여성의 최고경영진(TMT) 참여와 기업의 위험 감수
Female Presence in Top Management Teams and Firms' Risk-Taking

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We examine the effect of female presence in top management teams (TMTs) on firms' risk-taking by employing data on the executives of U.S.-listed firms from 2005 through 2018. Exploiting state-level variation in policies supporting women and families in the workplace as an instrument, we show that firms with a higher number of female executives in TMTs have lower stock return volatilities. The effect of female TMT presence on firm risk is larger in small firms, wherein decision-making processes presumably depend more on individual TMT members' characteristics than in large firms. We find evidence that firms with female TMT members tend to make less risky choices in managerial decisions, especially regarding operating leverage. This study provides important opportune insights into the risk consequences of gender-diverse TMTs.

Keyword: female, risk, top management team

Ⅰ. Introduction

In the past decade, there has been a surge of interest in the effects of gender on firms. As most firms are male-dominated, prior studies have sought to understand the effect of female presence and/or gender diversity. These studies have focused on the gender composition of various teams in firms, such as top management teams (TMTs), boards of directors, and lower-level employee teams, and examined whether and how teams with more women lead to corporate outcomes that might differ from those that are male-dominated. Studies on upper echelons and corporate governance have suggested that gender diversity in TMTs and boards positively impacts innovation (Chen et al., 2018; Lee and Chung, 2022; Lyngsie and Foss, 2017), financial

Submission Date: 08. 13. 2024 Revised Date: (1st: 10. 03. 2024) Accepted Date: 10. 17. 2024

policies (Bernile et al., 2018), and firm performance (Ahern, and Dittmar, 2012; Dezsö and Ross, 2012; Jeong and Harrison, 2017; Krishnan and Park, 2005). Other studies have focused on lower-level employees and similarly suggested that gender diversity in firms' research and development (R&D) workforce is also associated with firms' technological performance (Faems, and Subramanian, 2013; Østergaard et al., 2011).

Prior research on gender diversity in business is grounded, either explicitly or implicitly, in social role theory that women and men differ in their social proclivities, with women (men) being more relationship (voice-raising)-oriented (Eagly and Wood, 1999; Greene et al., 2003; Tang et al., 2020), and it suggests that gender-diverse teams behave differently, relative to their male-dominated counterparts. Gendered behavior manifests in female leaders' more collaborative and inclusive management styles (Eagly and Carli, 2003; Melero, 2011; Tate and Yang, 2015), whereby the embraced viewpoints may contribute to firm performance.

Furthermore, gendered behavior is also reflected in women's risk aversion inclination (Croson and Gneezy, 2009; Eckel and Grossman, 2008; Ertac and Gurdal, 2012; Filippin and Crosetto, 2016). Much of the empirical evidence suggests that women are more risk-averse than men, not only in individual risk-taking (e.g., driving and gambling) (Byrnes et al., 1999) but also in financial risk-taking required to make investment-related decisions (Charness and Gneezy, 2012). As financial investors, women tend to make smaller investments in risky assets than men, invest less in stocks, and prefer more conservative alternative investment plans (Sunden and Surette, 1998; Watson and McNaughton, 2007). Moreover, female employees exercise stock options more slowly than male employees (Carpenter et al., 2019). In light of the gender of chief executive officers (CEOs), research has shown that firms managed by female CEOs lead to lower firm risk, as measured by lower leverage (Huang and Kisgen, 2013), higher chances of survival (Faccio et al., 2016), and less volatile earnings (Vo et al., 2021).

A large body of research has examined the firm-level consequences of gender-diverse boardrooms. The effectiveness of boards lies in how well they monitor and ratify managers' strategic decisions (Fama and Jensen, 1983; Pugliese et al., 2009; Zingales, 1998), which also has implications for firm risk. Adams and Ferreira (2009) show that female directors have better attendance records and are more likely to join monitoring committees than male directors, leading the board to allocate more efforts to monitoring. However, empirical evidence on the effect of gender-diverse boardrooms on firms' risk-taking is mixed and inconclusive (see for a review, Teodósio et al., 2021), with some studies finding a positive association (Adams and Funk, 2012; Ahern

and Dittmar, 2012; Poletti-Hughes and Briano-Turrent, 2019) and others finding a negative association (Adhikari et al., 2019; de Cabo et al., 2011; Saeed et al., 2016). Especially, research that suggests that having women on boards can lower corporate performance focuses more on the process of how women are appointed to boards or executive positions than on the presence of women themselves. Yang et al. (2019) highlight that mandatory quotas for women can lower corporate performance.

Notwithstanding the abundant empirical evidence vis-à-vis the gender effect in firms, there is a relative dearth of research on how female presence in TMTs is related to firm risk. Thus, our research question is as follows: How do female executives in TMTs impact firms' risk? Although this study theoretically draws from a similar stream of research relating to women and risk-taking, it differs from prior studies on female CEOs and gender diversity in boardrooms in that it is also closely aligned with an upper echelons perspective (Hambrick and Mason, 1984), which suggests that firm-level decisions are shaped by TMT members' cognitions, values, and perceptions, which go into effect through group-level decision-making processes.[1] An upper echelons perspective defines the TMT as "the relatively small group of influential executives at the apex of an organization—usually the CEO (or general manager) and those who report directly to him or her" (Finkelstein, Hambrick, and Cannella, 2009: 10) and submits that studying the composition of the TMT can predict strategic firm behavior and outcomes (Carpenter and Fredrickson, 2001; Wiersema and Bantel, 1992).

In addition to the upper echelons perspective, our study is closely related to the female leadership and diversity theory, which has recently attracted much attention. Recently, various studies on female leadership have been conducted. Hoobler et al. (2018) find that female leadership is beneficial in creating a gender egalitarian organizational culture, which tends to increase corporate performance. Lyness and Grotto (2018) diagnoses the shortcomings of society in relation to female leadership and provides analysis on the causes of the gender gap. Studies on women's leadership commonly suggest that women's leadership significantly impacts on the organization, strategy, and performance of a company. Gender diversity (diversity theory) can explain the impact on corporate activities through a somewhat different mechanism from that of female leadership. While female leadership focuses on the impact on corporates of leadership characteristics that are distinct from those of

1) In this paper, the terminology "upper echelons perspective" is used interchangeably with "upper echelons theory". The theory suggests that the characteristics and behaviors of an organization's top executives (the upper echelons) significantly affect the corporate strategy made by the organization, which, in turn, influences its performance.

men, gender diversity(diversity theory) focuses on the advantages or disadvantages that diversity itself brings to a company by coexisting leadership of different genders (Wagner et al. (1984)).

Examining the effect of female presence in TMTs on firm risk can provide distinguishing insights from examining the effect of female presence in boardrooms and that of female CEOs. First, although the board is responsible for monitoring and advising managers in making investment decision-making processes, it is TMT members who practically tasked with making important strategic decisions and steering the firm. Moreover, TMT decision-making is characterized by extensive group decision-making processes (Sah and Stiglitz, 1986, 1991; Moscovici and Zavalloni, 1969), wherein the team members exchange information that is different but complementary and debate and reconcile strategic issues (Heavey and Simsek, 2017; Lubatkin et al., 2006). Thus, TMTs provide a valuable setting for investigating how adding women to a team enhances information use in the team and diminishes firm risk. Based on the streams of research on women's communal proclivity and risk aversion in various settings, we expect female executives to impact TMT group decisions in a way that reduces firms' risk-taking.

Notably, some studies have linked female presence in TMTs with firm risk. Bao et al. (2014) employ data on 48 firms in the US retail industry and suggest that female executives in TMTs are negatively associated with the legal risk of material lawsuits. Baixauli-Soler et al. (2015) analyze 1,123 US-listed firms and find an inverted U-shaped relationship between the wealth created by executive stock options (or delta) and firms' risk-taking, which is moderated by gender-diverse TMTs, such that risk-increasing behavior turns into risk-reducing behavior at a lower level of wealth at risk. Perryman et al. (2016) analyze 2,566 US-listed firms and show that gender-diverse TMTs are related to lower market risk. Although these studies provide valuable initial investigations into the implications of TMT gender diversity on firm risk, the causal effect of TMT gender diversity on market risk remains unclear relative to studies of boardroom gender diversity.

In this study, we seek to address this gap in the literature by examining the effect of female executives in TMTs on firm risk. In this topic, it is important to mitigate the potential endogeneity concerns. The concerns arise from the possibility that female presence in TMTs may be endogenous to other firm-level attributes also correlated with firm risk. For example, a firm may choose to appoint female TMT members for risk management purposes when it exhibits poor performance (Bruckmüller and Branscombe, 2010; Martin et al., 2009; Ryan and Haslam, 2005, 2007).

Moreover, firm risk can also drive firms to appoint female TMT members. In this study, we use two-stage least squares (2SLS) models with an instrumental variable (IV) to somewhat alleviate these concerns.

Specifically, we analyze a panel of 3,786 US-listed firms in the 2005 - 2018 period, matched (on the state of the firm's headquarters) to the US state-level score capturing how friendly the state is to the rights of women and families in the workplace, provided by the National Partnership for Women and Families (NPWF), a US non-profit organization well-known for its support for the passage of the Federal Medical Leave Act (FMLA) of 1993. The NPWF score is an aggregate score for the presence of the relevant state policies, such as those that mandate the state's employers to offer "paid family leave" and "flexible use of sick time" to their employees. We use this score as an IV since it plausibly meets the "exclusion restriction" (Angrist and Krueger, 2001). First, the NPWF score is related to female presence in TMTs because state policies protecting the rights of women and family workers facilitate career development by aiding in their dual demands of jobs and families, which can lead to greater female presence in TMTs (Hegewisch and Gornick, 2011). In our data, we also confirm that the NPWF score indeed leads to an increase in female presence in TMTs. Second, it is unlikely that the NPWF score is correlated with firms' risk-taking, given the construction of the score, which is essentially the sum of points for the relevant policies present in the state.

Our findings suggest that female presence in TMTs reduces firms' risk-taking, as measured by stock return volatility. Our results suggest that a single female member increase in a TMT results in a 50 basis point decrease in daily stock return volatility, which is approximately 24% of the standard deviation of daily stock returns. Furthermore, the effect of female presence in TMTs is larger in small firms (with assets and sales below the median values), which supports our result that the reduced volatility is driven by female presence in a TMT, namely, the effect of TMT composition. In small firms, the cognition and action of top managers impact organizational behavior and corporate outcomes more directly than in large firms, where various ecological and governance influences plausibly dampen the TMT effects (Heavey and Simsek, 2015; Lubatkin et al., 2006). In terms of economic significance, the effect of female presence in TMTs is twice as large in small firms as in large firms.

We further analyze whether female representation in TMTs leads to conservative managerial decisions. Operating leverage[2] has

2) Operating leverage refers to the proportion of fixed costs in operating activities. Generally, if it is high, firms are more vulnerable during recessions and make greater profits during booms.

drawn considerable attention as one channel that amplifies a firm's risk (Lev, 1974; Carlson et al., 2004), since fixed costs are detrimental when the economy or firm's operational environment worsens. Using state-level NPWF scores as an instrument, we run 2SLS regressions of female presence in TMTs on operating leverage. We find that an increase in female representation in TMTs results in a decrease in fixed costs. This is evidence that female presence in TMTs decreases risk through managerial decisions.

As a robustness check, we adopt an alternative variable for female presence in TMTs —the ratio of the number of women in the TMT to the total number of TMT members— and analyze how this ratio affects a firm's risk-taking behavior. Consistent with the main results, firms' risk-taking decreases with the TMT female ratio.

Much of the empirical work linking gender differences and corporate outcomes has focused on boardroom gender diversity as a critical determinant of firm risk (Adams and Funk, 2012; Adhikari et al., 2019; Ahern and Dittmar, 2012; de Cabo et al., 2011; Poletti-Hughes and Briano-Turrent, 2019; Saeed et al., 2016; Yang et al., 2019); however, TMT gender diversity has been rather insufficiently studied. Based on an upper echelons perspective and social role theory, we posit that more female executives in a TMT can reduce firm risk by enhancing the team's joint decision-making processes through collaborative and inclusive leadership styles. We show that the risk-reducing effect of female presence in TMTs is strikingly larger in small firms, wherein firm-level decisions depend more on individual TMT members, and there is greater room for improvement in group decision-making processes. This result provides valuable evidence for the proposed channel whereby female TMT presence reduces firm risk-taking.

Furthermore, this study contributes to the growing literature on gender diversity in business. The proportion of females in TMTs has been rising steadily, accounting for 17.6% globally and 21% in North America in 2014 (Credit Suisse, 2014). While the phenomenon of gender-diverse TMTs is growing, prior research lacks an understanding of its consequences for firms. Albeit prior research has considerably examined gender-diverse TMTs' implications for firm performance (Dezsö and Ross, 2012; Krishnan and Park, 2005) and innovation (Chen et al., 2018; Lee and Chung, 2022; Lyngsie and Foss, 2017) from strategic management perspectives, it has overlooked their implications for firm risk (the meta-analytic study of Jeong and Harrison (2017) is an exception since it considers firm risk in explaining the variation in long-term firm performance that might be potentially attributed to gender-diverse TMTs). Our finding that gender-diverse TMTs decrease firms' risk-taking provides important insights into the

often observed higher performance in firms with gender-diverse TMTs. Thus, this study further provides useful, practical implications by suggesting that a firm seeking to reduce risk can consider increasing female presence in its TMT.

The remainder of this paper is organized as follows: in Section 2, we describe our data, summary statistics, and method. In Section 3, we present the empirical results. Section 4 concludes.

II. Data and Method

2.1 Data

Our dataset is the intersection of Compustat, CRSP, Orbis, and BoardEx. Data on financial information and stock returns are obtained from Compustat and CRSP, respectively. We collect firm executive information from Orbis, which is provided by Bureau van Dijk. The sample includes 21,308 observations of 3,984 firms for the 2005 - 2018 period. Orbis provides individual-level executive information about firms. They assign a unique contact identifier to each executive and regularly track which firm they are working for, what position they are assigned to and when, and what their responsibilities are. Using the assignment date or the first date where the executive appears in the dataset, we link the executive information to the firm's financial data. We link executive personnel to the firm until the last observed date in the executive dataset or the executive's expiration date, if available. Consequently, we construct data that include the number of female executives each year in a firm. We use the "type of positions" field in Orbis to identify the executive as belonging to a TMT.[3] Gender information on board members is obtained from BoardEx.

2.2 Variable definitions

Following Bernile et al. (2018), we use the stock return volatility as a measure of firm risk. *Daily_volatility* is the standard deviation of the daily stock returns over a year. *Monthly_volatility* is the standard deviation of the monthly stock returns over a year. *Idio_voalitlity* is the standard deviation of the residuals of market return regressions on daily stock returns over a year. *Female_number* is the natural logarithm of the number of female TMT members plus one. *Gender_score*

3) The types of positions that we use in our analysis are administration department (AdmDep), branch office (BrOff), customer service (CustSv), financial accounting (FinAcc), government affairs (GovAff), human resource (HR), health (Health), legal department (LegDep), marketing advertising (MarkAdv), operation (Oper), other department (OthDep), product/market/project manager (PMPMan), quality manager (Qual), purchasing & procurement (Proc), sales (Sales), Senior manager (SenMan), IT&IS (IT&IS), R&D (R&D), and other specific positions (SpecPos).

is the state-level score provided by the NPWF. Size is the natural logarithm of the total assets. *Leverage* is the total liability divided by total assets. *BTM* is the ratio of book equity to market equity. *ROA* is the return on assets, that is, net income divided by lagged total assets. *Capx* is capital expenditure divided by lagged total assets. *Tangibility* is defined as fixed assets divided by total assets. *Cash* is the cash and cash equivalents divided by total assets. R&D is R&D expenses divided by lagged total assets. *Dividends* is a dummy variable that is equal to one if dividends are paid out and zero otherwise. *Costs/Assets* capture operating leverage. Following Novy-Marx (2010), we use the cost of goods sold (COGS in Compustat) plus selling, general, and administrative expenses (XSGA in Compustat) as the operating costs. *Costs/Assets* is operating costs divided by lagged total assets. *Female_ratio* is the ratio of the number of female TMT members to the total number of TMT members. *BoardFemale* is a dummy variable that takes the value one if there is at least one female director on the board of directors and zero otherwise. *Size, Leverage, BTM, ROA, Capx, Tangibility, Cash*, and *R&D* are winsorized at the 1% level.

2.3 Method

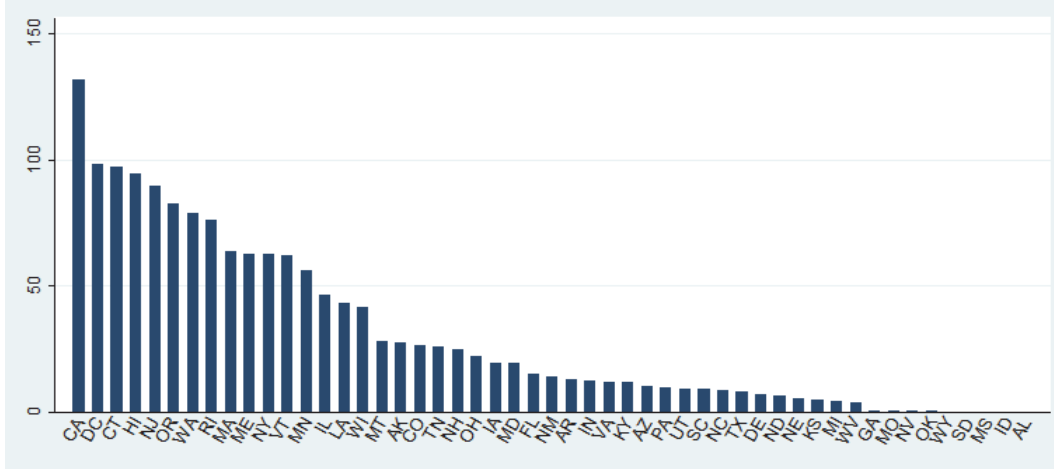
Although much research has been done on the relationship between the female presence of TMTs and risk-taking, it remains an open question of how female TMT members influence risk-taking. (Dezsö and Ross, 2012; Baixauli-Soler et al., 2015). Firms' inherent attitudes toward risk-taking can affect female representation in TMTs. Moreover, an unobservable organizational culture can simultaneously affect both female TMT presence and a firm's risk-taking. To address this concern, we use state-level policies for working parents and family caregivers as an instrument for 2SLS regressions, following Lee and Chung (2022).[4] We exploit the IV, *Gender_score*, which is neither mechanically correlated with the risk-taking of a firm nor other corporate policies. The NPWF, a US non-profit organization that encourages the rights of women and families in the workplace, produces state-level scores that assess how supportive each state is for working parents. The score is based on whether the states have

4) This paper introduces 2SLS to address the endogeneity problem, but it still has potential limitations. One can raise concerns about the exclusion conditions of the instrument. For example, The NPWF score is a state-level measure, but states can have different political leanings, which can affect legislation that helps women balance work and family life, as well as the advancement of women to senior leadership positions. In addition, this analysis does not control for year-fixed effects, because, as shown in Figure 2, the number of female TMT members in companies and the legislation that facilitates work-family balance show a pattern of increasing over time. Controlling for year-fixed effects is because the effects of changes in the social landscape over time and the changes in female executives are also absorbed into the control variables. These can potentially still raise concerns about endogeneity.

certain policies, such as paid family leave, paid sick days, flexible use of sick time, and pregnancy leave. The more favorable the working parents are, the higher the score the state earns.[5] The score is associated with work-related difficulties that impede women's career advancement toward top management positions, which is strongly correlated with the female presence in TMTs and orthogonal to the firms' policies, such as risk-taking.

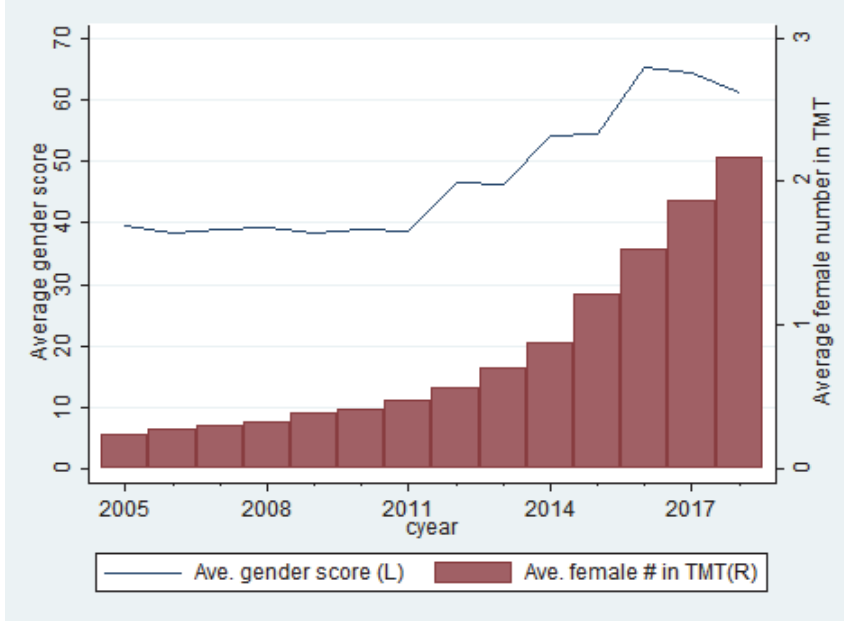
Figure 1 shows the state-level average of the gender scores. California, Washington DC, and Connecticut show high scores. On average, these states have more generous policies for working parents than others. Alaska, Idaho, Mississippi, South Dakota, and Wyoming earn zero scores. This means that these states do not have "state-level" policies for family caregivers beyond the policies defined by federal law. For example, these states do not have a state-administered program or employer policy that compensates for the wages of employees who take leaves to care for a new child. However, firms in those states have job-protected "unpaid" leave, which is guaranteed by a federal law known as the FMLA.

Figure 2 reports the yearly average of female members in the TMT and average gender scores. Both series have increased gradually since the initial year of the sample. Both trends reflect how society has evolved with regard to women in the workplace. The average *Gender_score* increased from 40 to 60, and the average number of female executive members was less than 0.5 in 2005, but increased to 2 in 2018.



〈Figure 1〉 State-level averages of gender score

5) The NPWF issued the reports in 2005, 2012, 2014, 2016, and 2018.



〈Figure 2〉 Gender scores and the number of female TMT members: yearly averages.

Using the *Gender_score* from the NPWF, we run a 2SLS regression to investigate the effects of female presence on firms' risk-taking. In the first-stage regression, we regress the endogenous variable *Female_number* on the IV *Gender_score* as follows:

$$Female\_number_{it} = \alpha_0 + \alpha_1 Gender\_score_{it-1} + \alpha_3 X_{it} + \varepsilon_{it}$$

Gender_score is a lagged variable since it might take time for policies for female workers to lead to an increase in female members in a TMT. The control variables, X_{it}, include *Size*, *Leverage*, *BTM*, *ROA*, *Capx*, *Tangibility*, *Cash*, *R&D*, and firm fixed-effect dummy variables. The second-stage regression is as follows:

$$Volatility_{it} = \beta_0 + \beta_1 \widehat{Female\_number_{it}} + \beta_2 X_{it} + \eta_{it}$$

Volatility is *Daily_volatility* or *Monthly_volatility*. $\widehat{Female\_number_{it}}$ is predicted as *Female_number* by *Gender_score* in the first stage. Our coefficient of interest, β_1, captures the effect of female TMT members on firms' risk-taking.

2.4 Summary Statistics

Table 1 reports the summary statistics of

〈Table 1〉 Summary statistics
(All financial variables except for Daily volatility and Monthly volatility are winsorized at 1% level)

	mean	Sd	p25	p50	p75
Daily_volatility	0.029	0.020	0.018	0.025	0.035
Monthly_volatility	0.119	0.082	0.070	0.101	0.145
Idio_volatility	0.026	0.020	0.015	0.022	0.032
Female_number	0.415	0.549	0.000	0.000	0.693
Gender_score	47.089	47.457	10.000	30.000	75.000
Size	6.708	2.011	5.276	6.677	8.109
Leverage	0.501	0.216	0.337	0.508	0.661
BTM	0.707	0.808	0.283	0.496	0.829
ROA	-0.001	0.192	-0.015	0.039	0.083
Capx	0.056	0.071	0.017	0.033	0.067
Tangibility	0.261	0.243	0.073	0.170	0.385
Cash	0.187	0.208	0.034	0.108	0.262
R&D	0.053	0.112	0.000	0.000	0.054
Dividends	0.468	0.499	0.000	0.000	1.000
Costs/Assets	1.048	0.805	0.494	0.841	1.363
Costs/Sales	1.262	2.542	0.794	0.882	0.953
Female_ratio	0.145	0.215	0	0	0.25
BoardFemale	0.611	0.488	0	1	1

our sample. Average *Female_number* is 0.415, which means that there are 0.51 (0.51= $e^{0.415}$-1) female executives in the TMT on average. *Female_number* is very skewed; the median of *Female_number* is zero, while the mean is 0.415. This shows that some firms have many female executives, and many other firms do not hire women as members of the TMT. The mean of *Female_ratio* is 14.5%, which is similar to the number in prior studies (Credit Suisse, 2014).

Ⅲ. Results

3.1 Main results

Table 2 reports the estimation results of the 2SLS regressions. Column (1) shows the first-stage regression results. It shows that *Gender_score* duly predicts *Female_number* as expected. It also indicates that policies supporting working parents are positively associated with the number of women working

〈Table 2〉 The effects of female number on stock return volatility
(Standard errors are reported in parentheses; standard errors are heteroskedasticity robust and clustered at the firm level)

	(1)	(2)	(3)	(4)
	Female_number	*Daily_volatility*	*Monthly_volatility*	*Idio_volatility*
Gender_score	0.009***			
	(0.000)			
Female_number		-0.005***	-0.030***	-0.000
		(0.001)	(0.005)	(0.001)
Size	0.221***	-0.007***	-0.020***	-0.007***
	(0.015)	(0.001)	(0.002)	(0.000)
Leverage	0.312***	0.020***	0.088***	0.018***
	(0.044)	(0.002)	(0.008)	(0.002)
BTM	-0.037***	0.008***	0.013***	0.007***
	(0.007)	(0.000)	(0.002)	(0.000)
ROA	-0.034	-0.009***	-0.037***	-0.009***
	(0.025)	(0.002)	(0.010)	(0.002)
Capx	-0.505***	-0.013***	-0.113***	-0.012***
	(0.070)	(0.004)	(0.017)	(0.004)
Tangibility	0.235**	0.010***	0.047***	0.009***
	(0.093)	(0.003)	(0.014)	(0.002)
Cash	0.117**	0.002	0.013	0.001
	(0.047)	(0.002)	(0.009)	(0.002)
R&D	0.052	-0.008**	-0.005	-0.006
	(0.070)	(0.004)	(0.024)	(0.004)
Dividends	0.046***	-0.002***	-0.010***	-0.002***
	(0.016)	(0.001)	(0.002)	(0.001)
BoardFemale	0.117***	-0.001	0.001	-0.001
	(0.016)	(0.001)	(0.002)	(0.000)
Firm FE	Y	Y	Y	Y
N	21,308	21,308	21,308	21,308
IV F-stats	223.94			
Durbin p-value		〈0.001	〈0.001	〈0.001

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

in top positions. It is consistent with the conventional knowledge that the relationship between duties for a family member and the working hours of women is rather substitutive. The environment for balancing work and family allows women to achieve top positions in a firm. If *Gender_score* increases from zero to 100, then the number of female members increases to approximately 0.8. Considering the average number of female members in a TMT in our sample is 0.57, the economic significance of *Gender_score* is substantial. The

first-stage F statistic is 223.94, sufficiently large to reject the hypothesis that *Gender_score* is a weak instrument for *Female_number*.

Column (2) of Table 2 shows the effect of the predicted number of females on firms' risk, measured by daily stock return volatility. *Daily_volatility* decreases with *Female_number* after controlling for variables such as size, leverage, and the book-to-market ratio. With a single female member increase in a TMT, daily stock return volatility decreases by 50 basis points ($-0.0050 = e^{-0.005} - 1$), which is approximately 25% of the standard deviation of *Daily_volatility* in our sample. Note that the dependent variables in this regression are predicted *Female_number* using *Gender_score*, which is not likely to be correlated with stock returns. Thus, the result has a causal implication on the relationship between *Female_number* and firm risk.

Column (3) of Table 2 reports the results with an alternative measure of firms' risk-taking. We use the monthly stock return volatility instead of the daily stock return volatility. These results are similar to those of the previous regression. Female presence in a TMT decreases the monthly stock return volatility after controlling for various firm characteristics and firm fixed effects. A single female executive increase in TMT is associated with a 2.96 percentage point decrease ($-0.03 = e^{-0.03} - 1$) in monthly stock return volatility.

Column (4) of Table 2 reports the effect of the predicted number of females on firms' risk, measured by idiosyncratic volatility. Interestingly, female presence in a TMT has no significant effect on idiosyncratic volatility. This can be interpreted as the presence of female TMT members reduces corporate risk through systematic risk rather than idiosyncratic volatility.

3.2 Small firms

In this subsection, we investigate how the effect of female representation in a TMT differs with firm size. If a firm is small, then its decision-making process will be more easily affected by the individual characteristics of the TMT members. This is because large firms are likely to have a more systematic decision-making process to dilute the effect of the gender characteristics of the TMT. If the characteristics of female executives moderate firms' decisions, then we should find that the effects of female presence in a TMT are more significant in small firms. We test whether the analysis by firm size is consistent with our conjecture. We use total assets and sales to differentiate the firms in the sample. We define the dummy variable *Sizelow* (*Salelow*) as one if total assets (sales) are below the bottom 25% value in our sample. Using dummy variables, we test whether the effect of *Female_number* decreases more in small firms than in large firms. If the effects of female presence are stronger in small firms, we should find

negative coefficients in the interaction term.

Table 3 reports the results of the second stages of the 2SLS regressions, where the independent variables of interest are the interaction terms between *Female_number* and size dummy variables (*Sizelow, Salelow*). We include various firm characteristics (total assets, leverage, book-to- market ratio, ROA, CAPX, cash, R&D, dividend) and firm fixed effects in the regressions to control for non-time varying unobservable characteristics of firms as in the previous analysis. Our estimation results show that the volatility decrease driven by female executives in a TMT is amplified in small firms. *Daily_volatility* decreases by 50 basis points ($0.0050=e^{-0.005}-1$), with a one unit increase in *Female_number* in both *non-Sizelow* firms *non-Salelow* firms. The magnitude of the decreasing effects in *Sizelow* firms is 70 basis points larger ($-0.0070=e^{-0.007}-1$) than those in *non-Sizelow* firms. The magnitude of the effects in *Salelow* firms is about 40 basis points, but it is not statistically significant. In *Monthly_volatility*, the magnitude of the decreasing effects in *Sizelow* and in *Sizelow* firms are 4.1% ($-0.041=e^{-0.042}-1$) and 2.8%($-0.028=e^{-0.028}-1$), respectively, and are all statistically significant.

3.3 Managerial decisions: Operating leverage

In the previous sections, we find that women's representation in TMTs lowers firms' risk. Using an IV that is not correlated with stock return volatility, a causal relationship between women in TMTs and firm risk can be established. In this section, we further investigate in which channel women's representation in TMTs affects firms' managerial decisions. We analyze how the operating leverage of firms can be affected by women's representation in TMTs. The literature suggests that operating leverage is a managerial choice that amplifies a firm's risk (Lev (1974), Carlson, Fisher, and Giammarino (2004). If the proportion of fixed costs for a firm is high (operating leverage is high), then firm value can further deteriorate during bad times. On the contrary, firms obtain higher returns in a good economic situation. If a firm's manager is more risk-averse, we can expect that those firms have a lower operating leverage than firms that actively take risks. By investigating whether firms with female TMT members show low operating leverage, we identify the mechanism by which such firms with women in their TMTs have lower stock return volatility. We use the same 2SLS approach to find a causal relationship between female presence in TMTs and operating leverage. We adopt the operating leverage measure, *Costs/Assets*, proposed by Novy-Marx (2010).

Column (1) of Table 4 reports the second-stage regression results of predicted *Female_number* on operating leverage. A single female member increase in TMTs results in a

〈Table 3〉 Low size and low sales dummy variables interaction effects
(Standard errors are reported in parentheses; Standard errors are heteroskedasticity robust and clustered at the firm level)

	(1)	(2)	(3)	(4)
	Daily_volatility	*Monthly_volatility*	*Daily_volatility*	*Monthly_volatility*
Female_number	-0.005***	-0.026***	-0.005***	-0.027***
	(0.001)	(0.005)	(0.001)	(0.005)
*Sizelow*Female_number*	-0.007*	-0.042**		
	(0.004)	(0.018)		
*Salelow*Female_number*			-0.004	-0.028*
			(0.004)	(0.015)
Size	-0.007***	-0.023***	-0.007***	-0.021***
	(0.001)	(0.002)	(0.001)	(0.002)
Leverage	0.020***	0.088***	0.020***	0.087***
	(0.002)	(0.008)	(0.002)	(0.008)
BTM	0.008***	0.013***	0.008***	0.013***
	(0.000)	(0.002)	(0.000)	(0.002)
ROA	-0.009***	-0.036***	-0.009***	-0.037***
	(0.002)	(0.010)	(0.002)	(0.010)
Capx	-0.013***	-0.111***	-0.013***	-0.114***
	(0.004)	(0.016)	(0.004)	(0.017)
Tangibility	0.010***	0.046***	0.010***	0.047***
	(0.003)	(0.014)	(0.003)	(0.014)
Cash	0.002	0.012	0.002	0.013
	(0.002)	(0.009)	(0.002)	(0.009)
R&D	-0.007**	-0.003	-0.008**	-0.006
	(0.004)	(0.024)	(0.004)	(0.024)
Dividends	-0.002***	-0.010***	-0.002***	-0.011***
	(0.001)	(0.002)	(0.001)	(0.003)
BoardFemale	-0.001	0.001	-0.001	0.001
	(0.001)	(0.002)	(0.001)	(0.002)
Firm FE	Y	Y	Y	Y
Obs.	21,308	21,308	21,308	21,308
IV F-stats	80.07	80.07	80.07	80.07
Durbin p-value	〈0.001	〈0.001	〈0.001	〈0.001

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

0.129 decrease ($-0.129 = e^{-0.138} - 1$) in *Costs/Assets*. The results suggest that the effects of female members in a TMT on risk are driven by conservative managerial decisions. One thing to note is that *Capx* is highly associated with *Costs/Assets*. Capital expenditures are investments in physical assets, such as property, plants, buildings, and equipment.

Owing to fixed assets, they incur fixed costs. Furthermore, capital expenditures fundamentally sacrifice current resources for future outcomes. Conservative firms would allocate fewer resources to capital expenditures than firms that actively take a risk when the expected returns of investment opportunities and the risk that the investment entails are the same. We analyze whether female presence in a TMT affects the physical capital investment policy.

Table 4, Column (2) shows the estimation results. As we expected, firms with female members in their TMTs have less aggressive physical capital investment. Note that the results are controlled for variables capturing

〈Table 4〉 Female presence in TMT and operating leverage
(Standard errors are reported in parentheses; standard errors are heteroscedasticity robust and clustered at the firm level)

	(1)	(2)
	Costs/Assets	*Capx*
Female_number	-0.138***	-0.023***
	(0.034)	(0.003)
Size	-0.123***	0.007***
	(0.016)	(0.002)
Leverage	0.276***	-0.009
	(0.042)	(0.006)
BTM	-0.038***	-0.008***
	(0.007)	(0.001)
ROA	0.155***	0.038***
	(0.056)	(0.007)
Capx	1.393***	
	(0.124)	
Tangibility	-0.725***	0.090***
	(0.079)	(0.015)
Cash	-0.149***	-0.002
	(0.055)	(0.006)
R&D	2.779***	0.151***
	(0.141)	(0.012)
Dividends	0.031**	0.000
	(0.013)	(0.002)
BoardFemale	0.001	-0.005**
	(0.015)	(0.002)
Firm FE	Y	Y
Obs.	21,308	21.308
IV F-stats	299.89	304.56
Durbin p-value	〈0.001	〈0.001

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

investment opportunities, such as *BTM, ROA,* and *Cash*. A single female member increase in a TMT results in a two percentage point decrease ($-0.023=e^{-0.023}-1$) in *Capx*. In sum, our results provide evidence that female TMT members have an effect on managerial decisions, and firms with female TMT members are more risk-averse in operating leverage.

3.4 Robustness check: Female_ratio

In this section, we use an alternative variable, *Female_ratio*, to investigate the effect of female TMT members on firm risk-taking. Previously, we have focused on the marginal effect of an additional female TMT member on firms' risk-taking. Considering that TMT

〈Table 5〉 Robustness check- *Female_ratio*
(Standard errors are reported in parentheses; standard errors are heteroscedasticity robust and clustered at the firm level).

	(1)	(2)
	Daily_volatility	*Monthly_volatility*
Female_ratio	-0.168*	-0.949*
	(0.094)	(0.507)
Size	-0.005**	-0.009
	(0.002)	(0.011)
Leverage	0.022***	0.099***
	(0.003)	(0.019)
BTM	0.008***	0.015***
	(0.001)	(0.003)
ROA	-0.007***	-0.026*
	(0.003)	(0.016)
Capx	-0.012*	-0.110***
	(0.007)	(0.035)
Tangibility	0.014**	0.066*
	(0.006)	(0.035)
Cash	0.003	0.018
	(0.003)	(0.019)
R&D	-0.010	-0.018
	(0.007)	(0.038)
Dividends	-0.001	0.000
	(0.002)	(0.009)
BoardFemale	0.002	0.015
	(0.002)	(0.012)
Firm FE	Y	Y
Obs.	23,108	24,340
IV F-stats	3.87	3.87
Durbin p-value	21,308	21,308

* $p<0.10$, ** $p<0.05$, *** $p<0.01$

size can jointly affect both the number of female TMT members and firms' risk-taking, it is possible that TMT size can account for the relationship between female presence in a TMT and firms′ risk-taking. To alleviate this concern, we construct a ratio variable, *Female_ratio*, and investigate how the proportion of female TMT members affects risk-taking in firms. Using the same instrument as in the main analysis, namely, *Gender_score*, we run 2SLS regressions on stock return volatilities. The results are presented in Table 5. Consistent with the previous analysis, firms′ risk-taking, as measured by stock return volatilities, decreases with the TMT female ratio. Thus, an increase in the proportion of female members in a TMT has a diminishing effect on firms′ risk-taking.

Ⅳ. Conclusion

There has been an upward trend that the position of women in society and the social activities of women have surged globally and in the U.S. in recent years. An increasing number of women are playing an essential role as executives in firms and making critical management decisions. In this study, we investigate the role of women in TMTs, which is relatively less explored with a large data set in the literature compared to board members, CEOs, and so on. Specifically, we examine the effect of female TMT members on a firm's risk-taking behavior and operating leverage as an outcome of managerial decisions from TMTs.

We find that female presence in a TMT decreases a firm's risk, as measured by stock return volatility. Our results contribute to the literature by providing corroborating evidence for an upper echelons perspective that the managerial background characteristics of top management can predict firms' outcomes. The effects are stronger in small firms, which are more dependent on the composition of TMTs, than in large firms. We also find further evidence of corporate policies that make firms less risky. Female presence in a TMT reduces operating leverage and capital expenditure, suggesting that female presence reduces risk by potentially affecting management's decision-making processes.

This study has important managerial implications by showing that firms′ shareholders can benefit from having more female members in a TMT, especially when the firms have risk management-related concerns. A cautionary note is that our results by no means imply that adding additional female members always reduces firm risk in all states of the TMT's gender composition. Today, although the proportion of female TMT members is growing, it is still low (14.5% in the U.S.), and female members may potentially reduce risk in firms

in such a state. However, in firms with non-male-dominated TMTs, adding extra female members may not diminish firm risk.

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