Gender Diversity on US Corporate Boards and Cost of Capital

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In this paper, using a sample of U.S. firms during the years 2001-2002, we find a significantly lower level of cost of capital in firms that have at least one female director on the board, after correcting for selectivity bias and controlling for other known board, firm and industry characteristics. The effect is also significant for female non-executive director presence. Our findings suggest that the market attributes lower risk for firms with female directors, *ceteris paribus*. Our findings are consistent with two strands of research, one linking gender diversity to better corporate governance and the other linking better corporate governance to lower cost of capital.

I. INTRODUCTION

In this paper, we investigate whether there is an association between gender-diversified boards and the cost of capital, after controlling for other board characteristics. Our study is positioned at the cross-section of two strands of research in the literature: female directors improve corporate governance by more effective board oversight and monitoring; and corporate governance can reduce the cost of capital. The first strand of research focuses on how gender-diversified boards affect board oversight and monitoring (Hillman et al., 2008). Adams and Ferreira (2009), for example, suggest that gender-diverse boards allocate more effort to oversight and monitoring. They show that female directors improve board inputs: they have better board attendance records, prompt male board members to improve their board attendance, are more likely to assume monitoring positions on audit, nominating, and corporate governance committees rather than on the compensation committee, and are more likely to hold CEOs accountable for poor performance. Audit and corporate governance committees are directly involved in increasing the transparency, improving the disclosure to, and facilitating the collection of value-relevant, firm-specific information by investors.

The second stream of research that we draw on focuses on the influence of corporate governance on the cost of capital. Leuz et al. (2009) show lower inflow of external capital in countries with poor corporate governance. Andersen et al. (2004) show an inverse relation between the cost of debt and corporate governance measured by board independence, board size, audit committee independence and meeting frequency. Likewise, Ashbaugh-Skaife et al. (2004) show an inverse relation between the cost of equity and board strength. Several other studies using both external governance proxied by the firm's exposure to the takeover market and internal governance proxied by board effectiveness also provide evidence supporting lower cost of equity and debt capital in firms with strong governance (Klock et al. 2005;

Claessens 2006; Chava et al. 2009; Carmelo 2009). Together, these two streams of research suggest that firms with gender-diversified boards should have lower cost of capital, *ceteris paribus*.

Investigating this relationship is timely because of the increasing recognition of board gender-diversity as a matter of both societal and economic importance. First, there is an increasing trend among US companies to appoint female directors and this is becoming an important feature of several US corporate boards (Rosener 2003). Since 1999 the number of female directors has also increased for S&P companies (Cohn 2006). For the period of our study, most firms across most industries in the US have at least one female director (see Table 1). Further, as shown in the table, most of the female directors are non-executive directors.[1] This trend could either be the recognition of the existence of the "glass ceiling" and unfairness towards women or the recognition of the improved effectiveness of gender-diverse boards or both. Interestingly, the proponents of board reform worldwide have called for greater gender diversity on corporate boards in order to *make them more effective* (Higgs, 2003; Tyson, 2003). Studies such as Terjesen et al. (2009) argue that gender diversity improves board level discussions and decisions, thereby affecting financial, social and reputational outcomes. Seemingly in response to this rationale, several countries have adopted guidelines and quotas for female representation on boards of publicly listed firms. For example, Sweden requires 25%, Norway requires 40% and Spain has proposed a requirement of 40% by 2015. In the face of these momentous changes in the gender diversity of board structures, it is surprising that little is known about the effect of female directors on US corporate boards on corporate finance.

[1] We use the term non-executive directors and outside directors inter-changeably.

Studies in management and organizational fields on the differences in the characteristics between men and women can point towards the potential effect of gender diversity on board decision-making and consequently, on the firm's cost of capital. Two important findings of these studies seem relevant to this issue: women are likely to be more ethical in than men; and women are typically more risk-averse than men[2]. Therefore, boards with female directors are less likely to make decisions with debatable ethical foundation (such as earnings management, consumption of private benefits etc.), and more likely to direct investment into less risky projects, thereby reducing the default risk for creditors and the beta for equity; may be more cautious in taking on debt. The improved ethical basis of decisions is likely to reduce litigation and reputation risks (Gilson 1990) and the re-focusing of investments into less risky avenues is likely to directly reduce the risk to the capital employed.

Based on this literature on the differences between men and women, we posit that corporate boards with female directors are more likely to provide a better oversight of decisions and operations in the firm and that the market is likely to attach lower levels of risk to such firms. As a consequence, firms with boards with female directors are more likely to be associated with lower cost of capital, *ceteris paribus.*

Using a sample of US firms for the period 2001-2002, we provide evidence in support of the above proposition. In particular, we show that firms with at least one female director on their boards are associated with lower costs of capital. Similar results are obtained when we examine female non-executive director presence on the board. In effect, these findings also show that the effect is a result of women acting as *board members* rather than as *insider managers*.

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[2] We provide a brief review of this literature in the next section.

Our paper links the growing literature that provides evidence on the linkage between board monitoring mechanisms and corporate financing issues with the broader literature on gender diversity by documenting how such diversity can impact the markets' assessments of firm risk. In contrast to prior studies on the role of women on corporate boards generally that have relied on survey and interview methodologies to report the views of female directors and CEOs (Bilimoria 2000), we provide empirical evidence based on archival data that the presence of female directors on corporate boards is associated with lower costs of capital This evidence is currently not available in the literature. The results in this paper suggest that studies on corporate decision making and strategies could benefit by explicitly considering the role of female directors on corporate boards.

The rest of the paper is organized as follows. In the next section, we present some of the relevant background literature on gender differences and outline the hypotheses. In section 3 we discuss the research design. The fourth section provides the empirical analysis and results. The final section concludes the paper.

II. LITERATURE REVIEW AND HYPOTHESES

Literature Review

There is considerable literature on the effect of board characteristics such as CEO duality, the proportion of independent members on the board, size of the board, the constitution of the audit committee and management ownership on information and performance variables such as earnings quality, value relevance of earnings, compensation, pay-performance relationship, accounting and market-based performance (Ajinkya et al. 2005; Cotter and Sylvester 2003;

Gul et al. 2003; Niemi 2005; Gul and Leung 2004; Klein 2002a, 2002b).[3] This strand of literature has documented that corporate board governance enhances the informativeness of disclosures by improving earnings quality and value relevance of earnings reports. It has also documented evidence in support of better performance both in terms of future accounting profitability and firm value.

A second strand of literature suggests that firms with female directors are associated with stronger board monitoring, higher profitability and more competitive advantage (Burke and Mattis 2000; Rosener 2003). More particularly, several studies provide evidence that female directors influence the firm's operating, investment and reporting decisions by improving the quality of board deliberations and corporate governance (Clarke, 2005; Fondas and Sassalos, 2000; Huse and Solberg, 2006; Stephenson, 2004; Van der Walt and Ingley, 2003). Kramer et al. (2006) find that women directors were more prepared than men to push "tough issues" at the board that others were reluctant to tackle. This is particularly relevant because corporate boards are often compliant or silent on critical issues (Bryne, 2002; Lorsch and MacIver, 1989). McInerney-Lacombe et al. (2008) argue that in addition to being dominated by management, the boards might fail to utilize truly deliberative processes with its directors giving inadequate attention to consequential issues (Taylor et al. 1996). Boards might well be in need of directors who could guide them through tension-filled issues to constructive outcomes (Fisher and Ury, 1991; Johnson et al., 2000). Women are more likely to fill this role than men (McInerney-Lacombe et al., 2008). This ability to champion tough issues, enables

[3] For example, Jensen and Fuller (2002) recommend that the board's ability to exercise its oversight function can be enhanced if the board has its own budget to hire independent experts, lawyers and consultants; meets privately with key managers to gather critical information and takes control of its own composition rather than depend on the CEO. In essence, these authors imply that in addition to the separation of rights over which the current debate is focused, two more factors affect the effectiveness of the board: the ability of the boards to independently collect relevant information and a philosophical shift from one of compliance and review to one of "insatiable curiosity".

women directors to select monitoring positions and improve the oversight function of the board as found by Adams and Ferreira (2009).

However, literature provides ambiguous evidence regarding the relationship between gender diversity and performance. On the one hand, Adams and Ferreira (2009) show lower performance among firms with gender-diverse boards. On the other hand, several earlier studies (Erhardt et al. 2003; Zahra and Pearce, 1989) show that firms with gender-diverse boards are more profitable. Carter et al. (2003) using data from 797 Fortune 1000 companies for 1999 find that there is a positive association between females on corporate boards and firm value. However, we argue that gender diversity on the boards are associated with lower risk and therefore lower cost of capital. Correspondingly, the market value is likely to be higher but in equilibrium, the market return is likely to be lower to reflect the lower risk associated with these firms, *ceteris paribus*. Therefore, ambiguity in the findings of a relation between board gender diversity and future performance is *per se* not inconsistent with finding a lower cost of capital.

A supporting body of literature on the differences in traits and behavior of men and women provides justification for the observed differences in the nature of decision making between female and male directors. Several studies in accounting suggest that women are more sensitive to ethical issues than men in most decision making situations that call for ethical decision making (Cohen et al. 1998; Bernardi and Arnold 1997; Bruns and Merchant 1990). A greater sensitivity to ethical issues explains the higher levels of vigilance in the financial reporting process found in gender-diversified boards than in all-male boards in Adams and Ferreira (2009), and Gul et al. (2009). There is also a broader literature in management and psychology which suggests that female directors are more risk averse and could make a difference on corporate boards (Brooks and Zank 2005; Jianakoplos and Bernasek 1998; Barber and Odean 2001). Higher aversion to litigation and reputation risk will induce female directors to push for greater monitoring of operations, prompter disclosure of relevant information to investors and selecting projects with less risk about future outcomes. For example, Chen et al. (2009) argues that the research and development expenditure undertaken by firms with stronger boards is less risky than that undertaken by others, after controlling for other factors.

Gender Diversity and cost of capital

While we make a case in the earlier paragraphs that gender diversified boards are more likely to be effective, in this section we link the effectiveness argument to the cost of capital. Boards that are more effective are likely to reduce the non-diversifiable expropriation risk by corporate insiders. The reduction in the non-diversifiable risk is likely to be linked to lower cost of capital. Further, more effective boards lowers the cost of outside monitoring which is also likely to lead to lower costs of capital. Suppliers of capital are likely to demand a lower required rate of return from firms with more effective boards since their monitoring tasks are lower. They spend less resource to monitor the management. Based on the above argument we posit the following alternative hypothesis.

H_1: Firms with more gender diversified boards is negatively associated with the cost of capital.

III. RESEARCH DESIGN

1. The Basic Model

The cost of financing a firm's capital is an aggregate of the cost of borrowing and the cost of equity. We use the interest rate (*IR*) as the proxy for the cost of debt. The interest rate of firm *i* for year *t* is defined as the interest expense divided by its average short-term and long-term debt during the year (Francis et al., 2004; Pittman and Fortin, 2004; Sengupta, 1998). We measure the cost of equity (*CoE*) using the Easton (2004) model.

$$P_0 = \left(eps_2 + r \times dps_1 - eps_1\right) / r^2 \qquad (1)$$

where r is the expected rate of return and a measure of cost of equity (*CoE*); P_0 the price per share in June of the current year; eps_2 (eps_1) the average of analysts' forecasts of two- (one-) year-ahead earnings per share; and dps_1 the average of analysts' forecasts of one-year-ahead dividend per share.[4] This model assumes that abnormal growth in earnings is constant in subsequent years.

Our basic model for testing the association between gender diversity and the cost of debt is the following.

$$\begin{aligned} IR = \beta_0 + \beta_1 \cdot I(GD \geq 1) &+ \beta_2 AccQuality + \beta_3 SIZE + \beta_4 Zmijewski \\ &+ \beta_5 CashF + \beta_6 Asset + \beta_7 BM + \beta_8 Lev + \beta_9 NEDprop \\ &+ \beta_{11}(Year2001) + (IndustryDummies) + u \end{aligned} \qquad (2)$$

In (2), $I(GD \geqq 1)$ is a dummy variable set to 1 if $GD \geqq 1$, 0 if $GD=0$. Several studies argue that female directors are chosen as mere tokens to satisfy social pressure (Bourez, 2005; Branson, 2006). To address this issue of "tokenism", we replicate all of our analyses with another dummy variable $I(GD \geqq 2)$ which indicates whether there are two or more female directors on the board.

[4] The analysts' forecasts made in June of the current year are obtained from the I/B/E/S database.

Several firm-specific variables are included in (2) to control for credit risk. Francis et al. (2005) show that accruals quality (*AccQuality*) is an important determinant of the cost of debt. Consistent with Francis et al. (2005), we measure accruals quality using the McNichols (2002) extension of the Dechow and Dichev (2002) model given in equation (3)

$$TCA_{j,t} = \phi_{0,j} + \phi_{1,j} CFO_{j,t-1} + \phi_{2,j} CF)_{j,t} + \phi_{3,j} CFO_{j,t+1} + \phi_{4,j} \Delta \mathrm{Re}\, v_{j,t} + \phi_{5,j} PPE_{j,t} + v_{j,t} \quad (3)$$

in which $TCA_{j,t} = \Delta CA_{j,t} - \Delta CL_{j,t} - \Delta Cash_{j,t} + \Delta STDEBT_{j,t}$ = total current accruals in year t; $CFO_{j,t} = NIBE_{j,t} - TA_{j,t}$ = cash flow from operations; $TA_{j,t} = \Delta CA_{j,t} - \Delta CL_{j,t} - \Delta Cash_{j,t} + \Delta STDEBT_{j,t} - DEPN_{j,t}$ = total accruals; $NIBE_{j,t}$= net income before extraordinary items; $\Delta CA_{j,t}$= change in current assets; $\Delta CL_{j,t}$= change in current liabilities; $\Delta Cash_{j,t}$= change in cash; $\Delta STDEBT_{j,t}$ = change in current liabilities; $DEPN_{j,t}$= depreciation and amortization expense ; $\Delta Rev_{j,t}$= change in revenue ; $PPE_{j,t}$= gross value of PPE ;$\Delta AR_{,j,t}$ = change in accounts receivable (all changes are between year t-1 and year t and all values are scaled by average total assets). We estimate (3) for each of Fama and French 91997) 48 industry groups with at least 20 firms and compute accruals quality for each firm as the standard deviation of the residual from (3) over years (t-4) through t. Among other control variables in (2), the size of the firm (log of total assets) reduces the possibility of default (berger and Udell, 1995). The risk of default increases significantly with bankruptcy risk. In order to control for bankruptcy risk, we use the probability of bankruptcy computed using the probit model (Zmijewski, 1984). The probability of bankruptcy in this model is determined by three ratios: return on assets defined as net income divided by total assets; total liabilities over total assets; and the currernt ratio defined as current assets divided by current liabilities. Cash flow from operations (CashF) and the fraction of total assets held in the form of property, plant and equipment (Asset) provide greater cushion to the lenders Growth opportunity (inversely measured by the book-to-market ratio, BM) could increase the uncertainty and risk but also provide a greater margin of safety for the lenders. Firms with higher leverage (Lev) have more legal obligation to pay interest and repay capital and therefore, reflects higher risk (Peterson and Rajan, 1994). We also include the proportion of independent directors on the board to control for non-gender-related board governance effectiveness.

The basic model for cost of equity is equation (4):

$$\begin{aligned} CoE = {} & \beta_0 + \beta_1 \cdot I(GD \geq 1) + \beta_2 AccQuality + \beta_3 Zmijewski + \beta_4 Growth \\ & + \beta_5 CashF + \beta_6 Asset + \beta_7 BM + \beta_8 ROA + \beta_9 Loss + \beta_{10} NEDprop \\ & + \beta_{11} Beta + \beta_{12}(Year2001) + (IndustryDummies) + u \end{aligned} \tag{4}$$

The control variables in equation (4) include accruals quality that has been shown in Francis et al. (2005) to affect the cost of equity. The risk of incurring the costs associated with bankruptcy can reduce the value of the firm and increase the cost of equity. Therefore, we include the probability of bankruptcy (Zmijewski) as a control variable. The cost of equity is also affected by the expected rate of growth which we proxy by the average annual sales growth over the past three years (Growth). As in (2), we include the operating cash flow (CashF), the proportion of fixed tangible assets to total assets (Asset) and the book-to-market ratio (BM). We expect more profitable firms to have a lower cost of equity and loss-making firms to have a higher cost of equity. Therefore, we include the return on assets (ROA) and a dummy variable for loss-making firm-years (Loss). We include the board independence variable as well. Finally, we include the firm's beta, based on the reasoning that firms with higher beta have higher required security returns which will equal the cost of equity and expected returns in equilibrirum. As in the case of (2), we repeat this analysis replacing the indicator variable for GD ≥ 1 by one for GD ≥ 2.

2. Control for Endogeneity

We note that firms could self-select to be gender-diversified or otherwise. We control for this endogeneity by estimating the effect of gender diversity on the cost of capital in a two-stage self-selection model developed by Heckman (1976). The self-selection model used in this study consists of three equations: one specifies the choice regarding the gender diversity and the other two equations relate the cost of capital with possible factors within each choice.

For the first-stage choice equation we use the following probit model.

$$\Pr(GD_{it} \geq 1) = F\left(\sum_{s} \alpha_s Z_{s,it}\right) \tag{5}$$

where GD_{it} is the number of female directors on the board in firm *i* during year *t*; $\Pr(GD_{it} \geqq 1)$ is the probability of having at least one female director on the board; and *F*( ) is the cumulative normal distribution function. The set Z_s denotes the set of firm characteristics that are likely to explain the differences between the firms that choose to have gender-diversified boards and those that do not. Using a disturbance ε and a latent variable y^* about gender diversity, we can rewrite this probit model as

$$\begin{aligned} & y^*_{it} = \sum_{s} \alpha_s Z_{s,it} + \varepsilon_{it} \\ & I(GD_{it} \geq 1) = 1 \quad \text{if} \quad y^*_{it} > 0 \quad \text{or} \quad \varepsilon_{\text{it}} > -\sum_{s} \alpha_s Z_{s,it} \\ & I(GD_{it} \geq 1) = 0 \quad \text{otherwise} \end{aligned} \tag{6}$$

where $I(GD_{it} \geqq 1)$ is an indicator set to 1 if the number of female directors on the board is equal to or greater than one (i.e., $GD_{it} \geqq 1$), 0 otherwise (i.e., $GD_{it}=0$). This probit regression can produce probabilities of GD≧1 for all observations, which are used to control for the self-selectivity in the second-stage equations.[5]

The second-stage regressions relate the cost of capital with possible factors using different coefficients depending on the first-stage choice.

$$Cost_{it} = \beta_{00} + \sum_k \beta_{0k} X_{k,it} + u_{0,it} \quad \text{if } \mathrm{G}D_{it} = 0 \tag{7}$$

$$Cost_{it} = \beta_{10} + \sum_k \beta_{1k} X_{k,it} + u_{1,it} \quad \text{if } \mathrm{G}D_{it} \geq 1 \tag{8}$$

These two regressions constitute a switching regression model as they allow the regression coefficients and the disturbance variances to vary between the GD=0 subsample and the GD≧1 subsample. In this study, we include the same set of explanatory variables X_k for equations (7) and (8).

If the disturbance (ε) in the first-stage choice model is correlated with the disturbances (u_0 and u_1) in the second-stage regressions, the conditional expected values of the disturbances in Eqs.(7) and (8) are not equal to zero.

$$E(u_{0,i} \mid GD_{it} = 0) = \sigma_{\varepsilon,u0}\left(-\frac{\phi(-\sum_s \alpha_s Z_{s,it})}{\Phi(-\sum_s \alpha_s Z_{s,it})} \right) \neq 0 \tag{9}$$

$$E(u_{1,it} \mid GD_{it} \geq 1) = \sigma_{\varepsilon,u1}\left(\frac{\phi(-\sum_s \alpha_s Z_{s,it})}{1-\Phi(-\sum_s \alpha_s Z_{s,it})} \right) \neq 0 \tag{10}$$

[5] Similarly we define $I(GD_{it}≧2)$ as a dummy variable indicating if the number of female directors on the board is equal to or greater than two. We can also predict $\Pr(GD_{it}≧2)$, the probability of having two or more female directors on the board.

where φ and Φ are the density and distribution functions of the standard normal distruibution, respectively. These nonzero co-variances $\sigma_{\varepsilon,u0}$ and $\sigma_{\varepsilon,u1}$ cause the OLS estimation of Eqs.(7) and (8) to be biased.

The Heckman (1979)'s two-stage method can correct the self-selection bias by including the nonzero conditional expected values of the disturbances; i.e., the inverse Mills ratios (*Mills*) computed by the first-stage probit regression, in the second stage of the regression.

$$E(Cost_{it} \mid GD_{it} = 0) = \beta_{00} + \sum_k \beta_{0k} X_{k,it} + \sigma_{\varepsilon,u0} Mills_{0,it} \tag{11}$$

$$E(Cost_{it} \mid GD_{it} \geq 1) = \beta_{10} + \sum_k \beta_{1k} X_{k,it} + \sigma_{\varepsilon,u1} Mills_{1,it} \tag{12}$$

where $Mills_{0,it} = \left(-\frac{\phi(-\sum_s \alpha_s Z_{s,it})}{\Phi(-\sum_s \alpha_s Z_{s,it})} \right)$ and $Mills_{1,it} \left(\frac{\phi(-\sum_s \alpha_s Z_{s,it})}{1-\Phi(-\sum_s \alpha_s Z_{s,it})} \right)$. In fact, this self-selection model estimates two equations separately for the sub-sample with GD=0 and the one with GD≧1, with accounting for the non-randomness of the GD variable.

This switching regression model has several advantages over the following restricted self-selection model of a single equation which includes a dummy variable $I(GD_{it}≧1)$ (Chaney et al., 2004; Shehata, 1991; Wald and Long, 2007).

$$Cost_{it} = \delta_0 + \sum_k \delta_k X_{k,it} + \theta \cdot I(GD_{it} \geq 1) + w_{it} \tag{13}$$

This restricted model assumes that the coefficients (δ_k's) for the explanatory variables are constant across all firms. This assumption can be restrictive as it does not allow for interactive effect between the *GD* status and firm characteristics. On the one hand, gender diversity could improve board effectiveness by providing higher levels of oversight and monitoring. At the same time, if female directors are also more risk averse than their male counterparts, they could influence firm characteristics such as leverage and bankruptcy risk. For example, the effects of factors associated with bankruptcy are likely to be attenuated in the presence of gender diversity. The switching regression model allows for this interactive effect between the gender diversity and other firm characteristics.

The above restricted model of the GD dummy variable, Eq.(13), also assumes that the cost effect of gender diversity, measured by the dummy coefficient (θ), is constant between the GD=0 subsample and the GD≧1 subsample. With this restriction, however, we cannot explain why some firms still choose to have GD=0 when the gender diversity could significantly reduce the cost of capital. It is possible, however, that the selection of GD=0 is optimal if the reduction in the cost of capital is not significant for the GD=0 subsample, given firm and board characteristics. The switching regression model allows the effect of gender diversity to differ between the GD=0 and the GD≧1 subsamples; this is another advantage of using the self-selection model with two switching regressions.

In order to examine the net effect of the GD on the cost of capital, we predict the costs for each observation using both estimated equations (Chaney et al., 2004; Shehata, 1991). For the observations with GD=0, we calculate their predicted (or fitted) costs using the coefficient estimates of Eq. (11). At the same time, we calculate their predicted costs using the coefficient estimates of the other equation Eq. (12), assuming that they had chosen to be GD≧1.[6]

[6] Notice that the inverse Mills ratios are not included in the calculation of the predicted values since their role is only to control for the self-selectivity bias.

$$Predict(Cost_{it} \mid GD_{it} = 0) = \hat{\beta}_{00} + \sum_k \hat{\beta}_{0k} X_{k,it}$$
$$Predict(Cost_{it} \mid GD_{it} \geq 1) = \hat{\beta}_{10} + \sum_k \hat{\beta}_{1k} X_{k,it} \quad (14)$$

Then we calculate the difference of the predicted costs for each observation, $\Delta Cost_i$, which can be interpreted as the predicted cost reduction by changing from GD=0 to GD≧1, with holding the explanatory variables $X_{k,it}$'s constant.

$$\Delta Cost_{it} = Predict(Cost_{it} \mid GD_{it} = 0) - Predict(Cost_{it} \mid GD_{it} \geq 1) \quad (15)$$

Similarly for the observations with GD≧1, we calculate their differences of the two predicted costs.

In order to evaluate the significance of cost reduction we calculate the average and median of the predicted differences for the full sample and also for the subsamples of GD=0 and GD≧1, respectively. In testing whether the mean and median cost reductions are significantly positive, we need to consider the uncertainty associated with the coefficient estimates in Eqs.(11) and (12). Thus, we approximate the standard errors and *t*-statistics of the mean and median differences by bootstrapping 1,000 random samples.

IV. EMPIRICAL RESULTS

1. The Sample

Our sample data are taken from the S&P Compustat, Corporate Library and IRRC databases for the period 2001-2002. We collected all firms for which director gender is available in the Corporate Library database. This gives us 2,576 firm-year observations, of which 1,218 are from 2001 and 1,358 are from 2002. To avoid undesirable influence of outliers, possibly caused by data entry errors, we delete observations if the measures of cost of capital exceed the 99 percentiles. We then deleted firm-year observations with missing values in the variables used in the first-stage estimation. This gives a sample of 1,192 firm-year observations (584 in 2001 and 608 in 2002).

For the analysis of cost of debt, we used 933 firm-year observations (453 in 2001 and 480 in 2002) after excluding the observations which are missing in the measure of cost of debt and the control variables. For the analysis of cost of equity we used 565 firm-year observations (279 in 2001 and 286 in 2002) which have data on the measure of cost of equity and the control variables.

Table 2 reports the descriptive statistics of the sample. The cost of debt, measured by the interest rate (*IR*), has a smaller mean of 0.077 for the GD≧1 subsample than for the subsample of no female director (0.085). Similarly, the cost of equity (*CoE*) also has a smaller mean when there exists gender diversity, 0.101 for the GD≧1 and 0.107 for the GD=0 subsample. However, the differences are not significant at a usual level of 10%.

All variables included in the first-stage probit models and the second-stage switching regressions are also defined and summarized in Table 2.

Insert Table 2 here

2. OLS Estimation without Controlling for the Self-selection

Table 3 presents the OLS estimates of regressions (2) and (4) with a dummy variable of gender diversity in Panels A and B respectively for IR and COE. The definition and summary statistics of these control variables are included in Table 2.

For GD≧1 [GD≧2], the coefficient estimate for the GD dummy is negative, -0.003 –[0.005] for the IR analysis in Panel A, but these are not significant. On the other hand, the coefficient in Panel B is -.008 [-.010] and is significant. The OLS results suggest that the gender diversity does not contribute to reducing the cost of debt but reduces the cost of equity.

However, as discussed in the previous section, the above regressions do not allow for interactive effects between GD and the explanatory variables. In addition, gender diversity could be self-selected by firms. If the interactive effect and the self-selectivity are ignored when they are significant, the OLS estimation is biased. In what follows, we estimate a self-selection model of two switching regressions to avoid such bias.

Insert Table 3 here

3. Prediction of Gender Diversity (first-stage estimation)

We use probit models to predict the presence of female directors on the board.

$$\begin{aligned}\Pr(GD \geq 1 \text{ or } 2) = F(&\alpha_0 + \alpha_1 ROA + \alpha_2 Size + \alpha_3 FirmAge \\ &+ \alpha_4 SalesGrth + \alpha_5 Directorships + \alpha_6 TD + \alpha_7 TotRisk \\ &+ \alpha_8 TobinQ + \alpha_9 RET + \alpha_{10} MarketRET + \alpha_{11} IndustryFpct \\ &+ year\ dummy + industry\ dummies)\end{aligned} \quad (16)$$

The definition and summary statistics of the variables are presented in Table 2. And these probit models are similar to that used by Hillman et al. (2007). Westphal and Stern (2007) and Adams and Ferreira (2008) contend that women directors are chosen more for their monitoring than advising qualities. If so, firms which have a greater need for monitoring and independence are expected to increase the gender diversity of their boards. Thus, we include sales growth (*Growth*), diversification in the product market (*TD*), and stock volatility (*TotRisk*) as variables in the model. *Growth* is the average year-to-year percentage sales over the three-year period from t-3 to t-1 and is expected to have a positive coefficient. The diversification in the product market is measured using Palepu (1985) entropy measure[7] and is expected to have a positive coefficient. *TotRisk* is measured by the standard deviation of daily stock returns over the fiscal year standardized to a mean of 0 and standard deviation of 1 over all of the firms and could have either a positive effect under the "glass cliff effect" whereby risky firms are more likely to appoint female directors and female directors are more likely to take up those appointments; or could have a negative effect because risky firms have less confidence to nominate female directors with unknown effects. Adams and Ferreira (2008) suggest that firm performance is associated with gender diversity. We include therefore several performance measures, such as accounting performance (*ROA*), Tobin's (*TobinQ*), and stock returns (*RET*). All the performance variables are expected to have positive coefficients. Consistent with Hillman et al. (2007), we include the value-weighted market return that acts as the benchmark return and is expected to have a negative coefficient. We include firm size (*Size*) because larger firms face greater pressure to conform to societal expectations (DiMaggio and Powell, 1985), which suggests a positive coefficient. Similar to Hillman et al. (2007), we include the percentage of female employees in the two-digit SIC

[7]The entropy measure is given in Appendix 2 of Palepu (1985) as $\sum_{i=1} P_i \, ln(1 / P_i)$ where P_i is the share of the i^{th} industry segment in the total sales of the firm. Consistent with Palepu (1985), we define industry segments as the four-digit SIC industry categories in which the firms operate.

industry category (*IndustryFpct*) that is expected to have a positive coefficient. To proxy for the demand for networking we include the average number of outside directorships held by independent directors (*Directorships*), which is expected to have a positive coefficient.

Table 4 provides the estimation results of the two probit models for GD>0 and GD>1 respectively. These models are significant with the likelihood ratios of 426.0 and 404.03. To assess the prediction performance of the probit model, we calculate the classification rates using a cut-off level of 0.5. That is, if the probability of being GD≧1 is greater than 0.5, the probit model predicts that the observation would choose to be GD≧1. In our sample, the classification rates are 75.0% for GD≧1 and 80.9% for GD≧2.

Insert Table 4 here

Consistent with our expectations, *Size, FirmAge* and *Directorships* have positive and *TotRisk* has negative significant coefficients (all *p*-values < 0.01). I percentage of employees who are women in each two-digit SIC industry category (*IndustryFpct*) has positive coefficients but are not significant..

Switching Regressions (second-stage estimation)

The switching regressions used in the self-selection model are the same as the OLS regression, Eq.(12), but allow the regression coefficients to vary between the GD=0 subsample and the GD≧1 subsample.

$$\begin{aligned} IR = \beta_{g0} + \beta_{g1} AccQuality + \beta_{g2} SIZE + \beta_{g3} Zmijewski \\ + \beta_{g4} CashF + \beta_{g5} Asset + \beta_{g6} BM + \beta_{g7} Lev + \beta_{g8} NEDprop \\ + \beta_{g9} Mills + \beta_{g10} (Year2001) + (IndustryDummies) + u \end{aligned} \tag{17}$$

where a subscript *g* identifies each equation in the two switching regressions, i.e., g=0 if GD=0 and g=1 if GD≧1.

Table 5 shows that several regression coefficients are significantly different between the GD=0 and the GD≧1 (or GD≧2) subsamples, indicating the existence of the interactive effect between the GD status and the explanatory variables. The coefficient for *Zmijewski*, a proxy for bankruptcy risk, is significantly bigger for the GD=0 than for the GD≧1, that is, 0.110 versus 0.080. This difference is more pronounced when the GD=0 is compared to the GD≧2 subsample, that is, 0.113 versus -0.002. It implies that if there exists gender diversity, debt-lenders are less concerned about the financial distress measured by Zmijewski as female directors are believed to provide higher levels of oversight and monitoring and also to exhibit greater risk aversion. Similarly, the physical component of assets is not a significant factor once there exists gender diversity, but its impact on the cost of debt is significantly negative (-0.034 and -0.032) when there is no female director on the board. Contrary to expectations, CashF has a positive coefficient and Lev has a negative coefficient.

The coefficient estimates for the inverse Mills ratio (*Mills*) are also significant, confirming that the self-selectivity is a significant factor that cannot be ignored. Based on these estimation results of the self selection model, we can conclude that the OLS estimation results of no gender-diversity effect on the cost of debt are biased since they did not account for the interactive effect and the self selectivity. In the next subsection we examine how significantly the gender diversity has reduced the cost of debt based on the estimates of the self selection model of two switching regressions.

Insert Table 5 here

Prediction of Cost Reduction by Gender Diversity

Table 6 reports the cost reduction predicted by the self-selection model of two switching regressions. Positive values indicate that the costs are reduced when firms change from GD=0 to GD≧1. For the GD≧1 subsample, these predicted values of cost reduction can be understood as the *realized* cost reduction as they have already chosen to be GD≧1. In contrast, for the GD=0 subsample, these predicted values are *potential* cost reductions which are to be realized if they choose to be GD≧1. We estimate the standard errors and the *t* statistics using a bootstrapping method drawing 1,000 random samples.

The reduction of the debt cost by choosing to be GD≧1 is significantly positive in the mean (median) values; 0.037 (0.030) for the full sample, 0.027 (0.024) for the GD=0 subsample and 0.042 (0.034) for the GD≧1 subsample. Although the potential reduction for the GD=0 subsample is smaller than the realized reduction for the GD≧1 subsample, the difference of -0.016 (-0.010) is not significant. Thus, it indicates that the gender diversity has a significant effect on the cost of debt for all firms while its influence is (insignificantly) smaller for the GD=0 subsample than for the GD≧1 subsample. The same cost-reduction effect is observed between GD=0 and GD≧2.

Insert Table 6 here

6. Cost of Equity

Using the cost of equity (*CoE*) as another measure of the cost of capital, we estimate the switching regressions and predict the cost reduction by the presence of female directors.

$$\begin{aligned} CoE = \beta_{g0} &+ \beta_{g1} AccQuality + \beta_{g2} Zmijewski + \beta_{g3} Growth \\ &+ \beta_{g4} CashF + \beta_{g5} Asset + \beta_{g6} BM + \beta_{g7} ROA + \beta_{g8} Loss + \beta_{g9} NEDprop \\ &+ \beta_{g10} Mills + \beta_{g11} Beta + \beta_{g12} (Year2001) + (IndustryDummies) + u \end{aligned} \quad (18)$$

Similar to the results for the cost of debt, Table 7 shows that several regression coefficients are significantly different between the GD=0 subsample and the GD≧1 (or GD≧2) subsample, indicating a significant interactive effect between the GD status and the explanatory variables. The coefficient for *AccQuality* is not significant for the GD=0 subsample but positive and significant for the GD≧1 and GD≧2 subsamples. And the coefficient for *Growth* is negatively significant for the GD=0 subsample but becomes insignificant when there are female directors. The coefficient estimates for the inverse Mills ratio (*Mills*) are also significant, confirming that the self-selectivity is a significant factor which should not be ignored.

Insert Table 7 here

Table 8 reports the cost reduction predicted by the self-selection model of two switching regressions. The reduction of the cost of equity (*CoE*) by choosing to be GD≧1 is significantly positive in the mean (median) values; 0.032 (0.032) for the full sample, 0.029 (0.029) for the GD=0 subsample and 0.033 (0.032) for the GD≧1 subsample. The predicted reductions of the cost of equity are similar in size to the ones of the cost of debt, but their significance levels are stronger for the cost of equity. Although the potential reduction for the GD=0 subsample is smaller than the realized reduction for the GD≧1 subsample, the difference of -0.004 (-0.003) is not significant. Thus, it indicates that the gender diversity has a significant effect on the cost of equity for all firms while its influence is (insignificantly) smaller for the GD=0 subsample than for the GD≧1 subsample. The same cost-reduction effect is observed between GD=0 and GD≧2.

Insert Table 8 here

7. Non-executive directors

As shown in Table 1, most of the female directors in the US are non-executive directors. Different from executive directors, the main role of non-executive directors is to protect shareholders' interests by improving board monitoring and independence. To examine this effect we focus on the female non-executive directors.

Table 9 reports the predicted cost reduction by the female non-executive directors. As shown in panel A, the cost of debt (*IR*) is significantly reduced when the number of female non-executive directors is equal to or greater than one, #(FNED)≧1. The mean values of the reduction are 0.037 for the full sample, 0.028 for the #(FNED)=0 subsample, and 0.033 for the #(FNED)≧1 subsample. The significance of the cost reduction is higher when we control for the possible tokenism by comparing the #(FNED)=0 subsample and the #(FNED)≧2 subsample: the mean values of the reduction are ranged 0.033~0.038 and significant at 5% and 10% levels. The cost of equity (*CoE*) is also significantly reduced by the presence of female non-executive directors, as shown in panel B.

Insert Table 9 here

V. CONCLUDING REMARKS

In this study we examine the association between gender diversity in the board of directors and the cost of capital. This study is motivated by an interest in exploring how the capital market reacts to boards with female directors. In our tests we consider the possible endogeneity of the decision about gender diversity and the interactive effect between gender diversity and firm characteristics. After controlling for the self-selection of gender diversity and allowing the regression coefficients to vary between the two groups of zero and at least one female director on the board, we find significant lower costs of debt and equity in firms that have gender-diversified boards.

These findings connect two important strands of research: the effect of board gender diversity on corporate governance and the influence of board-based corporate governance on the cost of debt and equity capital. In doing so, this study provides supporting evidence for the trend of increasing gender diversity in the U.S. and abroad. Furthermore, it provides evidence that increasing the gender diversity in the board is not meant merely to make the process of director selection fairer but could have real economic consequences in terms of reducing the cost of capital.

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Table 1
Distribution of at least One Female Director across Various Industries
(Number of at least one female non-executive director in parentheses)

Industry	Number of firms with no female director on the board		Number of firms with at least one female director (non-executive director) on the board		Total number of firms	
	2001	2002	2001	2002	2001	2002
Food products	0	1	15(13)	13(13)	15	14
Recreation	0	2	2(1)	1(0)	2	3
Entertainment	2	1	4(4)	5(5)	6	6
Printing and Publishing	1	2	11(10)	13(12)	12	15
Consumer Goods	5	5	13(13)	13(13)	18	18
Apparel	3	4	11(10)	11(10)	14	14
Healthcare	5	5	8(7)	7(6)	13	12
Medical Equipment	7	6	11(8)	14(14)	18	20
Pharmaceutical Products	5	5	13(12)	15(12)	18	20
Chemicals	5	4	20(19)	22(21)	25	26
Rubber and Plastic Products	1	1	3(3)	3(3)	4	4
Textiles	3	0	1(1)	0(0)	4	0
Construction Materials	8	7	9(9)	10(10)	17	17
Steel Work, etc.	7	8	9(9)	8(8)	16	16
Machinery	16	16	19(19)	21(21)	35	37
Electrical Equipment	5	5	7(7)	6(6)	12	11
Automobiles and Trucks	7	8	7(6)	6(5)	14	14
Petroleum and Natural Gas	16	15	8(8)	10(10)	24	25
Utilities	5	4	38(37)	41(41)	43	48
Communication	2	2	6(4)	4(4)	8	6
Personal Services	0	0	1(1)	4(4)	1	4
Business Services	22	25	30(29)	32(29)	52	57
Computers	14	9	5(5)	8(8)	19	17
Electronic Equipment	37	40	16(14)	20(19)	53	60
Measuring and Control Equipment	10	13	8(8)	8(8)	18	21
Business Supplies	6	8	12(12)	12(12)	17	18
Transportation	13	11	10(8)	9(8)	23	20
Wholesale	6	8	16(15)	17(16)	22	25
Retail	10	5	35(29)	40(37)	45	45
Restaurant, Hotels, Motels	7	7	9(9)	10(10)	16	17
Insurance	1	1	3(1)	5(3)	4	6
Trading	2	1	1(1)	2(2)	3	3
Total	230	227	361(334)	389(372)	591	616

Source: Gul, et al.(2009), Table 2.

Table 2
Descriptive Statistics

	Full Sample (N=933)			No Female Director on the board, GD =0 (N=317)			At least 1 Female Director on the board,			Difference in mean	
Variable	Mean	Median	Std Dev	Mean	Median	Std Dev	Mean	Median	Std Dev	diff	*p-value*
IR	0.080	0.068	0.072	0.085	0.069	0.080	0.077	0.068	0.067	0.008	0.140
CoE[a]	0.103	0.096	0.041	0.107	0.097	0.045	0.101	0.095	0.039	0.006	0.190
GD	0.939	1.000	0.861	0	0	0	1.423	1.000	0.660	-1.423	0.000
FDIRpct (%)	9.076	10.000	8.066	0	0	0	13.747	11.111	5.855	-13.747	0.000
FirmAge	20.285	22.000	5.625	18.356	18.000	5.709	21.278	25.000	5.320	-2.921	0.000
Directorships	2.019	1.900	0.677	1.774	1.667	0.552	2.145	2.095	0.700	-0.372	0.000
TD	0.659	0.671	0.558	0.546	0.560	0.520	0.718	0.701	0.568	-0.172	0.000
TotRisk	-0.114	-0.369	0.963	0.391	0.157	1.042	-0.374	-0.549	0.804	0.765	0.000
TobinQ	1.683	1.370	0.947	1.664	1.370	0.877	1.692	1.373	0.982	-0.028	0.659
RET	-0.043	-0.037	0.128	-0.045	-0.039	0.149	-0.041	-0.037	0.115	-0.004	0.705
MarketRET	-0.044	-0.059	0.028	-0.043	-0.059	0.028	-0.045	-0.059	0.028	0.001	0.486
IndustryFpct	0.364	0.337	0.153	0.348	0.383	0.152	0.372	0.337	0.153	-0.024	0.024
AccQuality	0.035	0.029	0.029	0.041	0.032	0.033	0.032	0.026	0.027	0.009	0.000
Size	7.521	7.323	1.407	6.797	6.650	1.047	7.894	7.827	1.424	-1.097	0.000
Zmijewski	0.196	0.101	0.231	0.142	0.046	0.211	0.223	0.143	0.236	-0.081	0.000
CashF	0.107	0.101	0.083	0.103	0.100	0.101	0.109	0.101	0.072	-0.006	0.354
Asset	0.615	0.537	0.359	0.571	0.463	0.371	0.638	0.588	0.351	-0.067	0.008
BM	0.548	0.474	0.396	0.577	0.484	0.415	0.533	0.471	0.385	0.045	0.113
Lev	0.267	0.267	0.147	0.244	0.243	0.153	0.280	0.285	0.143	-0.036	0.001
NEDprop	0.758	0.800	0.143	0.712	0.750	0.158	0.782	0.800	0.129	-0.070	0.000
SaleGrth	-0.015	-0.018	0.107	-0.027	-0.032	0.127	-0.009	-0.013	0.095	-0.018	0.023

ROA	0.029	0.039	0.091	0.013	0.033	0.102	0.037	0.041	0.084	-0.025	0.000
Loss	0.259	0.000	0.439	0.341	0.000	0.475	0.218	0.000	0.413	0.123	0.000

[a] For the measure of cost of equity (*CoE*), the numbers of observations are 565, 157 and 408 for the full sample, GD=0 and GD≧1, respectively.

Definition of the variables:

(a) Costs of debt and equity

IR = a proxy of cost of debt, defined as the interest expense (Compustat data 15) divided by its average short-term (Compustat data 34) and long-term debt (Compustat data 9) during each fiscal year.
CoE = cost of equity measured by the Easton (2004) model, measured in the rate unit.

(b) Gender Diversity

GD = number of female directors on the board
FDIRpct = percentage of female directors on the board

(c) Control variables

First stage (probit model)

FirmAge = number of years for which total assets was reported in Compustat since 1977
Directorships = average number of outside directorships
TD = total diversification measured by the entropy of Palepu (1985): $\sum P_i \ln(1/P_i)$ where P_i is the share of the *i*th industry segment in the total sales of the firm and the industry is defined as the four-digit SIC industry categories.
TotRisk = standard deviation in daily returns over a company's fiscal year (standardized to a mean of 0 and a standard deviation of 1 over all of the firms)
TobinQ = book value of assets minus the book value of equity, plus the market value of equity, scaled by the book value of assets
RET = annual return measured over the fiscal year
MarketRET = valued weighted market return measured over the fiscal year
IndustryFpct = the percentage of employees who were women in each two-digit SIC industry category

Main regressions (switching regressions)

AccQuality = accruals quality, measured by the extended Dechow and Dichev model. Large values indicate lower quality of accruals.

SIZE	=	natural log of total assets (Compustat 6)
Zmijewski	=	probability of bankruptcy estimated by the Zmijewski(1984)'s probit model, which is PROBNORM(-4.336-4.513*NI/TA+5.679*TL/TA - 0.004*CA/CL)
CashF	=	cash flow from operations (Compustat 308) scaled by total assets (Compustat 6)
Asset	=	asset structure as a proxy of gross property, plant and equipment (Compustat 7) divided by total assets (Compustat 6)
BM	=	firm j's book value (Compustat data 216) divided by its market value (Compustat data 25 x data 199)
LEV	=	sum of total short-term (Compustat 34) and long-term debt (Compustat 9) divided by total assets
NEDProp	=	proportion of non-executive directors on the board
Growth	=	year-to-year percentage change in sales over three year
ROA	=	return on assets, defined as the income before extraordinary items (Compustat data 18) divided by total assets (Compustat 6)
Loss	=	indicator variable, 1 if net income (Compustat 172) in year t is less than 0, 0 otherwise

Table 3:OLS Estimation of the costs of capital and Gender Diversity (*GD*),

Panel A: Cost of Debt (IR)

GD = # of female directors on the board	Dependent Variable: *IR* (cost of debt)			
	GD=0 vs. *GD*≧1		*GD*=0 vs. *GD*≧2	
	coefficient	t-statistic	coefficient	t-statistic
Dummy variable[a]				
I(*GD*≧1)	-0.003	-0.62		
I(*GD*≧2)			-0.005	-0.63
Intercept	0.111***	5.54	0.136***	5.49
AccQuality	0.115	1.37	0.042	0.39
Size	-0.007***	-3.63	-0.008***	-3.29
Zmijewski	0.055***	4.29	0.061***	3.75
CashF	0.138***	4.40	0.144***	4.11
Asset	-0.015**	-2.09	-0.021**	-2.46
BM	0.028***	4.57	0.023***	3.02
Lev	-0.164***	-8.34	-0.154***	-6.45
NEDprop	0.024	1.36	0.011	0.52
R^2 (adj R^2)	0.150 (0.136)		0.174 (0.150)	
N	933		527	

Panel B: Cost of Equity (COE)

GD = # of female directors on the board	Dependent Variable: *CoE* (cost of equity)			
	GD=0 vs. *GD*≧1		*GD*=0 vs. *GD*≧2	
	coefficient	t-statistic	coefficient	t-statistic
Dummy variable[a]				
I(*GD*≧1)	-0.008**	-2.36		
I(*GD*≧2)			-0.010**	-2.11
Intercept	0.075***	7.52	0.066***	5.04
AccQuality	0.144**	1.97	0.110	1.10
Zmijewski	0.028***	3.35	0.018	1.49
SaleGrth	-0.028*	-1.86	-0.039*	-1.83
CashF	-0.040	-1.60	-0.106***	-2.96
Asset	0.024***	4.65	0.038***	5.02
BM	0.026***	5.08	0.020***	2.99
ROA	-0.100***	-3.89	-0.045	-1.37
LOSS	0.019***	4.32	0.029***	4.50
NEDprop	0.009	0.87	0.022	1.58
R^2 (adj R^2)	0.391 (0.372)		0.423 (0.389)	
N	565		302	

[a] A dummy *I*(*GD*≧1) [*I*(*GD*≧2)] is set to 1 if the number of female directors is equal to or greater than one [two], 0 otherwise.

*** statistically significant at the 1% level (2-tailed); ** at the 5% level ; * at the 10% level. Industry dummies are included as control variables but are not reported. One year dummy is also included. The variables are defined in the footnote to Table 1.

Table 4
Probit Model for the Gender Diversity on the Board (First Stage)

	Dependent variable: dummy variable			
	dummy variable $I(GD\geqq 1)$[a]		dummy variable $I(GD\geqq 2)$[b]	
	coefficient	Chi-square	coefficient	Chi-square
Intercept	-4.029***	39.70	-5.585***	38.71
ROA	-0.324	0.40	-1.030	1.60
Size	0.323***	55.96	0.470***	58.87
FirmAge	0.034***	16.64	0.039***	10.46
Growth	0.421	0.93	-0.325	0.24
Directorships	0.237***	8.73	0.294***	6.97
TD	0.138	2.42	0.140	1.17
TotRisk	-0.187***	9.48	-0.206**	4.70
TobinQ	0.032	0.45	0.011	0.02
RET	0.086	0.06	0.197	0.14
MarketRET	-2.078	0.76	-2.086	0.32
IndustryFpct	1.157	2.57	1.241	1.28
Pseudo Rsq	0.409		0.580	
LR Statistic	426.0		404.3	
p-value	0.000		0.000	
Classification rate	75.0 %		80.9 %	
N	1192		728	

[a] GD denotes the number of female directors on the board. A dummy $I(GD\geqq 1)$ is set to 1 if the number of female directors is equal to or greater than one, 0 otherwise.

[b] A dummy $I(GD\geqq 2)$ is set to 1 if the number of female directors is equal to or greater than two, 0 otherwise.

*** statistically significant at the 1% level (2-tailed); ** at the 5% level ; * at the 10% level.

Note: Industry dummies are included as control variables but are not reported. One year dummy is also included. The other variables are defined in the footnote to Table 1.

Table 5
Self-selection Model of Two Switching Regressions, Accounting for an Endogenous Selection of Gender Diversity

Dependent variable = *IR* (cost of debt)

GD = # of female directors on the board	*GD*=0 vs. *GD*≧1						*GD*=0 vs. *GD*≧2					
	GD=0		*GD*≧1		Difference in coeff.		*GD*=0		*GD*≧2		Difference in coeff.	
	coeff.	t-statistic	coeff.	t-statistic	diff	t-statistic	coeff.	t-statistic	coeff.	t-statistic	diff	t-statistic
Intercept	0.141***	3.51	0.071**	2.18	0.070	1.35	0.132***	3.15	0.037	1.24	0.095*	1.85
AccQuality	-0.116	-0.81	0.187*	1.76	-0.303*	-1.70	-0.104	-0.73	0.207	1.50	-0.311	-1.57
Size	-0.002	-0.47	-0.005*	-1.83	0.003	0.45	-0.002	-0.38	-0.000	-0.02	-0.002	-0.34
Zmijewski	0.110***	4.24	0.030**	2.04	0.080***	2.70	0.113***	4.33	-0.002	-0.18	0.115***	3.94
CashF	0.188***	4.07	0.082*	1.85	0.106*	1.65	0.184***	4.00	-0.007	-0.15	0.191***	2.94
Asset	-0.034***	-2.61	-0.005	-0.59	-0.029*	-1.85	-0.032**	-2.53	0.002	0.26	-0.034**	-2.28
BM	0.018*	1.75	0.029***	3.85	-0.011	-0.83	0.019*	1.81	0.014	1.56	0.005	0.34
Lev	-0.201***	-5.75	-0.139***	-5.80	-0.062	-1.47	-0.204***	-5.86	-0.052**	-2.28	-0.152***	-3.65
NEDprop	-0.000	-0.01	0.041*	1.87	-0.041	-1.13	-0.003	-0.09	0.017	0.76	-0.020	-0.53
Mills	0.024*	1.85	0.007	0.63			0.029*	1.83	0.028***	3.73		
R^2 (adj R^2)	0.231 (0.193)		0.146 (0.125)				0.231 (0.193)		0.275 (0.219)			
N	317		616				317		210			

*** statistically significant at the 1% level (2-tailed); ** at the 5% level ; * at the 10% level.

Note: Industry dummies are included as control variables but are not reported. One year dummy for year 2001 is also included. *Mills* is the inverse Mills ratio.

Table 6
Cost Reduction Predicted by the Self-Selection Model of Two Switching Regressions: Cost of Debt

Cost reduction, measured by a difference in the interest rate (*IR*), is predicted as

$$\Delta Cost_{it} = \Pr edict(Cost_{it} \mid GD_{it} = 0) - \Pr edict(Cost_{it} \mid GD_{it} \geq 1 \text{ or } 2)$$

where
$$\Pr edict(Cost_{it} \mid GD_{it} = 0) = \hat{\beta}_{00} + \sum_k \hat{\beta}_{0k} X_{k,it}$$
$$\Pr edict(Cost_{it} \mid GD_{it} \geq 1 \text{ or } 2) = \hat{\beta}_{10} + \sum_k \hat{\beta}_{1k} X_{k,it}$$

(i) *GD*=0 vs. *GD*≧1 :

	Mean Values		Median Values	
	$\Delta Cost$	t-statistic[a]	$\Delta Cost$	t-statistic[a]
Full firms (n = 933)	0.037**	1.77	0.030*	1.53
(a) Subsample with *GD*=0 (n = 317)	0.027*	1.48	0.024*	1.37
(b) Subsample with *GD*≧1 (n = 616)	0.042**	1.84	0.034*	1.57
Difference of the cost reduction between (a) *GD*=0 and (b) *GD*≧1	-0.016	-0.68	-0.010	-0.48

(ii) *GD*=0 vs. *GD*≧2

	Mean Values		Median Values	
	$\Delta Cost$	t-statistic[a]	$\Delta Cost$	t-statistic[a]
Full firms (n = 527)	0.042***	2.41	0.035**	2.11
(a) Subsample with *GD*=0 (n = 317)	0.036**	2.25	0.031**	1.98
(b) Subsample with *GD*≧2 (n = 210)	0.050**	2.18	0.040**	1.88
Difference of the cost reduction between (a) *GD*=0 and (b) *GD*≧2	-0.015	-0.64	-0.009	-0.43

Note 1: The self-selection model estimates two equations separately for the observations with GD=0 and the ones with GD≧1 (or GD≧2) with controlling for the self selectivity, where GD is the number of female directors on the board. For each firm we calculate its predicted costs using the coefficient estimates of the two equations. Then we calculate the difference of the predicted costs, i.e., $\Delta Cost$ = Predict(*Cost*|*GD*=0) - Predict(*Cost*|*GD*≧1 or 2), which can be interpreted as a predicted cost reduction by changing from GD=0 to GD≧1 (or GD≧2) with holding all explanatory variables constant.

[a] The *t*-statistics are for testing a null hypothesis that the average reduction is equal to zero, calculated using 1,000 random samples drawn by the bootstrapping method.

*** (**, *) indicates a rejection of H_0: average($\Delta Cost$)=0 in favor of H_a: average($\Delta Cost$)>0 (i.e., one-tailed test) at the 1% (5%, 10%) significance level.

Table 7
Self-selection Model of Two Switching Regressions, Accounting for an Endogenous Selection of Gender Diversity

Dependent variable = *CoE* (cost of equity)

GD = # of female directors on the board	GD=0 vs. GD≧1						GD=0 vs. GD≧2					
	GD=0		GD≧1		Difference in coeff.		GD=0		GD≧2		Difference in coeff.	
	coeff.	t-statistic	coeff.	t-statistic	diff	t-statistic	coeff.	t-statistic	coeff.	t-statistic	diff	t-statistic
Intercept	0.082***	4.65	0.075***	6.00	0.007	0.33	0.078***	4.56	0.077***	3.45	0.001	0.05
AccQuality	-0.108	-0.81	0.181**	2.06	-0.289*	-1.81	-0.099	-0.76	0.386**	2.37	-0.485**	-2.32
Zmijewski	0.067**	2.57	0.037***	4.11	0.030	1.08	0.068***	2.67	0.024	1.63	0.044	1.48
SaleGrth	-0.067**	-2.46	-0.003	-0.13	-0.064*	-1.93	-0.075***	-2.83	0.020	0.50	-0.095**	-1.97
CashF	-0.096*	-1.97	-0.013	-0.45	-0.083	-1.46	-0.103**	-2.14	-0.085	-1.49	-0.018	-0.24
Asset	0.041***	3.67	0.016***	2.79	0.025*	1.98	0.042***	3.86	0.029***	2.73	0.013	0.89
BM	0.016*	1.71	0.030***	4.60	-0.014	-1.27	0.017*	1.84	0.031**	2.44	-0.014	-0.93
ROA	-0.100	-1.55	-0.088***	-3.21	0.013	-0.17	-0.112*	-1.76	-0.023	-0.58	-0.089	-1.19
LOSS	0.022**	2.18	0.016***	3.12	0.006	0.54	0.021**	2.11	0.022**	2.33	-0.001	-0.08
NEDprop	0.036**	2.07	-0.010	-0.72	0.046*	2.10	0.033*	1.91	-0.015	-0.60	0.048	1.58
Mills	0.023***	3.00	0.009*	1.72			0.030***	3.68	-0.003	-0.45		
R^2 (adj R^2)	0.519 (0.460)		0.405 (0.379)				0.533 (0.476)		0.427 (0.350)			
N	157		408				157		145			

*** statistically significant at the 1% level (2-tailed); ** at the 5% level ; * at the 10% level.

Note: Industry dummies are included as control variables but are not reported. One year dummy for year 2001 is also included.

Table 8
Cost Reduction Predicted by the Self-Selection Model of Two Switching Regressions: Cost of Equity

Cost reduction, measured by a difference in the rate (*CoE*), is predicted as

$$\Delta Cost_{it} = \Pr edict(Cost_{it} \mid GD_{it} = 0) - \Pr edict(Cost_{it} \mid GD_{it} \geq 1 \text{ or } 2)$$

where
$$\Pr edict(Cost_{it} \mid GD_{it} = 0) = \hat{\beta}_{0,0} + \sum_k \hat{\beta}_{0,k} X_{k,it}$$
$$\Pr edict(Cost_{it} \mid GD_{it} \geq 1 \text{ or } 2) = \hat{\beta}_{1,0} + \sum_k \hat{\beta}_{1,k} X_{k,it}$$

(i) GD=0 vs. GD≧1

	Mean Values		Median Values	
	$\Delta Cost$	t-statistic[a]	$\Delta Cost$	t-statistic[a]
All firms (n = 565)	0.032***	3.25	0.032***	3.31
(a) Subsample with GD=0 (n = 157)	0.029***	3.66	0.029***	3.61
(b) Subsample with GD≧1 (n = 408)	0.033***	3.03	0.032***	3.11
Difference of the cost reduction between (a) GD=0 and (b) GD≧1	-0.004	-0.41	-0.003	-0.31

(ii) GD=0 vs. GD≧2

	Mean Values		Median Values	
	$\Delta Cost$	t-statistic[a]	$\Delta Cost$	t-statistic[a]
All firms (n = 302)	0.021***	2.49	0.020***	2.51
(a) Subsample with GD=0 (n = 157)	0.014*	1.60	0.014*	1.60
(b) Subsample with GD≧2 (n = 145)	0.029***	2.72	0.026***	2.64
Difference of the cost reduction between (a) GD=0 and (b) GD≧2	-0.016*	-1.44	-0.013	-1.25

See the footnote to Table 6.

Table 9
Predicted Cost Reduction by the Presence of Female Non-Executive Directors (*FNED*)

A. Cost of Debt (IR)

(i) #(FNED)=0 vs. #(FNED)≧1

	Mean Values		Median Values	
	Δ*Cost*	t-statistic[a]	Δ*Cost*	t-statistic[a]
All firms (n = 933)	0.031*	1.41	0.025	1.19
(a) Subsample with #(FNED)=0 (n = 348)	0.028*	1.55	0.024*	1.33
(b) Subsample with #(FNED)≧1 (n = 585)	0.033*	1.31	0.026	1.09
Difference of the cost reduction between (a) #(FNED)=0 and (b) #(FNED)≧1	-0.004	-0.18	-0.002	-0.09

(ii) #(FNED)=0 vs. #(FNED)≧2

	Mean Values		Median Values	
	Δ*Cost*	t-statistic[a]	Δ*Cost*	t-statistic[a]
All firms (n = 537)	0.036**	1.91	0.031*	1.63
(a) Subsample with #(FNED)=0 (n = 348)	0.038**	1.89	0.034**	1.66
(b) Subsample with #(FNED)≧2 (n = 189)	0.033*	1.50	0.025	1.16
Difference of the cost reduction between (a) #(FNED)=0 and (b) #(FNED)≧2	0.006	0.26	0.009	0.40

B. Cost of Equity (CoE)

(i) #(FNED)=0 vs. #(FNED)≧1

	Mean Values		Median Values	
	Δ*Cost*	t-statistic[a]	Δ*Cost*	t-statistic[a]
All firms (n = 565)	0.023**	2.01	0.022**	1.98
(a) Subsample with #(FNED)=0 (n = 173)	0.023***	2.45	0.022***	2.36
(b) Subsample with #(FNED)≧1 (n = 392)	0.023**	1.77	0.022**	1.75
Difference of the cost reduction between (a) #(FNED)=0 and (b) #(FNED)≧1	-0.000	-0.01	0.000	0.02

(ii) #(NED)=0 vs. #(NED)≧2

	Mean Values		Median Values	
	Δ*Cost*	t-statistic[a]	Δ*Cost*	t-statistic[a]
All firms (n = 298)	0.023*	1.54	0.023**	1.59
(a) Subsample with #(FNED)=0 (n = 173)	0.023	1.18	0.024	1.26
(b) Subsample with #(FNED)≧2 (n = 125)	0.024**	1.75	0.022*	1.61

Difference of the cost reduction between (a) #(FNED)=0 and (b) #(FNED)≧2	-0.001	-0.10	0.002	0.13

See the footnote to Table 6.