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Board of directors and investment performance: A marginal Q approach

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A B S T R A C T

This paper aims to contribute to the debate on the effect of board characteristics on firm performance. We use marginal q to estimate the effect of board characteristics on investment performance. Using data of 1616 firms that traded on the Standard and Poor´s (S&P) 1500 between 1997 and 2014, we use between and fixed effects estimators to capture the long-run effects and control other endogeneity problems as omitted variable bias. We find a negative and statistically significant effect of board size on investment performance. For the sample under study, we also find empirical evidence on the nonlinear relation between board independence and investment performance. Finally, using two different measures, we also find a nonlinear relation between board busyness and investment performance.

1. Introduction

Modern financial theorists relying on an Agency Theory (AT) perspective have searched for corporate governance mechanisms that minimize agency costs. One of the key mechanisms identified by modern financial scholars is the role of the board of directors in mitigating agency conflicts. In a seminal paper, Fama and Jensen (1983) argued that the board of directors is a body whose function is to monitor the management on behalf of shareholders. They reasoned that since most corporate boards have a majority of outside directors and given that these directors would not collude with managers to exploit shareholders, the board of directors is an efficient mechanism to mitigate managerial opportunism and concluded that the corporate form of organization is economically efficient in the sense that it minimizes agency costs. There exists an important debate in the corporate governance literature concerning the relationship between the characteristics of the boards of directors and firm performance (Adams et al., 2010; Souther, 2021). The debate is between two opposing groups of researchers, with one group arguing for a causal relationship from board of directors' characteristics to firm performance (Baysinger & Butler, 1985; Rosenstein & Wyatt, 1990; Yermack, 1996; Duchin et al., 2010; Dang et al., 2018) and the other denying this causal association (Fosberg, 1989; Hermalin & Weisbach, 1991; Bhagat & Black, 2002; Hermalin & Weisback, 2003). Additionally, there exists an important dispute concerning the direction of causality. Particularly, Hermalin and Weisbach (1991) and Bhagat and Black (2002) argue that firms react to their performance by changing board composition, and that consequently the causal relationship does not run from board composition to firm performance but the other way around.

This study contributes to the literature by studying the relationship between board characteristics and firm investment performance, which we evaluate by calculating firm marginal qs (Mueller & Reardon, 1993; Gugler et al., 2004; Saravia, 2014). Marginal q allows for the identification of firms whose managers make bad investment decisions over a given period. Marginal q, denoted as q_{mt}, is simply "the change in the market value of the firm divided by the change in its capital stock

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(investment) that caused it" where "a sufficient condition for bad managerial decisions is that $q_{mt} < 1$" (Gugler & Yurtoglu, 2003). According to the marginal q method, a company with a q_{mt} less than unity for a sustained period has a management team that consistently makes bad decisions as it invests in negative net present value projects year after year. Now, if a management team repeatedly makes bad investment decisions, it is because the board of directors fails to properly execute its functions.

More importantly, since marginal q is a measure of investment performance over a given period, it allows us to test the direction of the causality as well. We assume that the board of directors approves investment projects, and that it has the obligation to avoid projects with negative net present value. In our setup, investment projects are first presented to the board by the manager for approval, and investment performance is observed after the project has been approved by the board and executed by the firm. Moreover, we aim to shed light on the issue of the direction of causality by measuring board characteristics at the beginning of each year and then use marginal q to measure how the market evaluates firm investments over several years. According to theory, corporate boards, through their monitoring capabilities, can prevent managers from undertaking poor investment projects over time (Fama and Jensen, 1983). However, good or bad investment performance during a given period, cannot determine board characteristics at the beginning of that period. If boards with certain characteristics allow their management to consistently invest in negative net present value projects year after year, then these boards are failing to properly monitor management and minimize agency costs (Shi, 2019; Yang and Kim, 2019).

Academics have mainly studied the effects of board size, "overboarded" directors, and board independence on firm performance. Regarding board size, the literature is inconclusive. Some authors have found a negative effect of greater board size on firm performance (Jensen, 1993; Lipton & Lorsch, 1992; Yermack, 1996; Eisenberg et al., 1998; Hermalin & Weisbach, 2001; Cheng, 2008). The reasons for the existence of large boards of directors within corporations are also discussed. These can be related to the role boards play in hiring, firing, and compensating managers (Fama and Jensen, 1983) and in guaranteeing the monitoring and management of the company's decision processes (Coles et al., 2006). The empirical literature also studies the role of "overboarded" directors, namely busy directors, and their impact on firm performance. A busy director is defined as a board member serving on more than three boards (Core et al., 1999; Ferris et al., 2003; Fich and Shivdasani, 2006). The positive effect of such directors is typically related to having more experience and better networks (Coles et al., 2012; Stuart and Yim, 2010; Ishii and Xuan, 2010), incentives to obtain prestige as monitoring specialists (Fama, 1980; Fama and Jensen, 1983), and being more visible and increasing commercial contacts (Mace, 1986). Contrary to the positive effects of director busyness on board performance, Shivdasani and Yermack (1999) argue that being too busy can reduce monitoring effectiveness. Fich and Shivdasani (2006) find that firms with a busy board (i.e., dominated by busy directors) have, on average, weaker profits, and lower market-to-book ratios. Finally, the effective separation of management and control requires the presence of independent directors in the corporate board (Fama & Jensen, 1983). Despite being considered endogenously determined (Hermalin & Weisbach, 2003), board independence is essential in corporate governance good practices. Several authors have contributed with empirical evidence on the positive effects of board independence on performance (Dahya & McConnell, 2007; Aggarwal et al., 2009; Bruno & Claessens, 2010).

To test the long-term effect of board characteristics on investment performance we use between estimator and fixed effects models on a sample consisting of 1,616 firms that traded on the Standard and Poor´s (S&P) 1500 between 1997 and 2014. Our results suggest a negative and statistically significant effect of greater board size at the beginning of a given year on investment performance during that year. For the sample under study, we also find empirical evidence on the nonlinear relation between board independence at the beginning of a given year and investment performance during that year. Finally, using two different measures of board busyness, we also find a nonlinear relation between board busyness as measured at the beginning of a year and investment performance during that year.

The rest of the paper is organized as follows. In the next section, we briefly review the literature on the board characteristics and firm performance, focusing on the role of board size, "overboarded" directors, and board independence. Next, we present the data and research methodology. Then, we develop the results and discussion section to finally conclude.

2. Theoretical framework and hypotheses development

Previous literature suggests that large boards are less effective than smaller boards (Jensen, 1993; Lipton & Lorsch, 1992). Theory suggests that agency problems increase inside boards when the number of directors increases considering they have to deal with coordination problems. Also, larger boards will suffer from free-riding problems affecting their participation in the administrative process (Hermalin & Weisbach, 2003). Evidence of the difficulty of large boards to reach consensus is reported by Cheng (2008). This author shows that larger boards are associated with lower variability in corporate performance. Therefore, one would expect that larger boards of directors will perform worse than smaller boards. Yermack (1996) and Eisenberg et al. (1998) show empirical evidence of the negative relationship between board size and firm performance. The question arises about the reason for the existence of large boards of directors within corporations. Considering boards are responsible for hiring, firing, and compensating managers and also for ratifying and monitoring strategic decisions (Fama & Jensen, 1983), some companies would need a larger board because those firms require directors to take on sufficient tasks that guarantee the proper functioning and proper management of the company's decision processes

(Coles, Daniel, and Naveen, 2006). The literature is not conclusive regarding the effect of board size on performance. In some cases, size is contingent on firm characteristics and circumstances (Raheja, 2005; Aggarwal, Evans, and Nanda, 2006). Bhagat and Black (2002) find no correlation between board size and firm performance because board size is an endogenous variable to factors that affect firm performance. These results cast doubt on previous studies about board size and firm performance. In this regard, it can be argued that because corporations are complex, it is not easy to find a direct relationship between board size and firm performance. This complexity can be exacerbated by agency problems. The previous discussion leads us to test the following hypothesis;

Hypothesis 1: *There is a nonlinear relationship between board size and firm Investment performance.*

The empirical literature has also studied the role of "overboarded" directors, namely busy directors, and firm performance. A busy director is usually defined as a board member serving in more than three boards (Core et al., 1999; Ferris et al., 2003; Fich & Shivdasani, 2006). It is assumed that busy directors have in general more experience and better networks (Coles, Daniel & Naveen, 2012; Stuart & Yim, 2010; Ishii & Xuan, 2010). These two characteristics make this type of director attractive to firms. Additionally, directors have incentives to participate in different directorships to get prestige as monitoring specialists (Fama, 1980; Fama & Jensen, 1983), be more visible, and increase commercial contacts (Mace, 1986). More directorships signal director quality and, therefore, they are asked to participate in more boards (Coles & Hoi, 2003; Bugeja, Rosa & Lee, 2009; Fich & Shivdasani, 2007). Contrary to the idea of the positive effects of director busyness on board performance, Shivdasani and Yermack, (1999) argue that too much busyness can reduce monitoring effectiveness. Fich and Shivdasani (2006) find that having a busy board, namely a board dominated by busy directors, has, on average, weaker profits and lower market-to-book ratios. According to the authors, the firms with busy boards report lower sensitivity to CEO turnover to firm performance. Similar results are reported by Core, Holthausen, and Larcker (1999) who argue that busy boards are not effective monitors considering that on average, CEOs are paid more when a firm has busy directors. There is a time constraint for directors willing to be effective monitors and too busy might be indicative of ineffective monitors (Fich and Shivdasani, 2006). Based on the previous discussion, we posit the following hypothesis:

Hypothesis 2: *There is a nonlinear relation between the presence of busy directors and investment performance.*

Effective separation of management and control implies the presence of independent directors in the corporate board (Fama & Jensen, 1983). Despite being considered endogenously determined (Hermalin & Weisbach, 2003), this board characteristic is considered essential in corporate governance good practices. Different authors have shown empirical evidence of the positive effect of board Independence and performance (Dahya, Dimitrov, & McConnell,2008; Aggarwal et al.; 2009; Bruno & Claessens; 2010). As stated by Hermalin & Weisbach (2003), the empirical analysis of the relation between board characteristics can be either $a_{t+s} = \theta c_t + \varepsilon_t, p_{t+s} = \beta a_t + \eta_t$, or a combination such $p_{t+s} = \beta(\theta c_t + \varepsilon_t) + \eta_t$, where c is board characteristics, a is a board action, and p is performance. What is clear is the non direct effect of the board on performance. The way this relationship is conveyed will be through the different channels taken by the board.

The channels through which independent directors affect performance are diverse. Dahya, McConnell, & Travlos, (2002) present empirical evidence of board Independence on CEO turnover. The authors find an improvement in CEO turnover performance after implementing the Cadbury code of good practices in the UK. Similarly, Chhaochharia & Grinstein (2009) document the effects of the Sarbanes-Oxley Act in CEO compensation. According to the Act, the compensation committee must consist of independent directors. The authors show a reduction in CEO compensation after the implementation of the code. Another channel through which independence affects performance is via reputation. Levit & Malenko (2016) argue that independent directors are better monitors because they care about their reputation to gain power, more board seats, and valuable networks among others. Clarkson, Craswell & Mackenzie (2008) state that the presence of independent directors increases, on average, the initial bid premium during a takeover. The independent directors will try to get the best deal thinking of their reputation. González et al. (2019) use the variable "director influence" measured as the ratio of independent directors over dependent directors and find that a board with the same proportion of dependent and independent directors reduces the level of initial public offering underpricing during the first day by 2.3%. A final example is the role of independent directors in reducing managerial opportunism (Chahine & Filatotchev, 2008). Armstrong, Core, & Guay (2014) report empirical evidence of a reduction of firms' opacity associated with the presence of independent directors. Based on the relevance of board actions in firm performance, we posit the following hypothesis:

Hypothesis 3: *A higher proportion of independent directors is positively related to investment performance.*

3. Data and research methodology

To measure the effects of board characteristics on investment performance, we use data from the Institutional Shareholder Services (ISS) database (formerly Risk Metrics) on the board characteristics of 1,616 firms that traded on the Standard and Poor's (S&P) 1500 between 1997 and 2014. The accounting data are from Compustat and the market data are from The Center for Research in Security Prices. We follow Mueller and Reardon (1993), who derive the following regression equation:

$$\frac{M_t - M_{t-1}}{M_{t-1}} = -\delta_t + q_{mt}\frac{I_t}{M_{t-1}} + \frac{\mu_t}{M_{t-1}}, \quad (1)$$

where the dependent variable, $\frac{M_t - M_{t-1}}{M_{t-1}}$, is the change in market value of firm *i* from the end of year *t-1* to the end of year *t* divided by the market value of the firm at the end of year *t - 1;* the intercept, δ_t, is the decrease in firm value due to yearly depreciation. The slope, q_{mt}, is the firm's marginal q which multiplies the independent variable, which is constructed by dividing investment during time t by firm market value at *t - 1*. The last term in the equation is the error term. This method has been used by Gugler et al. (2003, 2004, 2008), Gugler and Yurtoglu (2003), Mueller and Yun (1998), Mueller and Yurtoglu (2000), and Saravia (2014). A central point in the analysis is the magnitude of marginal q as a measure of investment quality. If marginal q is greater (less) than unity, this means that firms are investing in projects with positive (negative) net present value. We argue that the traits of the board of directors at firm level determine marginal q. Mainly, the number of directors participating, the number of directorships in which the directors participate, and the percentage of independence affect investment decisions. In our setup, investment proposals are presented to the board by the manager. We assume the board is in charge of evaluating these proposals, thus avoiding projects with negative net present value. Therefore, we propose the following specification for marginal q:

$$q_{mt} = \alpha + \beta\ BoardCharacteristics_{t-1}, \tag{2}$$

where board characteristics include variables such as board size, measured as the natural log of the number of board directors; busy directors, measured as the number of directors belonging to more than three boards; and independent directors, measured by the percentage of independent directors[1]. Substituting Eq. (2) into Eq. (1), we have:

$$\frac{M_{i,t} - M_{i,t-1}}{M_{i,t-1}} = -\delta_t + \alpha * \frac{I_{i,t}}{M_{i,t-1}} + \beta\ BoardCharacteristics_{t-1} * \frac{I_{i,t}}{M_{i,t-1}} + \frac{\mu_{i,t}}{M_{i,t-1}}. \tag{3}$$

We use the general form of Eq. (3) in a regression model to estimate the parameters of interest (e.g., $\hat{\alpha}$ and $\hat{\beta}$). To avoid misspecification we include some control variables as Firm size, measured as the natural log of market capitalization (Ferreira, Ferreira, & Raposo, 2011), Leverage as the long-term debt divided by total assets and R&D/sales as research and development expenses divided by total sales (Coles, Daniel, Naveen, & Naveen, 2008). We then use these estimates into Eq. (2) to generate graphs of marginal q as a function of lagged board characteristics. Lagged board characteristics associated with marginal qs lower than unity (poor investment performance) suggest systematic board failure in preventing malinvestment.

4. Results and discussions

4.1 Descriptive statistics

Table 1 shows descriptive statistics. Our sample consists of 14,022 firm-year observations. The firms in the sample have an average of nine directors, 72% of the directors are independent, and the boards have at least one busy director. Firms have, on average, total assets of USD 8,030 million, their leverage is around 16%, and on average R&D expenses are about 4% of total sales.

Table 1
Descriptive statistics

Variable	N	Mean	p50	Min	p25	p75	Max	SD
$(M_{it}-M_{it-1})/M_{it-1}$	14,022	0.127	0.078	-0.931	-0.076	0.254	11.439	0.391
I_{it}/M_{it-1}	14,022	0.163	0.093	-4.635	0.053	0.161	10.351	0.280
# Directors	14,022	9.120	9.000	0.000	8.000	11.000	26.000	2.300
Boardcomp	14,022	0.722	0.750	0.000	0.625	0.857	1.000	0.165
Busydirector	14,022	0.727	0.000	0.000	0.000	1.000	8.000	1.047
TotalAssets	14,022	8,030.307	1,799.296	17.321	705.500	5,573.492	479,921.000	23719.198
Leverage	14,022	0.175	0.164	0.000	0.028	0.273	0.929	0.149
R&D/Sales	14,022	0.038	0.003	0.000	0.000	0.043	1.561	0.071

The sample consists of 1,616 firms between 1997 and 2014. $(M_{it}-M_{it-1})/M_{it-1}$ is the change in market value during year t divided by firm market value at t - 1. I_{it}/M_{it-1} is investment during year t divided by firm market value at t - 1. *#Directors* is the number of total members of the board. *Boardcomp* is the number of independent directors divided by the number of the total directors. *Busydirector* is the number of directors that serve on three or more boards. *TotalAssets* is the total assets in millions of dollars. *Leverage* is Long-term debt divided by total assets. *R&D/Sales* is research and development divided by sales.

[1] See Appendix A for a detailed description of all variables used in the model.

Table 2 shows the correlation matrix of the variables used in this study. The correlation, between board size, busy director, and board composition are all positive and statistically significant at the 5% level. This suggests larger boards have more independent and busy directors. Additionally, the correlation between board size, firm size, and leverage is positive and significant, which indicates that firms with larger boards are larger and use more leverage. However, the correlation between board size and R&D is negative and significant, which suggests firms with larger boards invest less in R&D. Moreover, the correlations suggest that firms with busier boards and more independent directors are larger and use more leverage. Further, Table 2 indicates that firms with proportionally more independent directors invest more in R&D. We also find that the correlations between board characteristics and changes in market value, $\frac{M_t - M_{t-1}}{M_{t-1}}$, and investment, $\frac{I_t}{M_{t-1}}$, are negative and statistically significant. This shows that firms with larger, busier, and more independent boards invest proportionally less and the total market values of their firms increase by a lower percentage each year. Hence, firms with larger, busier, and more independent boards behave like value stocks, while firms with smaller, less busy, and less independent boards appear to be growth stocks.

Table 2
Correlation matrix

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
(1) $(M_{it}-M_{it-1})/M_{it-1}$	1.000						
(2) I_{it}/M_{it-1}	0.591*	1.000					
(3) *BoardSize*	-0.053*	-0.034*	1.000				
(4) *Boardcomp*	-0.046*	-0.094*	0.183*	1.00			
(5) *Busydirector*	-0.053*	-0.027*	0.337*	0.226*	1.000		
(6) Firm size	-0.007	0.039*	0.514*	0.229*	0.385*	1.000	
(7) *Leverage*	-0.019*	0.061*	0.174*	0.044*	0.098*	0.287*	1.000
(8) *R&D/Sales*	0.043*	-0.002	-0.130*	0.050*	-0.006	-0.056*	-0.204*

The sample consists of 1,616 firms between 1997 and 2014. $(M_{it}-M_{it-1})/M_{it-1}$ stands for change in firm market value during year t, divided by firm market value at t - 1. I_{it}/M_{it-1} equals investment during year t divided by firm market value at t - 1. *Board Size* is the natural log of total directors. *Boardcomp* is the number of independent directors divided by the number of total directors. *Busydirector* is a dummy variable that takes the value of 1 when the independent directors serve on three or more boards. *FirmSize* is the natural log of total assets. *Leverage* equals long-term debt divided by total assets. *R&D/Sales* stands for research and development expenses divided by sales.

4.2 Board characteristics and firm performance

A starting point in our analysis is the study of the effect of board characteristics on firm value as reported in previous works (for an extensive review of the literature see Adams, Hermalin, & Weisbach, 2010). We use a panel data model to control for variables that we cannot observe like business practices across firms or cultural characteristics that could influence investment performance. We use fixed-effects to control omitted variable bias that remain constant over time (Ferreira et al., 2011). The Hausman test confirmed the use of fixed effect regression for our model. Table 3 shows firm fixed effects regression results with Tobin´s Q as the dependent variable. Columns 1 to 4 report the marginal effects of board characteristics on firm value. In column 1 we show a negative effect of board size on firm value. The result is statistically significant at the 1% level. In column 2 we test the nonlinear relation between board independence and firm value. For the sample and specification under study, we do not find a statistically significant effect of board independence. Finally, in columns 3 and 4 we test the effect of "overboarded" directors on firm value. More specifically, column 3 shows a quadratic relationship between board composition and firm value. The coefficient on board composition is negative and statistically significant while that on board composition squared is positive and significant, both at the 1% level. Similar results are observed in column 4 where we test again the effect of "overboarded" directors, this time measured as the ratio between the number of busy directors divided by the total number of directors.

This table presents the results from estimating fixed effect models. The sample consists of an unbalanced panel data of 1,616 firms between 1997 and 2014. The dependent variable in all models is Tobin's Q, which is calculated by subtracting book equity from book assets and then adding the market value of equity, all divided by book assets. *BoardSize* is the natural log of the total number of directors. *Boardcomp* is the number of independent directors divided by the number of the total directors. *Busydirector* is the number of directors that serve on three or more boards. *Busycomposition* is the number of busy directors divided by the number of the total directors. *FirmSize* is the natural log of total assets. *Leverage* is long-term debt divided by total assets. *R&D/Sales* is research and development expenses divided by sales. Standard errors are between parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. As stated previously, a critical point in this type of specification is the endogeneity problem due to simultaneity bias. In this paper, we argue that using marginal q, as a measure of firm investment performance, surpasses previous measures of performance such as Tobin´s Q, for example, and allows us to test the direction of causality. Since investment proposals are presented to and approved by the board prior to their implementation, board characteristics will likely impact the quality of the investments that are undertaken.

Table 3
Board characteristics and firm performance

Variables	(1)	(2)	(3)	(4)
Boardsize $_{t-1}$	-0.18***			
	(0.06)			
Boardcomp$_{t-1}$		0.53		
		(0.323)		
Boardcomp$^2_{t-1}$		-0.43		
		(0.26)		
Busydirector$_{t-1}$			-0.06***	
			(0.01)	
Busydirector$^2_{t-1}$			0.05***	
			(0.01)	
Busycomposition$_{t-1}$				-0.39*
				(0.22)
Busycomposition$^2_{t-1}$				0.19
				(0.53)
Firmsize	-0.38***	-0.39***	-0.39***	-0.39***
	(0.03)	(0.03)	(0.03)	(0.03)
Leverage	-1.62***	-1.6056***	-1.62***	-1.62***
	(0.11)	(0.11)	(0.11)	(0.11)
R&D/Sales	-3.06***	-3.0535***	-3.06***	-3.06***
	(0.32)	(0.32)	(0.32)	(0.32)
Constant	5.67***	5.24***	5.37***	5.35***
	(0.20)	(0.20)	(0.18)	(0.18)
Observations	14,022	14,022	14,022	14,022
R-squared	0.10	0.10	0.11	0.10

However, it is not logically conceivable that poor investment performance in the future may have an impact on board characteristics in the past, at the time of investment appraisal. Table 4 reports regression results with the percentage change in market value as a dependent variable (see Eq. (3)).[2] Column 1 shows that the estimated marginal q equals 0.98 for all firms in our sample during the period studied. This means that, for every dollar invested by these U.S. corporations, their market value increased by USD 0.98 on average.

Table 4
Board characteristics and firm investment performance

Variables	(1)	(2)	(3)	(4)	(5)
I_t/M_{t-1}	0.98***	1.65***	0.97***	1.00***	1.00***
	(0.02)	(0.14)	(0.14)	(0.02)	(0.02)
Boardsize $_{t-1}(I_t/M_{t-1})$		-0.16***			
		(0.04)			
Boardsize$^2_{t-1}(I_t/M_{t-1})$		0.01***			
		(0.00)			
Boardcomp$_{t-1}(I_t/M_{t-1})$			-1.31**		
			(0.54)		
Boardcomp$^2_{t-1}(I_t/M_{t-1})$			1.71***		
			(0.47)		
Busydirector$_{t-1}(I_t/M_{t-1})$				-0.33***	
				(0.06)	
Busydirector$^2_{t-1}(I_t/M_{t-1})$				0.05***	
				(0.02)	
Busycomposition$_{t-1}(I_t/M_{t-1})$					-3.03***
					(0.45)
Busycomposition$^2_{t-1}(I_t/M_{t-1})$					4.13***
					(1.10)
Firm Size	0.01***	0.01***	0.01***	0.01***	0.01***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Leverage	-0.14***	-0.12***	-0.15***	-0.13***	-0.13***
	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
R&D/Sales	0.10	0.07	0.11*	0.09	0.10
	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)
Constant	0.08	0.07	0.07	0.02	0.03
	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)
Observations	14,022	14,022	14,022	14,022	14,022
R-squared	0.74	0.75	0.75	0.75	0.75

[2] We argue that the effect of corporate governance traits on investment performance is observed in the long run. To estimate this effect, we use a between estimator (BE) considering it converges to long-run effects (Pirotte and Mur, 2017; Godoy-Bejarano, J. M., Ruiz-Pava, G. A., & Téllez-Falla, D. F., 2020).

This table presents estimates of 'marginal q' using a technique developed by Mueller and Reardon (1993). The sample is a panel of 1,616 firms between 1997 and 2014. We use a between estimator (BE) and include year dummy variables to pick up movements in stock market values common to all companies. $(M_{it}-M_{it-1})/M_{it-1}$ stands for change in firm market value during year t divided by firm market value at t - 1. I_{it}/M_{it-1} equals a firm's investment during year t divided by its market value at t - 1. *BoardSize* is the natural log of the total directors. *Boardcomp* is the number of independent directors divided by the number of the total directors. *Busydirector* is the number of directors that serve on three or more boards. *Busycomposition* is the number of busy directors divided by the number of total directors. Standard errors are between parentheses. *** p < 0.01, ** p < 0.05, * p < 0.1. Column 2 shows the impact of lagged board size on investment performance. The coefficients of lagged board size and board size squared suggest a U-shape relation with investment performance that is statistically significant at the 1% level. From Fig. 1, firms with up to five directors have marginal q greater than unity. From six to sixteen directors, marginal q is less than unity reaching the lowest point when board size is eleven. Although there are few firms in our sample with more than sixteen members, Fig. 1 suggests that marginal q turns again greater than unity. This suggests that these larger boards are not good monitors of their firms' management teams, as they allow firms to invest in projects that, on average, return USD 0.8 for every invested dollar.

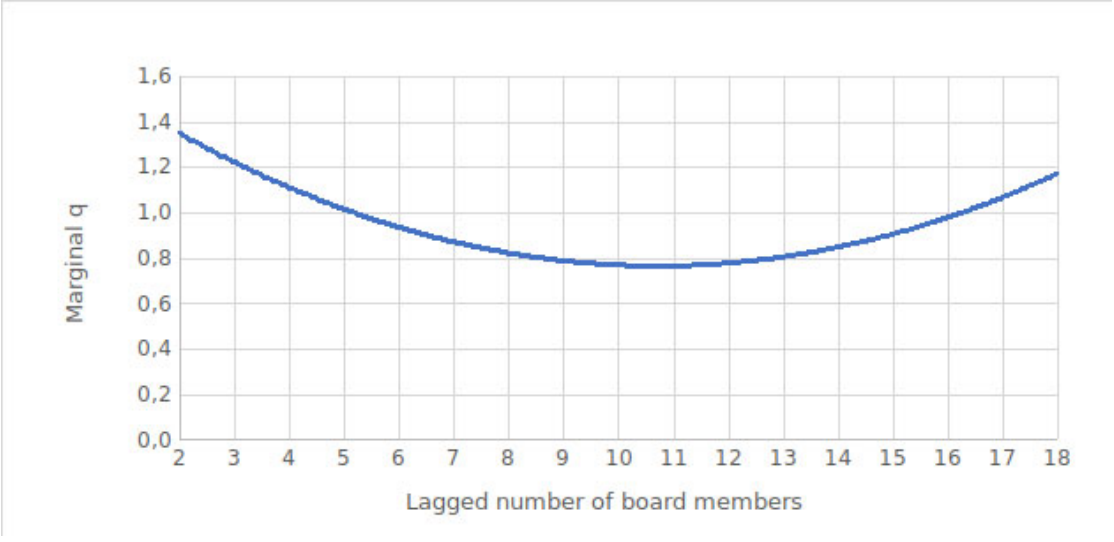

Fig. 1. Lagged board size and investment performance

Table 4, column 3 shows a quadratic relationship between lagged board composition and investment performance. The coefficient on lagged board composition is negative and statistically significant at the 5% level, while that on lagged board composition squared is positive and significant at the 1% level. As per Fig. 2, marginal q is less than 1 for firms with boards with less than 80% of independent directors. Hence, the boards with a minority of independent directors, on average, cannot stop managers from investing in negative net present value projects. Therefore, this result is consistent with the view that independent directors help mitigate agency conflicts between management and shareholders.

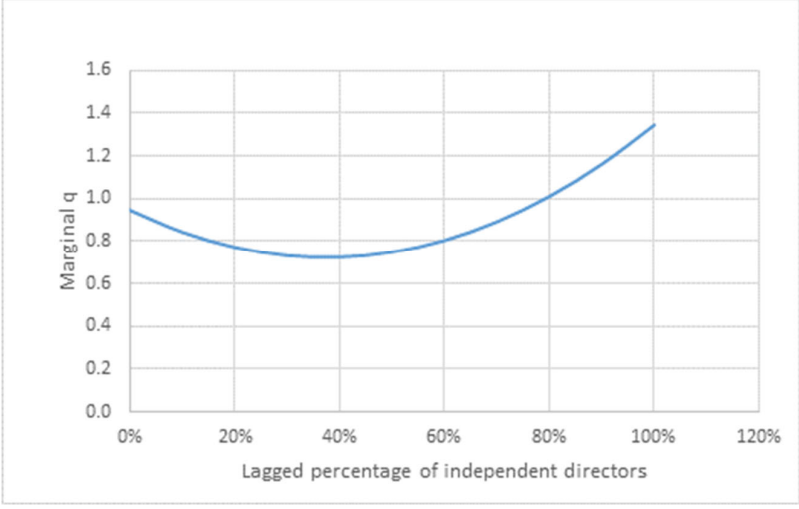

Fig. 2. Lagged board composition and investment performance

Table 4, column 4 shows the quadratic relationship between the lagged number of busy directors and investment performance. The coefficient on lagged busy directors is negative and statistically significant at the 1% level, while that on lagged busy directors squared is positive and significant at the same level. Fig. 3 shows the relationship between a busy board and investment performance. We limit the discussion to the range between zero and four busy directors, as most boards in our sample belong to this range. Marginal q equals one for companies with no busy directors, while as the number of busy directors increases, marginal q falls until it reaches a minimum for three busy directors and then starts increasing again. Therefore, this result indicates that busy directors cannot efficiently monitor the management or prevent investments in negative net present value projects, and investment performance becomes worse as the number of busy directors increases.

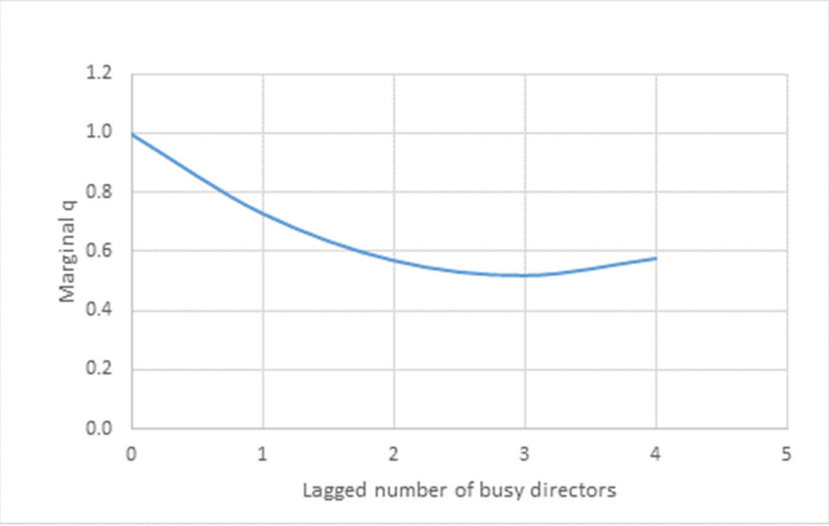

Fig. 3. Lagged number of busy directors and investment performance

Table 4, column 5 shows a quadratic relationship between the lagged percentage of busy directors on the board and investment performance. The coefficient on the lagged percentage of busy directors is negative and statistically significant at the 1% level, while that on the square lagged percentage of busy directors is positive and significant at the same level. Again, we limit our discussion to a range between zero to 50%, as the majority of boards in our sample belong to this range. Figure 4 shows that consistent with our previous findings, marginal q equals 1 for companies with no busy directors; however, as the percentage of busy directors increases, marginal q falls until it reaches a minimum around the 35% range and then starts increasing again. This result suggests that the boards composed of busy directors are less capable of efficiently monitoring the management and are not capable of preventing investments in negative net present value projects. Therefore, investment performance worsens as the percentage of busy directors increases.

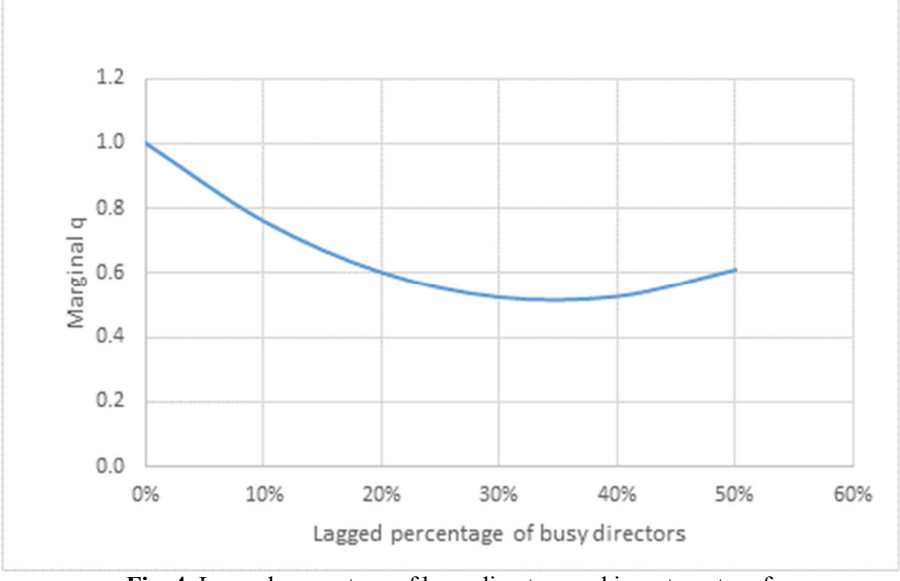

Fig. 4. Lagged percentage of busy directors and investment performance

5. Robustness

To tackle other endogeneity problems, more specifically omitted variable bias, in this section, we estimate the model proposed in equation 3 using fixed effects. Moreover, as was done in Table 4, we also include year dummy variables to pick up movements in stock market values common to all companies. Table 5 reports the results of five specifications. In general, the results of interest are similar to the ones reported in table 4. In particular, in column 2, the results continue to indicate a negative relationship between board size and investment performance. Moreover, in column 3 we also find an inverted U-shape relationship between board independence and investment performance. Both of these results are significant at 1% level. However, in this specification, the quadratic relationship between the lagged number of busy and percentage of busy directors and investment performance is not statistically significant for the sample studied (columns 4 and 5).

Table 5
Board characteristics and firm investment performance

Variables	(1)	(2)	(3)	(4)	(5)
It/Mt-1	0.72***	1.19***	0.86***	0.73***	0.72***
	(0.01)	(0.08)	(0.07)	(0.01)	(0.01)
Boardsize $_{t-1}(I_t/M_{t-1})$		-0.08***			
		(0.02)			
Boardsize^2 $_{t-1}(I_t/M_{t-1})$		0.00***			
		(0.00)			
Boardcomp$_{t-1}(I_t/M_{t-1})$			-0.53**		
			(0.23)		
Boardcomp$^2_{t-1}(I_t/M_{t-1})$			0.43**		
			(0.19)		
Busydirector$_{t-1}(I_t/M_{t-1})$				-0.03	
				(0.02)	
Busydirector$^2_{t-1}(I_t/M_{t-1})$				0.01	
				(0.01)	
Busycomposition$_{t-1}(I_t/M_{t-1})$					-0.43**
					(0.18)
Busycomposition^2 $_{t-1}(I_t/M_{t-1})$					1.49***
					(0.46)
Firm Size	0.17***	0.17***	0.17***	0.17***	0.17***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Leverage	0.11***	0.11***	0.11***	0.11***	0.11***
	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
R&D/Sales	0.02	-0.01	0.02	0.02	0.02
	(0.10)	(0.10)	(0.10)	(0.10)	(0.10)
Constant	-1.16***	-1.16***	-1.16***	-1.17***	-1.16***
	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)
Observations	14,022	14,022	14,022	14,022	14,022
R-squared	0.53	0.53	0.53	0.53	0.53

This table presents estimates of 'marginal q' using a technique developed by Mueller and Reardon (1993). The sample is a panel of 1,616 firms between 1997 and 2014. The estimation method is firm fixed effects. The regressions also include year dummy variables to pick up movements in stock market values common to all companies. (Mit-Mit-1)/Mit-1 stands for change in firm market value during year t divided by firm market value at t - 1. Iit/Mit-1 equals investment during year t divided by firm market value at t - 1. BoardSize is the natural log of the total directors. Boardcomp is the number of independent directors divided by the number of the total directors. Busydirector is the number of directors that serve on three or more boards. Busycomposition is the number of busy directors divided by the number of total directors. Standard errors are between parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

5. Conclusions

In this paper, we contribute to the debate on the simultaneity bias between board characteristics and firm performance. In our setting, investment proposals are presented to the board by the manager. We assume the board is in charge of evaluating these proposals, thus avoiding projects with negative net present value. Following Mueller and Reardon (1993), we estimate marginal q to determine if firms invest in projects with positive or negative net present value. Our results differ from those of previous works, which mainly rely on Tobin's Q to measure firm performance, in that the marginal q method allows us to test the direction of the causality as well. While corporate boards have the authority and the duty to prevent their firms from undertaking poor investment projects during the next period, investment performance over this next period cannot determine board characteristics at the beginning of the period. Therefore, in our setup, causality runs from board characteristics to investment performance. Our empirical results seem to indicate a statistically significant effect of board size, board independence, and board busyness on investment performance. In particular, contrary to Fama and Jensen (1983) and others, our results suggest that the board of directors is not a sufficient mechanism to minimize agency costs for example when it comes to malinvestment. This has managerial implications in corporate governance design. There is a need for the

enhancement of additional mechanisms like the market of corporate control, activism, government and market regulations to help mitigate the agency conflicts.

Possible future directions for research include investigating how board characteristics determine investment performance in emerging markets where corporate governance problems may be more acute.

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Appendix A

Variable Definitions

Variable	Description
$(M_{it}-M_{it-1})/M_{it-1}$	Change in firm market value during year t divided by firm market value at t - 1. Firm market value equals market value of equity plus total assets minus book value of equity
I_{it}/M_{it-1}	Investment during year t divided by firm market value at t - 1
#Directors	Number of total members of the board
IndepDirector	Directors with no material connection to the company
Board Size	Natural log of the total directors
Boardcomp	Number of independent directors divided by the total number of directors
Busydirector	Number of directors serving in three or more boards.
Busycomposition	*Busydirector* divided by the number of the total directors
Firm Size	Natural log of market capitalization
Leverage	Long-term debt divided by total assets
R&D/Sales	Research and development expenses divided by sales