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Board size and firm value: evidence from Australia

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Abstract We study the effect of board size on firm value in Australia. Using a large sample of Australian firms over the period 2001–2011, we find strong evidence of a negative relationship. We show that firms with a large board are associated with CEO compensation that is sensitive to firm size, but not to firm performance. This incentive to accumulate assets is congruent with the fact that firms with a large board also exhibit lower operating performance and higher operating costs. Furthermore, we find that the effect of board size is stronger in small firms. This result might explain why earlier studies, which focused on large Australian firms, found board size to have little impact on firm value.

Keywords Board of directors · Corporate governance · Firm performance · CEO compensation

JEL Classification G30 · G31 · G32 · G34

1 Introduction

The role of the board of directors is to monitor the firm's operations and make strategic decisions to sustain the firm's business. To perform its duties, the board is required to have deep knowledge of the firm's operating environment. But for this knowledge to create value, board members need to contribute effectively towards

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the firm's objectives. In this respect, board size is one of the key factors that might affect the board's effectiveness. According to the resource dependence theory, large boards carry advantages because of the superior quality of advice provided to the firm's management (Pfeffer 1972; Zahra and Pearce 1989; Lynall et al. 2003). In contrast, Lipton and Lorsch (1992) and Jensen (1993) contend that large boards are detrimental because they are associated with weaker monitoring and slow decision-making. Jensen (1993) argues that large boards are inclined to emphasize politeness and dampen criticism. As a result, underperforming managers are less likely to be fired and replaced by competent ones. In addition, Cheng (2008) demonstrates that large boards tend to make more conservative investments.

The implications of board size for firm performance have been tested in a number of studies. Yermack (1996) examines a sample of large US firms and detects a significant negative impact. In line with the views expressed by Lipton and Lorsch (1992) and Jensen (1993), this suggests that large boards are overwhelmed by weaker control mechanisms. Eisenberg et al. (1998) focus on a sample of small private firms in Finland and confirm the negative influence of board size on firm performance. Mak and Kusnadi (2005) validate the inverse relationship between board size and firm value in Malaysia and Singapore. Several papers investigate the impact of board size in other countries: Denmark (Bennedsen et al. 2008), UK (Guest 2009) and Japan (Nakano and Nguyen 2013). Overall, these papers suggest that the negative impact of board size on firm value transcends national boundaries.

Australia is an interesting case to examine the effect of board size on firm value. The stock market consists of a few large firms with global operations while the rest are relatively small. This offers the opportunity to evaluate the effect of board size on a type of firm that is underrepresented in most studies. In addition, the market for corporate control is much less active compared to, say, the US. This makes the role of internal governance mechanisms potentially more important in Australia (Pham et al. 2012). However, the studies based on Australian firms provide limited insight due to their small samples and predominantly cross-sectional nature. Bonn et al. (2004) examine a sample of 104 manufacturing firms. Board size is found to have a negative, but insignificant, influence on operating performance and firm value. Kiel and Nicholson (2003) analyze a larger sample of 348 firms. The effect of board size appears to be positive. However, their study does not control for industry effects. Henry (2008) also finds a positive effect of board size on Tobin's Q that disappears when industry effects are included. While his study involves a significantly larger panel of firms and controls for a range of firm characteristics, endogeneity of board size is not addressed for the reason that board size is not the focus of his investigation.

In this paper, we conduct a comprehensive analysis using a large panel of Australian firms over the period 2001–2011. Our study includes a number of observable firm characteristics. It also takes unobservable firm characteristics into account through the use of fixed firm effects. Unlike previous studies, we check that the influence of board size does not stem from reverse causality and use an instrumental variables approach to control for the endogeneity of board size. In addition, we explain why firms with a large board are less effective. We first examine the link with profitability and operating costs. We then investigate whether board size affects the firm's willingness to incentivize its CEO with performance-related compensation. Hence, this paper is able to provide more conclusive evidence of the negative impact of board size on firm performance in Australia.

Our results broadly agree with the findings of Yermack (1996) that firms with a large board are associated with significantly lower market values. This relationship does not stem from reverse causality. In fact, past performance is usually followed by an increase in board size. We find that investors are justified in assigning lower values to firms with large boards. The reason is that the latter are less profitable and associated with higher operating costs. Large boards also offer higher CEO compensation that is unrelated to firm performance, but rather depends on the size of the firm's balance sheet. This type of compensation is likely to encourage the accumulation of assets at the expense of shareholder value (Cooper et al. 2008; Watanabe et al. 2013).

Overall, this study makes several contributions to the literature. First, it demonstrates the significantly lower valuation of firms with large boards in Australia using a more comprehensive dataset and more rigorous econometric methods. Second, the study highlights two important channels through which large boards may impair firm performance. Namely, it shows that large boards are less effective at restraining operating costs and are more prone to offer overly generous CEO compensation that depends on the size of the firm's balance sheet rather than the CEO's performance. Third, the study documents a significant moderating effect related to the firm's size. Consistent with Coles et al. (2008) and Di Pietra et al. (2008) the negative board size influence is found to be stronger in small firms. A likely explanation is that small firms require less quality advice and have greater difficulty attracting talented directors. As a result, increasing board size tends to bring fewer advantages than in large firms.

The rest of this paper is structured as follows. Section 2 briefly reviews the literature relating to the effect of board size. Section 3 presents the data and methodology. Section 4 provides evidence of a negative relationship between board size and firm value. It also presents results that explain this negative relationship. Section 5 concludes.

2 Literature review

The board of directors has two fundamental functions: to advise and to monitor management. Mace (1971) observes that directors serve as a source of advice and counsel, and act in crisis situations when a change in management becomes necessary. In this regard, board size is considered to affect the effectiveness with which these functions are performed.

Building on the resource dependence theory of the firm, Dalton et al. (1999) posit that large boards offer better advice to management. Goodstein et al. (1994) argue that board size reflects the firm's ability to extract resources from its environment. Zahra and Pearce (1989) point out that outside directors can provide quality advice unavailable from the corporate staff. As a matter of fact, a number of them are CEOs of other corporations (Lorsch and MacIver 1989). Coles et al. (2008) assume that the larger the firm, the more complex its operations; hence the more advice and monitoring it requires, and the larger the size of its board should be.

In contrast, Lipton and Lorsch (1992) and Jensen (1993) argue against large boards because of the latter's greater emphasis on politeness and aversion to conflicts. Firstenberg and Malkiel (1994) hypothesize that small boards promote greater focus, participation, and genuine interaction and debate. One reason is that they offer fewer opportunities for free riding. Likewise, Judge and Zeithaml (1992) posit that small boards exhibit greater cohesiveness and ability to reach consensus. In particular, they are more likely to be involved in strategic decision making whereas large boards seem to inhibit the firm's ability to initiate strategic changes. In this respect, Goodstein et al. (1994) find evidence that larger boards hold back corporate restructuring and lead to slow reaction in crisis situations.

These opposite effects suggest that each firm has an optimal board size that depends on the firm's characteristics. Jensen (1993) argues that the relationship between board size and firm value becomes negative after board size increases beyond seven or eight. Lipton and Lorsch (1992) suggest a similar ideal of eight directors. Given that corporate boards in public companies tend to be somewhat larger, empirical tests generally point to a negative effect.[1]

In a seminal paper, Yermack (1996) provides clear evidence of a negative relationship between board size and firm value using a sample of large US firms. Moreover, the effect is economically significant. An additional director on the board appears to decrease firm value by about 4.3 %. Using event-study methodology, Yermack (1996) also shows that investors react positively to the announcement of a decrease in board size and negatively to the announcement of a board size increase. This effect is attributed to poor monitoring and inefficient decision-making. Eisenberg et al. (1998) confirm these results in a study of small and medium-sized Finnish firms. The relative absence of separation between ownership and control in small firms suggests that the inefficiency associated with large boards is not the result of greater agency conflicts, but is likely to arise from greater communication and coordination problems.

Conyon and Peck (1998) examine the effect of board size on corporate performance across a number of European countries and show that the effect is generally negative when performance is measured by return on equity. Singh and Davidson (2003) show that firms with large boards are associated with less efficient use of their assets as measured by the asset-turnover ratio. Andres et al. (2005) corroborate the detrimental effect of board size using a sample of firms from the OECD countries. Using a sample of firms from Singapore and Malaysia, Mak and Kusnadi (2005) find that board size is the most significant governance variable and that it has a strong negative effect on both firm value, proxied by Tobin's Q, and firm operating performance, proxied by return on assets, return on sales and asset turnover. Guest (2009) examines the influence of board size on firm performance in

[1] Private equity firms seem to recognize this problem. In firms taken private, board size is dramatically reduced. Wruck (2008) indicates that the typical board of a private equity-controlled company has typically five to eight members, including a non-executive chairman, and only one executive director.

the UK and reports a strong negative impact on firm profitability, Tobin's Q and stock returns.

With a view to establishing causality, Bennedsen et al. (2008) analyze a sample of family firms in Denmark. Using the founder's number of adult children as an instrument to control for endogenous variations in board size their study provides convincing evidence of a negative effect running from board size to firm performance. Nakano and Nguyen (2013) also apply an instrumental variable approach to reveal the negative influence of large boards on the market value of Japanese firms. In addition, their analysis indicates that firms with large boards are more likely to overinvest and are less likely to divest poorly-performing assets.

Australian studies provide generally mixed and inconclusive results. Using cross-sectional data, Kiel and Nicholson (2003) detect a positive relation between board size and Tobin's Q. However, their model includes few control variables and no industry effects. Henry (2008) also reports a significant positive effect on Tobin's Q that disappears when industry effects are taken into account. The panel structure of his data allows control for unobservable firm characteristics through the inclusion of firm fixed effects. Pham et al. (2011) likewise find a significant positive relation between board size and Tobin's Q in their OLS regression, but not in their firm fixed effects regression. Christensen et al. (2010) directly adjust Tobin's Q by subtracting the median in the firm's industry. Once this adjustment is made, the positive effect of board size on Tobin's Q all but disappears.

Looking at the influence of board size on operating performance, Bonn et al. (2004) observe a negative but insignificant relationship. This result is based on a relatively small cross section of manufacturing firms. Using a larger cross section of Australian firms, Christensen et al. (2010) report a negative effect that is highly significant. But, while their study controls for a large number of governance characteristics, it does not control for unobservable heterogeneity and does not address the endogeneity of board size.

As Lipton and Lorsch (1992) and Jensen (1993) explain, the relation between board size and firm value is not uniformly decreasing. This happens only when firms have excessively large boards. By contrast, when boards are relatively small, adding more directors can increase the firm's value because the latter bring their expertise and relationships that increase the firm's competitiveness. For similar reasons, Larmou and Vafeas (2010) argue that firms with a history of poor operating performance can benefit from increasing the size of their board. Coles et al. (2008) recognize that different firms require different sets of advice. As a result, their optimal board size may not be the same. Complex firms need larger boards to provide more advice to their CEOs. Risky firms should have smaller boards to achieve faster decision making. Their empirical results suggest that the relation between board size and firm value can be both increasing and decreasing, which may explain why some studies find an absence of effect when these differences are not taken into account.

3 Data and methodology

3.1 Sample and descriptive statistics

To build our sample, we select all Australian firms with available board and financial data. Board information comes from SIRCA's corporate governance database. This database has been purposefully built to provide details on the board ownership and each director's background and compensation. The coverage for our study is from 2001 to 2011. Stock price data also come from SIRCA. Financial data are from Aspect Huntley's Fin-Analysis. Industry affiliation is based on CRIF codes due to the fact that the newer S&P GICS codes are unavailable for delisted firms. Consistent with previous studies, we exclude utilities and financial firms from the sample as their market values may be affected by government regulation. We also eliminate observations with any incomplete data. The final sample consists of a panel of 7999 observations corresponding to 1141 unique firms over an 11-year period.

The sample descriptive statistics are presented in Table 1. The average board size is 5.19 and the median is 5, which is visibly lower compared to other Australian studies. For instance, Kiel and Nicholson (2003) report an average board size of 6.6 while Bonn et al. (2004) and Kang et al. (2007) report average board sizes of 7.36 and 8.19 respectively. The reason for this difference is that our sample includes a much larger proportion of small firms while other studies have mostly focused on large firms.[2] Similarly, the US sample of Yermack (1996) exhibits a higher average board size of 12.25 since it consists of large firms. In comparison, the small to medium-sized Finnish firms analyzed in Eisenberg et al. (1998) are associated with an average board size of only 3.71. More importantly, with a standard deviation of 1.86, the variation in board size is significantly larger in our sample (about 4.3 times larger) than in Yermack (1996). This variation makes our tests of board size more powerful irrespective of the sample's low average (as in Eisenberg et al. 1998).

The pairwise correlations between the main explanatory variables are reported in Table 2. Board size appears to be highly correlated with firm size, in line with the argument that more complex firms require greater advisory support (Coles et al. 2008; Guest 2008). Board size is also positively correlated with financial leverage, which might be because highly-levered firms require greater expertise to access external resources (Mizruchi and Stearns 1994; Coles et al. 2008). In contrast, firms with higher capital expenditures are more likely to have smaller boards. According to Coles et al. (2008) this is due to the fact that they require less monitoring since their internal cash flows are soaked up by their higher rates of investment. Overall, these correlations underline that board size is influenced by a number of factors reflecting the firm's operating environment.

[2] The samples analysed by Kang et al. (2007) and Bonn et al. (2004) cover the 100 largest Australian companies; the sample of Kiel and Nicholson (2003) contains 460 firms and is closer to ours. However, it consists of only one cross section. The 500 largest firms in our sample are characterized by an average board size of 7.82 (median of 8 and standard deviation of 2.46).

Table 1 Descriptive statistics

	Mean	SD	25 pctle	Median	75 pctle
Log Tobin's Q	0.498	0.747	−0.002	0.374	0.890
Board size	5.188	1.867	4	5	6
Firm size	18.145	2.143	16.539	17.999	19.491
Total debt	0.129	0.157	0	0.053	0.232
Fixed assets	0.211	0.228	0.023	0.114	0.355
Capex	0.092	0.106	0.015	0.048	0.129
R&D	0.102	0.628	0	0	0
Board ownership	0.099	0.166	0.001	0.020	0.121
CEO ownership	0.065	0.132	0	0.008	0.056
New CEO	0.414	0.493	0	0	1
ROA	−0.113	0.321	−0.174	0.007	0.078
EBITDA	−0.063	0.322	−0.155	0.030	0.141
Operating expenses	0.833	0.771	0.253	0.577	1.178

This table presents the descriptive statistics of the main variables in this paper. Tobin's Q is proxied by the market value of equity plus total liabilities, scaled by the book value of assets. Board size is the number of directors. Board ownership is the proportion of shares held by all directors. Firm size is the natural log of market value of equity plus total debt. Total debt is sum of current debt and non-current debt scaled by total assets. Fixed assets is property, plant and equipment, scaled by total assets. Capex is spending on fixed assets scaled by total assets. R&D is the natural log of one plus spending on research and development scaled by total assets. CEO ownership is the proportion of shares held by the CEO. New CEO is a dummy equal to 1 if the CEO's tenure is less than 2 years; and zero otherwise. ROA is EBIT scaled by total assets. Operating expenses is total revenue less EBITDA, scaled by total assets. Capex, Operating expenses and ROA are winsorized at the 5 % level in both tails. EBITDA is scaled by total assets, and winsorized at the 5 % level in both tails. Financial data are from Aspect Huntley's Fin-Analysis, corporate governance and market data are from SIRCA. The sample period is from 2001 to 2011

3.2 Model specification

The dependent variable Tobin's Q is proxied by the ratio of market value of equity plus total liabilities, scaled by the book value of assets. Consistent with Coles et al. (2008) we take the natural log of Tobin's Q because of the latter's large positive skew. Our variable of interest, board size, is measured by the number of board members. Unlike Yermack (1996), we do not take the natural log of board size since that variable does not exhibit a significant degree of skewness.

To isolate the effect of board size on firm value, we include a number of control variables. *Firm size*, defined as the natural log of equity at market value and total debt, is a control for potential size effects. *Total debt* is current and non-current debt scaled by total assets. Its effect on firm value is unclear. On the one hand, higher leverage provides larger tax savings and imposes stricter discipline on management (Jensen 1986). On the other hand, higher leverage is often associated with more mature firms that have fewer growth options, resulting in a lower market to book value of assets.

Table 2 Correlation between the main variables

	Board size	Firm size	Capex	Total debt	Fixed asset	R&D	Board owner.	CEO owner.	ROA	EBITDA	Operating expenses	CEO comp.
Board size	1											
Firm size	0.659	1										
Capex	−0.117	−0.033	1									
Total debt	0.229	0.328	−0.064	1								
Fixed asset	0.221	0.325	0.222	0.343	1							
R&D	−0.037	−0.032	0.125	−0.032	0.0003	1						
Board ownership	−0.127	−0.159	−0.105	−0.034	−0.087	0.016	1					
CEO ownership	−0.173	−0.158	−0.079	−0.045	−0.064	0.0025	0.8056	1				
ROA	0.282	0.451	−0.129	0.162	0.214	−0.0595	0.0883	0.0820	1			
EBITDA	0.303	0.468	−0.121	0.211	0.264	−0.0557	0.0974	0.0845	0.9536	1		
Operating expenses	0.026	−0.084	−0.186	0.126	−0.059	−0.0519	0.0889	0.0764	−0.1654	−0.0944	1	
CEO compensation	0.539	0.743	−0.037	0.245	0.217	−0.0112	−0.1750	−0.1579	0.2989	0.3190	0.0404	1

This table presents the Pearson product moment correlation between the main financial and governance variables. Board size is the number of directors. Firm size is the natural log of market value of equity plus total debt. Total debt is sum of current debt and non-current debt scaled by total assets. Fixed assets are property, plant and equipment, scaled by total assets. Capex is spending on fixed assets scaled by total assets, and winsorized at the 5 % level in both tails. R&D is the natural log of one plus spending on research and development scaled by total assets. Board ownership is proportion of shares held by all directors. CEO ownership is the proportion of shares held by the CEO. ROA is EBIT scaled by total assets, and winsorized at the 5 % level in both tails. EBITDA is scaled by total assets, and winsorized at the 5 % level in both tails. ROA is EBIT scaled by total assets, winsorized at the 5 % level in both tails. Operating expenses is total revenue less EBITDA, scaled by total assets, winsorized at the 5 % level in both tails. CEO compensation is the natural log of CEO total compensation

We take the firm's asset structure into account by including the ratio of fixed assets, measured by property, plant and equipment, over total assets (*Fixed assets*). Higher fixed assets ratio implies higher operating leverage. By using higher operating leverage firms may be able to leverage their underlying profitability and thus increase their market value. Another important regressor is the amount of growth options available to the firm. We include two measures of growth opportunities: capital expenditures (*Capex*) and R&D expenditures (*R&D*), both scaled by total assets. Higher levels of capital expenditures or investments should produce higher cash flows in future years. To mitigate its large kurtosis, the Capex variable is winsorized at the 5 % level in both tails. Similarly, higher R&D expenditures are likely to generate future projects with greater profitability. Demsetz and Lehn (1985) show that R&D is associated with higher firm value. Due to a large skewness and the fact that some firms do not report their R&D expenditures, we take the natural log of R&D after incrementing the ratio by one unit.

In addition to board size, we include another governance variable, namely, *Board ownership*, defined as the proportion of shares owned by board members. Equity ownership serves to align the interests of directors with those of the shareholders, which reduces the extraction of private benefits (Jensen and Meckling 1976). Morck et al. (1988) and McConnell and Servaes (1990) observe a positive association between board equity ownership and firm value in the US. Henry (2008) confirms this positive relationship for Australian firms.

Our model also includes either industry effects or firm fixed effects. Industry classification is based on the Australian School of Business CRIF codes which cover nineteen sectors. Year effects are included to control for economy-wide variations in firm values over time. Overall, the main regression model is as follows:

$$\begin{aligned}\ln(Tobin's\ Q) = {} & \beta_1\ Board\ size + \beta_2\ Board\ ownership + \beta_3\ Firm\ size + \beta_4 Total\ debt; \\ & + \beta_5 Fixed\ assets + \beta_6\ Capex + \beta_7\ R\&D + \gamma'\ Industry + \vartheta'\ Year + \varepsilon\end{aligned}$$

Board size is the number of directors. *Board ownership* is the proportion of shares held by all directors. *Firm size* is the natural log of market value of equity plus total debt. *Total debt* is current and non-current debt scaled by total assets. *Fixed assets* is property, plant and equipment over total assets. *Capex* is spending on fixed assets over total assets. *R&D* is the natural log of one plus spending on research and development scaled by total assets. *Industry* is a set of nineteen industry dummies. *Year* is a set of 11 year dummies. The model is estimated using OLS and fixed effects regressions with standard errors corrected for clustering at the firm level.

4 Results

4.1 Relation between board size and firm value

Table 3 presents regression results of Tobin's Q on board size. The OLS and fixed-effects models both provide negative and highly significant estimates regarding the

Table 3 Regressions of firm value on board size

	Dependent variable: log Tobin's Q		
	OLS (1)	Firm effects (2)	OLS (3)
Board size	−0.092***	−0.071***	−0.053***
	(0.009)	(0.008)	(0.005)
Board ownership	0.030	−0.014	0.037
	(0.088)	(0.097)	(0.042)
Firm size	0.129***	0.273***	0.067***
	(0.011)	(0.015)	(0.006)
Fixed assets	−0.501***	−0.443***	−0.215***
	(0. 062)	(0.076)	(0.035)
Total debt	−0.396***	−0.144	−0.212***
	(0.106)	(0.109)	(0.064)
Capex	1.327***	0.945***	0.684***
	(0.139)	(0.121)	(0.093)
R&D	0. 019	−0.054***	0.005
	(0.022)	(0.017)	(0.013)
Log Tobin's Q (t − 1)			0.602***
			(0.015)
Intercept	−1.588***	−4.027***	−2.139***
	(0.184)	(0.246)	(0.120)
Observations	7999	7999	7625
Adjusted R^2	0.193	0.552	0.516

This table shows the regression results of firm value on board size and other control variables. Tobin's Q is proxied by the market to book value of assets. Board size is the number of directors. Board ownership is proportion of shares held by all directors. Firm size is the natural log of market value of equity plus total debt. Total debt is sum of current debt and non-current debt scaled by total assets. Fixed assets are property, plant and equipment, scaled by total assets. Capex is spending on fixed assets scaled by total assets, and winsorized at the 5 % level in both tails. R&D is the natural log of one plus spending on research and development scaled by total assets. Standard errors are in parentheses and corrected for clustering at the firm level. ***, **, * Significance at the 1, 5 and 10 % level

effect of board size. Model 1 suggests that increasing board size by one member decreases Tobin's Q by about 9.2 %. Model 2, which includes fixed firm effects to control for unobservable firm characteristics, indicates that the reduction in Tobin's Q is about 7.1 %. In Model 3 these unobservable firm characteristics are captured through the lag of the dependent variable. These characteristics are also implicitly allowed to vary over time. Accordingly, the coefficient on board size is moderated, but remains highly significant. Overall, the results point to the detrimental effect of large boards in Australia, which is stronger than the one reported by Yermack (1996) for US firms, where expansion of an eight-director board by one member is reckoned to decrease Tobin's Q by about 4 %.

Concerning the other explanatory variables, board equity ownership is insignificant in all three models. This result is not in line with the implications of agency theory, but is congruent with Agrawal and Knoeber (1996) who find the effects of insider ownership on Tobin's Q disappears when other control variables are included. As in Yermack (1996), firm size is found to be associated with higher market values. In contrast, Henry (2008) and Christensen et al. (2010) report a lower valuation for large firms in Australia. The difference with our finding may be due to the fact that their measure of firm size is not firm value, but revenue and total assets.

The coefficient on fixed assets is strongly negative. Likewise, Coles et al. (2008) find that US firms with more intangible assets are associated with higher market values. The effect of debt on firm value is negative, but only significant in the OLS regressions. This suggests that leverage is linked to an important unobservable firm characteristic that is negatively correlated with firm value. In the fixed effects model, the influence of this characteristic is captured in the firm specific dummy. It follows that variations in leverage are not associated with significant changes in firm value. Capex has a strong positive effect in all the regressions, indicating that firms with higher growth opportunities are more richly valued. On the other hand, the effect of R&D is mixed. This result is in contrast to Coles et al. (2008) who find that in the more technology intensive US economy, R&D expenditures are associated with higher firm values.

4.2 Control for endogeneity

The negative relationship between board size and firm value may stem from the poor monitoring and decision-making of large boards. However, an alternative explanation may be that past firm performance determines current board size. For instance, a firm with a poor performance in the previous year may be inclined to appoint additional directors to bring more expertise to its board. We address this reverse causality concern by running regressions of change in board size on past firm performance. Finally, we use an instrumental variables approach to isolate the variation in board size uncorrelated with firm performance.

Table 4 presents the regressions of change in board size on change in firm value. Two proxies for change in firm value are used: (1) market-adjusted return defined as the difference between the firm's stock return and the value-weighted market return; (2) change in the natural logarithm of Tobin's Q. Both variables are measured over the past year or over the past two years. The results show that market-adjusted return and change in Tobin's Q are positively and significantly related to change in board size. These results are different from those in Yermack (1996) and Eisenberg et al. (1998) but, like theirs, provide strong evidence that the negative relationship between board size and firm value is not due to reverse causality.

Besides industry dummies, the control variables include change in firm size and the one-year lag of board size. In this table, change in firm size is measured by change in the natural log of total assets between the current and the previous year to avoid multicollinearity issues. As a matter of fact, measuring firm size by the market value of equity and debt would lead to change in firm size being highly correlated with stock returns and even more so with change in Tobin's Q. In line with Yermack

Table 4 Effect of past performance on change in board size

	Dependent variable: change in board size			
	(1)	(2)	(3)	(4)
Market-adjusted return	0.079***			
	(0.020)			
Market-adjusted return (past 2 years)		0.073***		
		(0.012)		
Change in log Tobin's Q			0.103***	
			(0.023)	
Change in log Tobin's Q (past 2 years)				0.037**
				(0.015)
Change in log total assets	0.208***	0.200***	0. 290***	0. 252***
	(0.023)	(0.024)	(0.024)	(0.023)
Board size (t − 1)	−0.161***	−0.160***	−0.160***	−0.160***
	(0.011)	(0.012)	(0.012)	(0.012)
Intercept	1.256***	0.757***	1.308***	0.707***
	(0.161)	(0.112)	(0.162)	(0.116)
Observations	7724	7410	7615	7284
Adjusted R^2	0.118	0.119	0.120	0.118

This table presents the regression results of change in board size on past firm performance. Board size is the number of directors. Market-adjusted return is the stock return less the return on the value-weighted market index in the past year (past 2 years). Tobin's Q is proxied by the market-to-book value of assets. Standard errors are in parentheses and corrected for clustering at the firm level. ***, **, * Significance at the 1, 5 and 10 % level

(1996), the results indicate that increase in firm size is strongly associated with increase in board size, which supports the resource-dependence theory that large firms require the advisory support of a larger board (Pfeffer 1972; Lynall et al. 2003). The coefficient on the one-year lag of board size is significantly negative, indicating that larger (smaller) boards are likely to shrink (expand) in the following year.

Finally, we address the potential endogeneity of board size using two-stage least squares regressions. We use two instruments separately and together. The first instrument is a new CEO dummy (*New CEO*) that equals 1 if CEO tenure is 2 years or less. Hermalin and Weisbach (1988) suggest that the board is likely to make new director appointments just before a CEO change so that the board can evaluate candidates to succeed the current CEO. Due to this practice in succession planning, the new CEO dummy should be positively correlated with board size. At the same time, there is no reason to suspect that this instrument is correlated with firm value (or more precisely the residuals of the regression or unexplained firm value). This is because board size increases to address the CEO's succession regardless of the firm's performance.

The second instrument is CEO stock ownership, defined as the CEO's equity holdings scaled by the total number of shares outstanding. In the agency view, entrenched CEOs with large equity stakes will try to increase their power by limiting appointments to the board. An alternative argument, suggested in Boone et al. (2007), is that higher CEO ownership better aligns the interests of the CEO with the interests of shareholders, thus reducing the need for incurring the higher monitoring cost of a large board. In either case, we expect a negative relation between CEO stock ownership and board size. The exogeneity of the CEO stock ownership variable is more difficult to defend for the precise reason that it may also enhance firm performance. However, Demsetz and Lehn (1985) and Himmelberg et al. (1999) argue that management ownership should be unrelated to firm value when firms maintain their optimum ownership structures. Besides, our own results indicate that board equity ownership has no effect on firm value in Australia (see Table 3).

Table 5 presents the results for the two-stage least squares instrumental variables regressions. Used separately, the new CEO dummy plays a positive role in explaining board size. However, both the partial R^2 and the associated F-value at the bottom of Column 1a suggest that this instrument is weak. The second-stage regression implies an absence of association between board size and firm value. However, the Hausman Wu statistic at the bottom of Column 1b indicates that the difference between the OLS and 2SLS results is not statistically significant. In other words, the OLS result does not appear to be affected by a missing variable bias. Considering the higher efficiency of OLS compared to 2SLS (due to the lower variation in the predicted board size variable compared to the original board size variable) it is sensible to rely on the results coming from the former (Larcker and Rusticus 2010). We can thus conclude that the lower value of firms with a large board is due to the latter's negative influence on the firm's decision making (rather than firm performance having a negative effect on board size).

We then use CEO stock ownership as an instrument. As expected, its effect on board size is significantly negative. The F-value at the bottom of Column 2a clearly shows that it represents a strong instrument. The partial R^2 is also large at about 1.53 %. The second-stage regression indicates that board size and firm value are unrelated. But given that the Hausman Wu statistic at the bottom of Column 2b is insignificant, it is advisable to rely on the OLS estimate because of its greater efficiency (given the absence of bias suggested by the Hausman Wu test). Finally, when the instruments are used together, the new CEO dummy becomes insignificant. This might be because the CEO is likely to have been in place for a number of years (at least more than two) in firms where his or her stock ownership is high. In the second stage regression, the coefficient on board size is similarly insignificant. Again, this is due to the 2SLS estimator being less efficient. The Sargan test at the bottom of Column 3b indicates that the instruments are valid, while non-rejection from the Hausman Wu test suggests an absence of bias in the OLS estimate.

4.3 Effect of board size on operating performance

Apart from affecting the firm's future cash flows through poor management decisions, the negative effect of large boards is likely to show up in the firm's

Table 5 Instrumental variable regressions

	Board size (1a)	Log Q (1b)	Board size (2a)	Log Q (2b)	Board size (3a)	Log Q (3b)
Board size		0.023		0.061		0.068
		(0.289)		(0.076)		(0.087)
New CEO	0.080**				0.014	
	(0.037)				(0.047)	
CEO ownership			−2.171***		−2.249***	
			(0.383)		(0.447)	
Board ownership	−0.541***	0.075	0.814**	0.161	0.865**	0.135
	(0.179)	(0.182)	(0.340)	(0.1058)	(0.390)	(0.121)
Firm size	0. 574***	0. 054	0.583***	0.049	0.579***	0.036
	(0.024)	(0.166)	(0.027)	(0.045)	(0.028)	(0.051)
Fixed assets	0.234	−0.532***	0.172	−0.506***	0.205	−0.506***
	(0.152)	(0.093)	(0.161)	(0.069)	(0.169)	(0.073)
Total debt	−0.186	−0.320**	−0.254	−0.452***	−0.155	−0.430***
	(0.191)	(0.130)	(0.210)	(0.111)	(0.220)	(0.119)
Capex	−0.789**	1.499***	−0.870***	1.455***	−0.984***	1.542***
	(0.244)	(0.277)	(0. 268)	(0.161)	(0.029)	(0.179)
R&D	−0.021	−0.020	−0.049**	0.039	−0.034	0.036
	(0.027)	(0.024)	(0.037)	(0.027)	(0.037)	(0.028)
Intercept	−4.038***	−0.555	−4.598***	−0.667	−3.40***	−0.503
	(0.765)	(1.534)	(0.703)	(0.454)	(0.801)	(0.506)
Observations	6817	6817	6502	6502	5599	5599
Adjusted R^2		0.146		0.1389		0.131
Partial R^2	0.001		0.015		0.016	
F value (instruments)	4.454***		32.192***		13.139***	
Hausman Wu test		0.155		4.151		3.462
Sargan test						2.044

This table presents the instrumental variable regression results of firm value on board size using the following instrumental variables: New CEO and CEO ownership. Board size is the number of directors. Log Q is the natural log of the market to book value of assets. New CEO is a dummy equal to 1 if the CEO's tenure is less than 2 years; and zero otherwise. CEO ownership is the proportion of shares held by the CEO. Board ownership is proportion of shares held by all directors. Firm size is the natural log of market value of equity plus total debt. Total debt is sum of current debt and non-current debt scaled by total assets. Fixed assets are property, plant and equipment, scaled by total assets. Capex is spending on fixed assets scaled by total assets, and winsorized at the 5 % level in both tails. R&D is the natural log of one plus spending on research and development scaled by total assets. Standard errors are in parentheses and corrected for clustering at the firm level. ***, **, * Significance at the 1, 5 and 10 % level

current operating performance. We investigate this link using two measures of operating performance: Operating return on assets (ROA) and EBITDA over total assets. In order to mitigate the effect of outliers, both variables are winsorized at the 5 % level in both tails.

Table 6 Effect of board size on operating performance

	ROA (1)	EBITDA (2)	Operating expenses (3)
Board size	−0.009***	−0.009***	0.044***
	(0.003)	(0.003)	(0.015)
Board ownership	0.229***	0.237***	−0.181
	(0.029)	(0.030)	(0.166)
Firm size	0.074***	0.075***	−0.107***
	(0.004)	(0.004)	(0.017)
Fixed assets	0.138***	0.195***	0.294**
	(0.022)	(0.023)	(0.125)
Total debt	−0.213***	−0.154***	0.483***
	(0.038)	(0.037)	(0.151)
Capex	−0.301***	−0.237***	0.114
	(0.058)	(0.057)	(0.256)
R&D	−0.013	−0.015	0.294**
	(0.009)	(0.009)	(0.125)
Intercept	−1.393***	−1.238***	2.157***
	(0.069)	(0.058)	(0.363)
Observations	7999	7999	7999
Adjusted R^2	0.300	0.345	0.317

This table shows the regression results of firm operating performance on board size. ROA is EBIT scaled by total assets, and winsorized at the 5 % level in both tails. EBITDA is scaled by total assets, and winsorized at the 5 % level in both tails. Operating expenses is the difference between total revenue and EBITDA, scaled by total assets and winsorized at the 5 % level in both tails. Board size is number of directors. Board ownership is proportion of shares held by all directors. Firm size is the natural log of market value of equity plus total debt. Total debt is sum of current debt and non-current debt scaled by total assets. Fixed assets are property, plant and equipment, scaled by total assets. Capex is spending on fixed assets scaled by total assets, and winsorized at the 5 % level in both tails. R&D is the natural log of one plus spending on research and development scaled by total assets. Standard errors are in parentheses and corrected for clustering at the firm level. ***, **, * Significance at the 1, 5 and 10 % level

Table 6 reports the regressions of operating performance on board size in columns 1–2. The control variables are the same as in Sect. 4.1. The coefficient on board size is negative and significant at the 1 % level for both performance measures. Consistent with its positive effect on firm value, firm size is associated with higher operating performance. The effect is opposite for total debt. On the other hand, board ownership is now positively related to firm performance, while capital expenditures become negatively related to firm performance. An explanation for this result is that capital expenditure proxies for growth firms, which tend to push back their profits into the future. Finally, the coefficient on fixed assets is positive, suggesting that higher operating leverage is associated with higher operating returns.

Overall, the operating performance results suggest that large boards are characterized by poor decision-making, leading to lower current and future performance, which in turn is reflected in the lower present value of the firm. One reason large boards may be less effective is that they allow the CEO to control the firm's policy. Given their intrinsic interest in expanding the firm, managers are tempted to accumulate assets and grow the firm's balance sheet beyond its optimal level. The implication is that the firm's profitability and value are likely to deteriorate. This inefficiency is a typical agency problem arising from the fact that managers personally benefit from growing the firm's assets. As a matter of fact, job prestige and compensation are strongly correlated with firm size. For instance, managerial compensation has been found to increase by about one-third each time the firm doubles in size. In the case of the 500 largest Australian firms, Merhebi et al. (2006) suggest a size-elasticity coefficient of 27.4 %.

Accordingly, we expect firms with large boards to be less effective and to be associated with a higher cost structure. We measure poor cost efficiency by the ratio of operating expenses to total assets. This ratio has been used in the literature to indicate the existence of agency costs. For instance, Ang et al. (2000) investigate the effect of management ownership on agency costs using that ratio. Their results indicate a significant negative relation between management ownership and operating costs, consistent with agency predictions. Fleming et al. (2005) find a similar result in Australia using the firm's discretionary expenses.

The regression of operating expenses on board size is reported in column 3 of Table 6. In line with agency theoretic arguments, the coefficient on board size is significantly positive. This result confirms that large boards are less effective at curbing management spending. Consistent with Ang et al. (2000) and Fleming et al. (2005), board ownership is associated with lower operating inefficiency, but this effect is not significant. Firm size is found to have a significant negative influence, which may be due to larger economies of scale. On the other hand, total debt and fixed assets (both in proportion of total assets) have a positive effect on operating expenses.

4.4 Effect of board size on CEO compensation

One way good governance can enhance firm performance is by providing compensation that encourages CEOs to create shareholder value. If they are expressly rewarded for that, CEOs are likely to exert greater effort to increase firm value. In addition, they are likely to apply greater caution when expanding the firm's assets knowing that such a decision could reduce the firm's share price and hence their own wealth. Compensation contracts that are strongly linked to increases in shareholder value have another highly-desirable feature in that they attract more competent managers while deterring low-quality managers from applying for the job (Arya and Mittendorf 2005). Whether the benefit is due to greater managerial effort or selection of more talented managers, better-designed compensation contracts are expected to have a positive impact on firm performance.

We test this idea by running regressions explaining CEO total compensation. Besides board size, the main variables on the right-hand side are Tobin's Q and total assets. Larger firms, which are typically more complex, offer higher compensation packages to their CEOs. Core et al. (1999) show that the total compensation of US

CEOs is strongly related to firm size. Schultz et al. (2013) find a similar result for Australian CEOs. Managers of growth firms make more discretionary investments and, hence, are often incentivized with high-powered compensation involving larger equity-linked components (Smith and Watts 1992). Thus CEO total compensation should be positively correlated with Tobin's Q since any increase in the firm's share price mechanically increases both Tobin's Q and CEO total compensation. We use interaction terms of Tobin's Q and total assets with board size to evaluate the latter's effect on the design of CEO compensation.

Table 7 presents the regression results. Model 1 includes board size, but no interaction terms. In line with Schultz et al. (2013), CEO total compensation is positively related to firm size and firm value. It also increases with board size, which suggests that firms with a large board are more generous with their CEOs. However, the implication is not necessarily negative since this may contribute to attract and retain better CEOs. Model 2 includes the interaction of board size with Tobin's Q. The coefficient on that term is indistinguishable from zero, suggesting that board size does not affect the use of shareholder value-related compensation. Model 3 involves the interaction between board size and total assets. The positive and significant coefficient on that term indicates that in firms with large boards, CEO total compensation is more sensitive to firm size than in firms with small boards. Thus firms with a large board encourage their CEOs to accumulate assets and inflate their firm's balance sheet. This often leads to the acquisition of poor-quality assets or the purchase of assets that are overvalued. In both cases, shareholder value is

Table 7 Effect of board size on CEO compensation

	Dependent variable: log (CEO total compensation)			
	(1)	(2)	(3)	(4)
Board size	0.044***	0.041***	−0.108*	−0.131*
	(0.012)	(0.013)	(0.061)	(0.067)
Log Tobin's Q	0.287***	0.251***	0.284***	0.205***
	(0.023)	(0.070)	(0.023)	(0.074)
Log total assets	0.378***	0.378***	0.337***	0.332***
	(0.011)	(0.011)	(0.021)	(0.022)
Log Tobin's Q × board size		0.007		0.016
		(0.014)		(0.015)
Log total assets × board size			0.008**	0.009**
			(0.003)	(0.003)
Intercept	5.437***	5.459***	6.252***	6.388***
	(0.206)	(0.205)	(0.397)	(0.425)
Observations	6545	6545	6545	6545
Adjusted R^2	0.584	0.584	0.585	0.585

This table presents the regression results of CEO compensation on board size. The dependent variable is the natural log of CEO total compensation. Board size is number of directors. Tobin's Q is proxied by the market to book value of assets. Standard errors are in parentheses and corrected for clustering at the firm level. ***, **, * Significance at the 1, 5 and 10 % level destroyed. In this regard, Cooper et al. (2008) show that firms that expand their assets too rapidly dramatically underperform firms that curb the growth of their balance sheet. Finally, Model 4 shows that the inclusion of both interaction terms does not change the results. Board size tends to be associated with poorly-designed CEO compensation contracts that reward the accumulation of assets rather their efficient management. This may ultimately explain the lower operating performance, higher operating costs, and lower market value of firms with larger boards.

4.5 The moderating effect of firm size

Several characteristics related to firm size are likely to constrain the board's influence and its capacity to sustain firm performance. Finkelstein and Hambrick (1996) indicate that managers are more influential and tend to have greater discretion in small firms. Accordingly, managers have greater opportunity in small firms to extract private benefits. Board attributes, and board size in particular, are thus expected to have a weaker effect on firm performance. Dalton et al. (1999) provide evidence from meta-analysis consistent with this prediction.

However, it is also possible to counter that board size can have a stronger effect in small firms. As a rule, small firms face greater challenges attracting talent (Barber et al. 1999; Hiltrop 1999). It follows that increasing board size may bring little additional value, while simultaneously exacerbating the coordination problems associated with large boards. Finally, small firms are more risky since their business conditions often change rapidly. This characteristic requires that they operate with a small board in order to achieve quicker decision making. With a large board, reaching consensus is likely to take longer, which may impair the firm's ability to react to external shocks and compete effectively.

The above arguments suggest that the detrimental effect of board size should be stronger in small firms. Coles et al. (2008) defend a similar idea. In their analysis, simple firms require less advice and are better off having smaller boards. Increasing board size does not allow them to benefit from better advice, but is only associated with greater coordination problems. In contrast, the better advice that complex firms can get from a larger pool of directors can offset the cost of less effective board communication. Interestingly, the main proxy for complexity is firm size, followed by leverage, which happens to be highly correlated with firm size.

To test the hypothesis of a moderating effect associated with firm size, we split the sample in two size groups and run regressions similar to those in Sect. 4.1 for each group. In Table 8, the cutoff point is set at $500 million in firm value. The fixed effects regressions show that board size has a significantly stronger effect in smaller firms. The difference across the two size groups is more modest in the OLS regressions including the lagged dependent variable. Nevertheless, the results continue to support the existence of stronger board size effect in smaller firms. We also consider two alternative cutoff points. With a lower cutoff of $100 million, the coefficients on board size across the two size groups become closer. But using a higher cutoff of $1 billion, which roughly distinguishes the largest 200 largest Australian companies, the coefficient on board size becomes nearly

Table 8 Regressions with sample split by firm size

	Dependent variable: log Tobin's Q			
	Firm effects		OLS with lagged dependent	
	Small firms (1)	Large firms (2)	Small firms (3)	Large firms (4)
Board size	−0.0818***	−0.0186**	−0.0593***	−0.0258***
	(0.011)	(0.009)	(0.007)	(0.007)
Board ownership	−0.0797	0.6690**	0.0023	0.1025
	(0.101)	(0.298)	(0.047)	(0.093)
Firm size	0.2768***	0.2491***	0.0779***	0.0352***
	(0.017)	(0.058)	(0.009)	(0.011)
Fixed assets	−0.4682***	0.0257	−0.2646***	−0.1013*
	(0.085)	(0.164)	(0.042)	(0.060)
Total debt	−0.0064	−0.6255***	−0.1120	−0.3775***
	(0.123)	(0.143)	(0.073)	(0.112)
Capex	0.8963***	1.2504***	0.6748***	0.6937***
	(0.132)	(0.306)	(0.103)	(0.202)
R&D	−0.0549***	0.0000	−0.0064	0.0257
	(0.017)	(0.016)	(0.014)	(0.023)
Log Tobin's Q (t − 1)			0.5830***	0.7357***
			(0.016)	(0.025)
Intercept	−3.9188***	−4.8953***	−0.7624***	−0.4861***
	(0.265)	(1.283)	(0.15)	(0.19)
Observations	6475	1524	6144	1481
Adjusted R^2	0.537	0.803	0.494	0.701

This table shows the regression results of firm value on board size for small and large firms. Small (large) firms are defined by a value below (above) $500 million. Tobin's Q is measured by the market to book value of assets. Board size is the number of directors. Board ownership is proportion of shares held by all directors. Firm size is the natural log of market value of equity plus total debt. Total debt is the sum of current and non-current debt scaled by total assets. Fixed assets are property, plant and equipment, scaled by total assets. Capex is spending on fixed assets scaled by total assets, and winsorized at the 5 % level in both tails. R&D is the natural log of one plus spending on research and development scaled by total assets. Year and firm (or industry) fixed effects are not reported. Standard errors are in parentheses and corrected for clustering at the firm level. ***, **, * Significance at the 1, 5 and 10 % level

indistinguishable from zero for the group of large firms. This result is consistent with Coles et al. (2008) and Di Pietra et al. (2008) and points to heterogeneity in the effect of board size.

5 Conclusion

This study demonstrates the negative effect of board size on firm performance in Australia. Consistent with Yermack (1996) we find that firms with a large board achieve significantly lower market values. This negative relationship evident in both

OLS and fixed effects regressions is not due to reverse causality whereby successful firms might choose to decrease the size of their board. In fact, we show that strong past firm performance is followed by a significant increase in board size. Using CEO stock ownership and a variable indicating a new CEO as instruments to identify exogenous variations in board size unrelated to firm value, we verify that the negative board size effect is robust to endogeneity concerns.

The detrimental influence of a large board is also reflected in lower operating performance and higher operating costs. Lipton and Lorsch (1992) and Jensen (1993) explain that firms with a large board perform poorly because their decision making processes are impaired by free-rider and coordination problems. Goodstein et al. (1994) contend that large boards inhibit corporate restructuring and tend to be indecisive in crisis situations. Firm performance is therefore expected to deteriorate. Furthermore, we provide evidence that large boards offer CEO compensation that is not sensitive to shareholder value, but exhibits high sensitivity to firm size. CEOs are thus incentivized to accumulate assets regardless of their profitability instead of improving the firm's efficiency and increasing shareholder value.

The results in this paper have practical implications. Whilst Australian corporate boards are relatively small, with an average of 5.2 directors, increasing their size might not have the benign consequences that one would expect. In fact, adding one director is likely to cause a decrease in firm value of about 7 %. This effect is economically large and stronger than the one obtained by Yermack (1996) based on a sample of US firms whose boards are much larger since they include on average 12.25 directors. We thus demonstrate a stronger negative impact of board size on firm value at the lower range of board sizes. Previous results along these lines by Eisenberg et al. (1998) only established that board size has a significant negative impact on operating performance for firms with a relatively small board.

Our results further explain why earlier studies, which focused on large Australian firms, found board size to have little impact on firm value (e.g., Bonn et al. 2004; Henry 2008). After splitting the sample by firm size, we show that the effect of board size is effectively weaker in large firms. However, the assumption that board size is irrelevant to firm value is all but wrong since it does not apply to most Australian firms. The results are broadly consistent with Coles et al. (2008). Because small firms require less advice and do not control their environment in the same way that large firms do, the benefit they can derive from a larger board is limited. Instead increasing the size of their board appears to mainly increase their communication problems, which can be costly given the elevated risk they face from their rapidly-changing environment. In contrast, the apparently weaker effect on large firms supports the resource dependence view that large firms benefit from the better advice and the connections to their more complex environment that they can receive from a larger board (Zahra and Pearce 1989).

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