−0.020	0.129***	0.033	0.116*	0.036
	(0.031)	(0.057)	(0.031)	(0.040)	(0.083)	(0.039)	(0.030)	(0.069)	(0.032)
Ln(1+Total Assets)	−0.044***	0.041***	−0.060***	−0.065***	0.051**	−0.087***	−0.004	0.005	−0.003
	(0.005)	(0.010)	(0.005)	(0.013)	(0.024)	(0.013)	(0.004)	(0.015)	(0.005)
Ln(1+Firm Age)	−0.076***	−0.073***	−0.086***	−0.337***	−0.597***	−0.262***	0.046**	0.024	0.024
	(0.009)	(0.016)	(0.009)	(0.037)	(0.071)	(0.035)	(0.021)	(0.055)	(0.023)
Diversification	0.011	−0.022	0.022*	0.005	−0.010	0.006	0.205*	−0.503***	0.176
	(0.009)	(0.014)	(0.013)	(0.004)	(0.011)	(0.004)	(0.119)	(0.189)	(0.115)
Return on Assets	−0.992***	−1.222***	−1.005***	−0.530***	−0.610***	−0.547***	0.017	0.060	0.010
	(0.048)	(0.104)	(0.049)	(0.045)	(0.093)	(0.046)	(0.015)	(0.043)	(0.016)
Surplus Cash	−0.170***	−0.584***	−0.105**	−0.177***	−0.549***	−0.134***	−0.310	−2.607**	−0.121
	(0.052)	(0.130)	(0.050)	(0.040)	(0.093)	(0.041)	(0.464)	(1.139)	(0.434)
Risk Measure (Lag 1)							0.501***	0.239	0.569***
							(0.115)	(0.149)	(0.129)
Risk Measure (Lag 2)							0.133	0.309***	0.005
							(0.089)	(0.111)	(0.096)
Observations	13,581	13,581	13,581	13,581	13,581	13,581	8,629	8,629	8,629
R^2	0.597	0.328	0.599	0.613	0.205	0.596			
Hansen (df=40)							45.998	50.810	48.777
AR(1)							−4.609***	−2.746***	−4.827***
AR(2)							−0.776	−1.504	0.518

Table A4: Difference-in-Difference Robustness Checks

This table report results from difference-in-difference estimations. Dependent variables are firm equity risk measures. Treatment observations are firms that replace a departing male director with a female director. Control observations are firms that replace a departing male director with another male director. All control variables from Table 8 are included but not reported for brevity. In Panel A, treatment firms are matched with control firms whose differences in propensity of appointing a women director are within 10%, 2%, 1% and 0.5% of the treatment firms. Propensity scores are calculated from Model 1 in Table 3. In Panel B, treatment firms are matched with control firms using the nearest-neighbor matching method (Abadie et al., 2004). Instead of four nearest matches, treatment firms are matched with one, two, three, five and six nearest matches from the control group. Matching variables are the independent variables in Model 1 of Table 3. Treatment firms and matched control firms are in the same year and industry. *Female Appointment* is a dummy variable which equals one if the firm appoints a female director and zero otherwise. *Post Period* is a dummy variable which equals one in the period after the appointment and zero in the period before. Control variables are defined in Table A1. Within-cluster heteroskedasticity and serial correlation robust standard errors are reported in parentheses. Intercepts are included but not reported. *, **, *** denote statistical significance at 10%, 5% and 1% respectively.

	Panel A: Propensity Score Matching		
Dependent Variable =	Total Risk	Systematic Risk	Idiosyncratic Risk
	10% (112 Matched Firms)		
Female Appointment × Post Period	−0.013	0.008	−0.007
	(0.036)	(0.062)	(0.037)
Female Appointment	−0.045*	−0.088*	−0.048*
	(0.027)	(0.046)	(0.028)
Post Period	−0.004	−0.003	−0.006
	(0.012)	(0.023)	(0.012)
Observations	2,672	2,672	2,672
R^2	0.566	0.372	0.557
	2% (79 Matched Firms)		
Female Appointment × Post Period	−0.026	−0.016	−0.014
	(0.047)	(0.082)	(0.048)
Female Appointment	−0.028	−0.040	−0.038
	(0.034)	(0.062)	(0.035)
Post Period	0.008	0.016	0.002
	(0.023)	(0.042)	(0.023)
Observations	854	854	854
R^2	0.579	0.369	0.560
	1% (65 Matched Firms)		
Female Appointment × Post Period	−0.054	−0.036	−0.039
	(0.051)	(0.095)	(0.051)
Female Appointment	−0.002	−0.019	−0.015
	(0.036)	(0.073)	(0.036)
Post Period	0.027	0.025	0.019
	(0.030)	(0.058)	(0.031)
Observations	506	506	506
R^2	0.620	0.401	0.597
	0.5% (43 Matched Firms)		
Female Appointment × Post Period	−0.049	−0.077	−0.029
	(0.068)	(0.127)	(0.068)
Female Appointment	0.069	0.115	0.055
	(0.046)	(0.095)	(0.047)
Post Period	0.050	0.080	0.045
	(0.041)	(0.081)	(0.044)
Observations	266	266	266
R^2	0.666	0.499	0.644

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(Table A4 continued)

Dependent Variable =	Panel B: Nearest Neighbor Matching		
	Total Risk	Systematic Risk	Idiosyncratic Risk
	One Nearest Match Per Treatment Firm		
Female Appointment × Post Period	0.017	0.064	0.014
	(0.027)	(0.052)	(0.028)
Female Appointment	−0.01	−0.028	−0.008
	(0.030)	(0.055)	(0.030)
Post Period	−0.024	−0.053	−0.02
	(0.021)	(0.038)	(0.022)
Observations	612	612	612
R^2	0.682	0.464	0.675
	Two Nearest Matches Per Treatment Firm		
Female Appointment × Post Period	−0.004	0.029	−0.005
	(0.023)	(0.045)	(0.024)
Female Appointment	−0.027	−0.051	−0.028
	(0.027)	(0.049)	(0.027)
Post Period	−0.001	−0.014	0
	(0.016)	(0.029)	(0.017)
Observations	1,224	1,224	1,224
R^2	0.65	0.428	0.652
	Three Nearest Matches Per Treatment Firm		
Female Appointment × Post Period	−0.001	0.015	−0.002
	(0.022)	(0.043)	(0.023)
Female Appointment	−0.025	−0.043	−0.025
	(0.025)	(0.046)	(0.025)
Post Period	−0.004	0.002	−0.003
	(0.014)	(0.025)	(0.014)
Observations	1,836	1,836	1,836
R^2	0.656	0.443	0.658
	Five Nearest Matches Per Treatment Firm		
Female Appointment × Post Period	−0.012	0.004	−0.011
	(0.021)	(0.042)	(0.021)
Female Appointment	−0.024	−0.044	−0.024
	(0.024)	(0.043)	(0.024)
Post Period	0.004	0.01	0.003
	(0.012)	(0.023)	(0.013)
Observations	3,060	3,060	3,060
R^2	0.639	0.418	0.643
	Six Nearest Matches Per Treatment Firm		
Female Appointment × Post Period	−0.008	0.001	−0.009
	(0.020)	(0.041)	(0.021)
Female Appointment	−0.029	−0.044	−0.03
	(0.023)	(0.042)	(0.024)
Post Period	0.002	0.011	0.002
	(0.012)	(0.022)	(0.012)
Observations	3,672	3,672	3,672
R^2	0.642	0.418	0.646

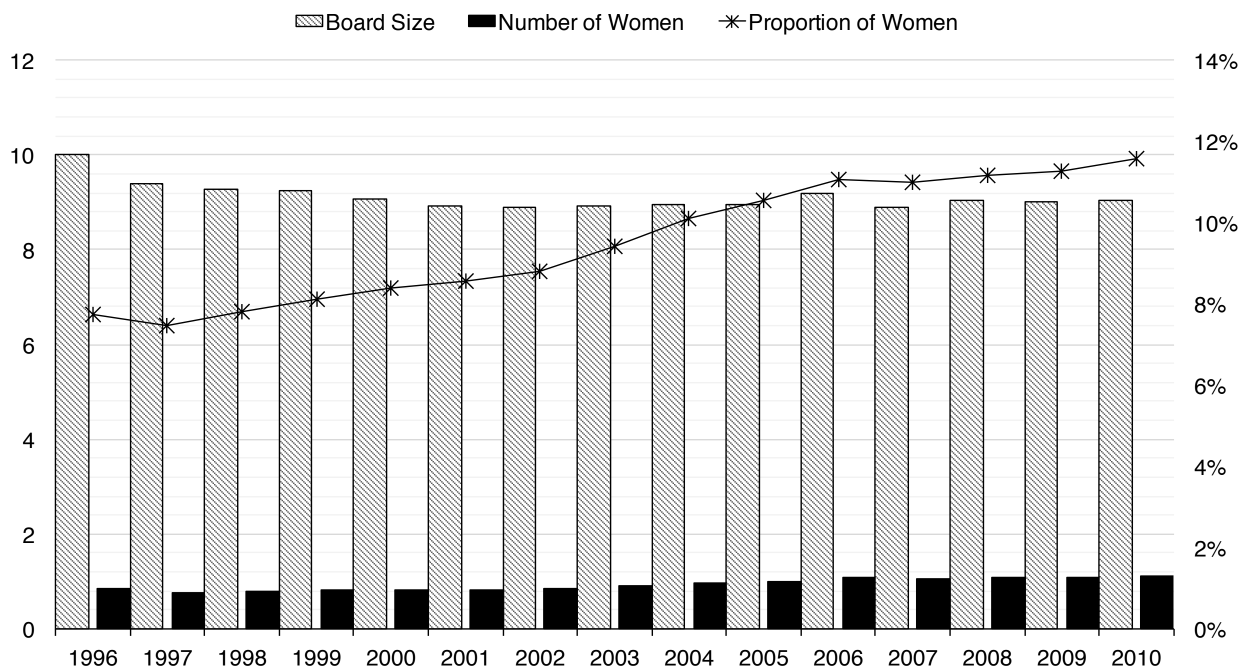

Figure 1. Board characteristics by year.