BOARD EFFECTIVENESS AND FIRM INVESTMENT EFFICIENCY

by

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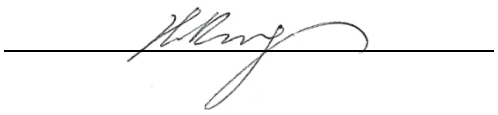
DECLARATION

I hereby certify that this thesis is the result of my own research and that it has not, nor has any part of it, been submitted for a higer degree to any other university or institution.



Rong He

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ABSTRACT

Business leaders and the Australian Stock Exchange (ASX) are calling for more effective boards, to ensure the goal of long-term survival and prosperity of firms. Efficient investment is the key to achieving firms' sustainability. Using 14-year panel data of all the companies listed on the ASX, this study investigates the association between a variety of board attributes and firm investment efficiency. The study provides evidence that boards with more concentrated functional expertise and higher director shareholdings are more effective in reducing both over-investment and under-investment. Smaller boards are able to reduce under-investment but not over-investment, while boards with longer average tenure restrain over-investment but not under-investment.

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LIST OF ABBREVIATIONS

Abbreviation	Explanation
ASX	Australian Stock Exchange
CAMAC	Australian Government Corporations and Markets Advisory Committee
CEO	Chief Executive Officer
CF	Cash Flow
CGPR	Corporate Governance Principles and Recommendations
FCLT	Focusing Capital on the Long Term
FRC	Financial Reporting Council
GFC	Global Financial Crisis
GICS	Global Industry Classification Standard
IAS	International Accounting Standard
IFRS	International Financial Reporting Standards
IPO	Initial Public Offering
MTB	Market To Book Ratio
NPV	Net Present Value
OCF	Operation Cash Flow
PPE	Property, Plant And Equipment
R&D	Research and Development
ROA	Return On Assets
ROE	Return On Equity
ROS	Return On Sales
SEC	Securities and Exchange Commission
UNCTD	United Nations Conference on Trade and Development
WC	Working Capital

CHAPTER 1: INTRODUCTION

1.1 Overview of this study

In the last few decades, sustainable development has become a focus of discussion globally. Sustainable development is important because it concerns the well-being for all people – not only for the present generation but also the future generations (Kuhlman, 2010). For corporations, sustainability is the goal of meeting the needs of their current and future, direct and indirect stakeholders, including shareholders, employees, clients, suppliers, and communities (Dyllick & Hockerts, 2002). To achieve this goal, firms must consider their operations and investments from a long-term perspective.

Attention given to the importance of long-term development can be seen from changes in regulations and market initiatives. For example, the recently issued 3rd edition of ASX Corporate Governance Principles and Recommendations (CGPR, hereafter) has made a significant change to the principle of risk management (ASX, 2014). This indicates that the focus of corporate governance has now extended beyond the goal of maximizing shareholder value to the long-term survival and prosperity of the company. The newly formed S&P Dow Jones Indices' Long-Term Value Creation Global Index further symbolises investors' attention to firms' long-term performance (FCLT, 2016).

Boards of directors (boards, hereafter) as "the ultimate decision-making body of an organisation" play an important role in ensuring the long-term sustainable development

of corporations (Psaros, 2009, p. 67). They are critical to strong corporate governance that serves to enhance the effective deployment of shareholder capital that ultimately contributes to firm growth and positive long-term performance (SEC, 2015). One of boards' responsibilities in corporations is to provide strategic advices for investment decision-making and risk management. This role is particularly important in today's business environment (Barton, 2011), because it takes a forward-thinking perspective, and emphasises the future prosperity and sustainability of the firm.

To achieve financial success in the long term, firms must invest for their future and promote innovation, prosperity, and productivity. Boards have motivations and capabilities to make sound investment decisions and guide firms towards sustainable development. This is because first, boards act as the link between shareholders and management, and have a legal duty to shareholders to add value to firms. Second, directors are motivated by their financial interest in the firm, either through remuneration or shareholding, to make good decisions to maximise firm value. Finally, the fact that most directors are experts in their area – industry or professional – suggests they have the ability to make good decisions in choosing proper investment projects. Considering the important role of boards in making investment decisions to ensure firm sustainability, this study investigates whether board effectiveness contributes to firm investment efficiency. In particular, this study examines a number of attributes that represent the level of board effectiveness and see if they enhance firm investment efficiency.

Efficient firm investment is conceptually defined as the situation that a firm undertakes

all the available projects with positive net present value (NPV) under the scenario of no market frictions (Biddle, Hilary, & Verdi, 2009). Accordingly, there are two types of inefficient firm investment situations, under-investment, and over-investment. Under-investment refers to the situation that a firm passes up investment opportunities that would have positive NPV; over-investment refers to situations that a firm invests in more projects than optimal level, even if they have negative NPV. Inefficient firm investments are caused by financial market frictions, such as information asymmetries between management and capital providers and agency problems (e.g. Myers & Majluf, 1984; Jensen, 1986). Inefficient firm investments not only are detrimental to the market value of firms (McConnell & Muscarella, 1985) but also affect the economic well-being of the society (Harris & Raviv, 1996). Therefore, improving efficiency in firm investment is important in enhancing wealth at both firm level and macro-economic level. Prior studies have provided evidence that firm investment efficiency can be improved through exercising governance mechanisms (Chen & Chen, 2012), improving financial reporting quality (Biddle et al., 2009) and improving firm information environment (Badertscher, Shroff, & White, 2013). However, there is little evidence about how boards contribute to firm investment efficiency.

The link between boards' effectiveness and firm investment efficiency can be established using various theories. The over-reliance on one specific theory (e.g. agency theory) of board research is criticised by some researchers.[1] Thus, this study attempts to integrate agency theory, resource dependence theory, and a strategic decision-making group

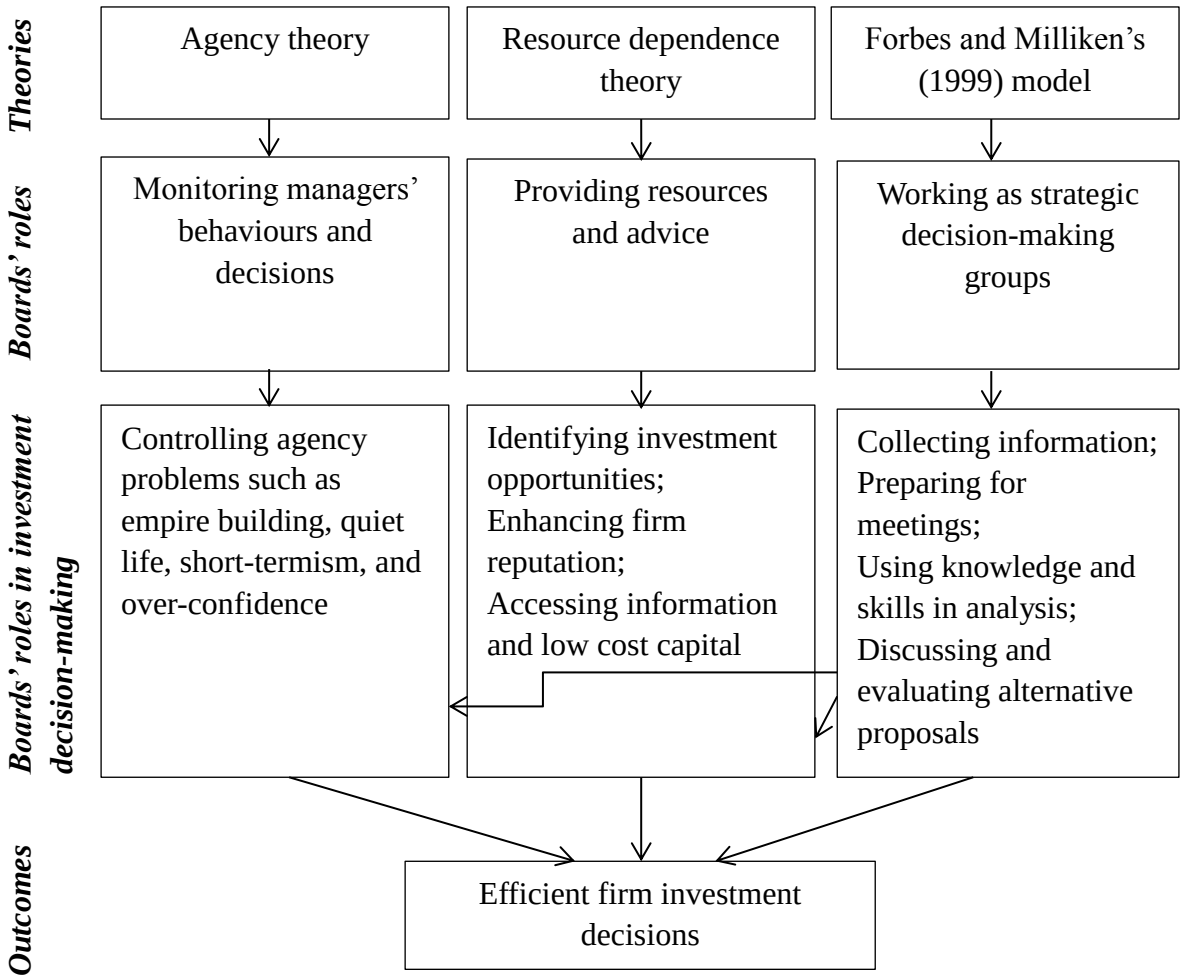
[1] Detail discussion is provided in Section 1.2.2.

theoretical model to explore how boards achieve investment efficiency. According to agency theory, boards reduce agency costs by effective monitoring of managers' behaviour and decisions (Jensen & Meckling, 1976). Inefficient investments are associated with agency problems in various ways, such as empire building, the quiet life, short-termism, and over-confidence (Stein, 2003). Through effective monitoring, boards can mitigate these agency problems and restrain over- and under-investment. According to resource dependence theory, directors bring valuable resources such as knowledge and skills to the firms (Pfeffer & Salancik, 1978). These resources help boards to identify valuable investment opportunities, to choose between investment alternatives and to help management make better judgements. In addition, directors with high reputation and credibility boost investors' confidence in the firms, and hence encourage investors to provide capital and reduce under-investment (Hillman, Cannella, & Paetzold, 2000). Based on the above discussion, if boards exercise their strategic role effectively, they are expected to improve firms' investment efficiency by reducing both over- and under-investment, through either monitoring or facilitating and empowering managers.

While agency theory and resource dependence theory explore the roles that boards play in firm investment decision-making, the strategic decision-making group model developed by Forbes and Milliken (1999) (Forbes and Milliken's (1999) model, hereafter) explores the processes that boards engage in to achieve effective decision-making. Ideally, to make firm investment decisions, board members first obtain relevant information and prepare for board meetings. Using their knowledge and skills, they

analyse the situation and provide different interpretation for the business environment and investment proposals. They participate in discussions and evaluate all the alternatives before achieving consensus and making final decisions (Bezemer, Nicholson, & Pugliese, 2014). These board processes affect board monitoring and advising task performance and contribute to the quality of strategic decision-making in uncertain environment (Forbes & Milliken, 1999). The theoretical links between boards and firm investment efficiency are illustrated in Figure 1.

Figure 1 – Theoretical links between boards and firm investment efficiency



Using a sample from all the ASX listed companies in the period from 2001 to 2014, this

study aims to investigate the association between board effectiveness and firm investment efficiency. The rest of this chapter is organised as follows. Section 1.2 details the motivations for the study. Section 1.3 discusses the contributions of this study. Section 1.4 outlines the structure of the thesis.

1.2 Motivation

This study investigates whether board effectiveness affects firm investment efficiency from a strategic perspective, applying agency theory, resource dependency theory and Forbes and Milliken's (1999) model. The study is motivated by the importance of boards' forward-thinking role of strategy planning and criticisms of theoretical approaches to board research.

1.2.1 The importance of studying the boards' role in strategic planning

Boards play an important role in achieving firms' sustainability. Academic literature provides evidence that the most important role of boards is participating in strategic decisions. Demb and Neubauer's (1992) survey results suggest that eighty percent of the directors agree their main task is setting strategy and overall direction for the firms they serve. Stiles and Taylor (1996) provide further survey evidence that boards are actively involved in all the strategic processes especially strategy developing and strategic options analysis. They suggest that boards work as partners of top management in most of the important strategic areas instead of just reviewing and analysing management's proposals

and decisions.

The importance of boards' strategic planning role can be seen from the corporate governance codes of various countries. In Australia, the ASX CGPR states that boards are responsible for setting the strategic objectives of the entity and overseeing management's implementation of the strategic objectives (ASX, 2014). In the UK, the *Guidance On Board Effectiveness* issued by the Financial Reporting Council (FRC) suggests that while executive directors are responsible for developing and presenting proposals on matters of strategy, non-executive directors are encouraged to constructively challenge and test their proposals (FRC, 2011).

Since firms' development strategies are generally realised through firms' investment activities in new business opportunities, innovation and highly efficient plant and equipment, boards must make sound investment decisions to ensure firms' sustainability and long-term performance (Barton, 2011). Therefore, taking a forward-looking perspective to study board effectiveness in investment decisions is as important as evaluating board effectiveness based on past firm performance, which takes a backwards-looking perspective. Accordingly, this study examines a variety of attributes of boards to understand the important factors that make them effective in terms of investment decision-making, and thus provides insight into boards' role in strategic planning.

1.2.2 Criticisms of theoretical approaches to board research

Some scholars are critical of research on boards that has been over-reliant on agency theory (e.g. Daily, Dalton, & Cannella Jr, 2003; Roberts, McNulty, & Stiles, 2005). Studies relying on agency theory assume managers are self-interested and opportunistic, while ignoring the cooperative potentials of agency and frequent isomorphism between managers and shareholders interest (e.g. Daily et al., 2003; Huse, 2005; Roberts et al., 2005; Minichilli, Zattoni, & Zona, 2009). Scholars argue that this theoretical choice leads researchers to take a narrow view of boards as monitors while, in fact, they have a broader, more inclusive role as strategic decision makers. They suggest that the simplistic theoretical choice is one of the reasons that prior board effectiveness studies report inconsistent results on the association between board attributes and firm performance (Roberts et al., 2005). Therefore, they encourage theoretical pluralism – the integration of various theories – in board research to understand better and explain boards' roles.

The issue of over-relying on one specific theory also exists in prior studies on boards' roles in firm investment decisions. The literature heavily relies on agency theory and argues that a board's role in firm investment decision-making is to monitor managers' decisions. Consequently, these studies generally use board composition or other measures of monitoring intensity as the independent variable. For example, a number of studies investigate the association between board independence and firm acquisition performance and argue that more independent boards are more effective in monitoring CEO's decisions to make better acquisitions (e.g. Byrd & Hickman, 1992; Desai, Kroll,

& Wright, 2005; Walters, Kroll, & Wright, 2007). However, as suggested by Adams and Ferreira (2007), boards play both monitoring and advisory roles when making investment decisions. While prior studies provide some insights into how boards affect firm investment decisions through monitoring, how they utilise their social links and human capital to affect firm investment decisions through advising is understudied.

In relation to the issues of simplistic theoretical choices proposed by scholars, more and more researchers integrate multiple theories in their board effectiveness studies. The trend of theoretical pluralism in board research can be seen in Pugliese, Minichilli, and Zattoni (2014), Chen, Hsu, and Chang (forthcoming) and Guldiken and Darendeli (forthcoming). Following this trend, this study examines board effectiveness relying on agency theory, resource dependence theory, and Forbes and Milliken's (1999) theoretical model.

1.3 Contributions

This study makes several contributions to both practice and the literature. First, this study contributes to the board effectiveness literature in several aspects. Differentiating itself from prior studies examining board effectiveness in improving firm performance, this study focuses on board effectiveness in improving firm investment efficiency. Firm performance measures the profitability of the past, while firm investment efficiency reflects firms' future and long-term sustainability. Therefore, this study takes a forwarding-looking perspective, rather than a backward-looking perspective. In today's

business environment where sustainable development and long-term value-adding become firms' ultimate goal, studying boards' roles in securing the future of firms is particularly important. Moreover, firm investment efficiency is a measure of board task performance rather than overall firm performance. While firm performance may be affected by boards' decisions indirectly, it is also subject to the effects of numerous factors such as market environment, competition and operation efficiency. Compared to firm performance, firm investment efficiency measures the quality of firm investment decisions in regards to resource allocation, which are generally assumed to be the direct outcomes of board participation. Therefore, board effectiveness is expected to have a tight association with firm investment efficiency.

Second, this study is different from previous studies on boards' investment decisions that generally focus on the association between board attributes and acquisition performance or R&D investment decisions. While these studies provide evidence on boards' role in investment decisions about acquisitions and R&D investments, the evidence is limited when capital expenditures are also included. Since acquisitions are episodic, and R&D only reflects the innovative aspect of firms' investments, these studies do not capture all the investment activities of firms and thus do not provide comprehensive insights into boards' roles in firms' overall investment decision-making. Extending prior studies, this study focuses on whether board effectiveness is associated with firm investment efficiency using a measure of a firm's overall investments.

Third, this study also fills some gaps in the firm investment efficiency literature by

focusing on the effects of firms' internal factors on firm investment efficiency. Prior studies on firm investment efficiency generally focus on the effects on firm investment efficiency of external factors such as financial reporting quality (Biddle et al., 2009) and firm information environment (Badertscher et al., 2013). These factors influence firm investment decisions indirectly through improving capital providers' confidence in the firm and facilitating the contracting process to improve investors' ability to monitor management (Healy & Palepu, 2001). Extending prior studies, this study argues that boards' participation in firm investment decision-making is an important firm internal factor affecting firm investment efficiency. Since firms invest to achieve their strategic goals, their investment activities are determined by their strategic directions and strategic plans. Being responsible for firms strategic planning, effective boards not only influence firm investment efficiency indirectly through monitoring management and maintaining stakeholder relationships, but also work closely with management and directly participate in firm investment decision-making. By investigating the impact of board effectiveness on firm investment efficiency, this study focuses on boards as a firm internal factor, and provides insights into firm investment decision-making process.

Finally, this study may provide suggestions to companies about the features of effective boards for investment decision-making. The results of this study suggest that smaller board size, more director shareholdings, more concentrated functional expertise on boards and longer average director tenure contribute to board effectiveness in firms' investment decision-making. The findings may help firms to design board structure and

composition to facilitate better investment decisions.

1.4 Structure of thesis

The remainder of this thesis is structured as follows. Chapter 2 provides a review of the theoretical framework and literature that underpin this study, and develops the seven testable hypotheses. Chapter 3 explains the research design of this study in details. Chapter 4 outlines the sample selection and data collection procedures and describes the data. Chapter 5 presents the results of data analysis and some further analyses while Chapter 6 presents further discussions of the results and the implication of the findings, as well as limitations of the current study and suggestions for future research.

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

Historically, the board is developed to meet the needs of central management: when a corporate has a large number of owners, it is impractical to have all the owners frequently meeting together to make decisions for the firm (Gevurtz, 2004). Therefore, the board is appointed by shareholders of the firm and makes important decisions for the firm on behalf of the shareholders. Boards do not participate in firms' everyday operations. Rather, they make decisions that can affect all the stakeholders such as deciding firms' strategic directions and CEO replacement.

Numerous studies have been undertaken to understand the roles of boards and how their work adds value to firms to ensure the expected outcomes are achieved (Hermalin & Weisbach, 2003). In general, the studies find that boards have a significant impact on firms' financial performance, management behaviour and firm investments. To further investigate boards' roles in firm investment decision-making, this study examines the association between board effectiveness as measured by a number of board attributes and firm investment efficiency.

This chapter reviews the prior literature relevant to this study and is structured as follows. Section 2.2 reviews the literature on board effectiveness, while Section 2.3 reviews the literature on the cause of inefficient firm investment and the mechanisms improving firm

investment efficiency. Section 2.4 discusses the link between boards and firm investment efficiency and develops testable hypotheses, and Section 2.5 concludes the chapter.

2.2 Board effectiveness

As decision-making groups appointed by shareholders, boards have important responsibilities in corporations. These responsibilities include overseeing corporations' financial, operational and investment policies; overseeing corporations' financial accounting, reporting and disclosure; deciding corporations' strategic directions and risk management framework; appointing and replacing the CEO and other senior executives; and deciding the remuneration structure (ASX, 2014). A board is effective if it can discharge its responsibilities effectively and thus add value and bring about corporate performance that satisfies the interests of both shareholders and stakeholders (Petrovic, 2008).

This section reviews the literature on board effectiveness and is organised as follows. Section 2.2.1 introduces the theoretical foundation of hypotheses of this study, including agency theory, resource dependence theory and Forbes and Milliken's (1999) model. Sections 2.2.2, 2.2.3 and 2.2.4 review the empirical studies on board effectiveness, focusing on boards' roles in improving firm performance, monitoring management, and strategic decision-making respectively.

2.2.1 Theoretical background

A number of theories have been used in the literature to explain what encompasses effective boards. These theories include agency theory, stewardship theory, resource dependence theory and stakeholder theory. Among them, agency theory and resource dependence theory are the theoretical foundations of most of the empirical studies in this research area.

Agency theory assumes that managers are opportunistic and will consider their own welfare over and above those of shareholders. Due to the potential costs incurred when management pursues its own interests at the expense of shareholders' interests, it is important that managers' behaviour is monitored properly (Jensen & Meckling, 1976). Consequently, boards are placed at the apex of the decision control system of organisations to oversee top management behaviours and decisions, in order to safeguard shareholders' interests. Boards exercise their decision control function through a set of activities such as hiring and firing top management, deciding CEO's compensation, and ratifying important decisions (Fama & Jensen, 1983).

Resource dependence theory, on the other hand, assumes managers as intrinsically motivated agents acting in the best interest of the firm (Davis, Schoorman, & Donaldson, 1997). It suggests a corporation's success and survival is contingent on its ability to control its external resources. Boards provide crucial links to the external environment and bring different types of resources to the firm (Pfeffer, 1972; Pfeffer & Salancik, 1978; Hillman et al., 2000). For example, directors add value to the firm by dealing with

problems of external interdependence and uncertainty, thus reducing transaction costs associated with the firm's external linkages (Pfeffer, 1972). Directors also benefit firms by bringing resources, such as information, skills, access to key constituents and legitimacy, as well as enhancing the reputation and credibility of their firms (Hillman et al., 2000).

Apart from accounting theories, some scholars study board effectiveness based on social-psychological theories. Among them, Forbes and Milliken (1999) suggest that boards are large, elite, and episodic decision-making groups that face complex tasks concerning strategic-issue processing. Therefore, board effectiveness depends significantly on social-psychological processes, particularly those relating to group participation and interaction, information exchange and critical discussions. Accordingly, they develop a model of board processes by integrating the literature on boards of directors with the literature on group dynamics and workgroup effectiveness. Forbes and Milliken's (1999) model identifies three board processes that affect board performance and board cohesiveness. The model also suggests that board demographic factors such as board size, board independence, and tenure are likely to have an effect on board processes and in turn affect board performance.

The three board processes discussed in the model are effort norms, cognitive conflict and the presence and use of knowledge and skills. Effort norms refer to the efforts by individual directors and their influence on other directors. Directors who devote more time in collecting information and preparing for board meetings, and more actively

participate in discussions, are more likely to perform their tasks effectively. Cognitive conflict refers to the critical investigation process when board members hold different views and perspectives about a task. It normally leads to more consideration and careful evaluation of alternatives and thus results in better strategic decisions. Knowledge and skills of boards can be classified into functional area knowledge and skills, and firm-specific knowledge and skills. Functional area knowledge and skills (e.g. accounting, finance, marketing and legal) help directors in information gathering and problem solving, while firm-specific knowledge and skills are critical for directors to understand firms operation and internal issues. Effective boards not only need to possess a high degree of knowledge and skills, but also have the ability to apply their knowledge and skills to various tasks (Forbes & Milliken, 1999).

This section has introduced agency theory, resource dependence theory and Forbes and Milliken's (1999) model that underpin board effectiveness. The rest of Section 2.2 provides a review of empirical studies on board effectiveness in fulfilling their various roles in corporations.

2.2.2 Boards' role in improving firm performance

To find out whether boards are effective in adding value to firms, abundant research has been undertaken to study the association between boards attributes and firm financial performance, measured by either accounting (return on assets (ROA), return on equity (ROE), and return on sales (ROS)) or market (market to book ratio (MTB), Tobin's Q,

and abnormal stock return) indicators. Prior studies provide evidence that board size, independence, activity, busyness and gender diversity can have an effect on firm performance or firm value. The findings on each board attribute are discussed in this section.

Some empirical studies examine the association between board size and firm performance/firm value. Yermack (1996) finds a negative association between board size and firm value in large US companies and concludes that smaller boards are more effective. Using a sample of small US firms, Eisenberg, Sundgren, and Wells (1998) also find that larger boards are associated with lower firm value. Mak and Kusnadi (2005) provide further evidence of this association based on a sample of Singapore and Malaysian companies. However, Kiel and Nicholson (2003) find a positive association between board size and firm performance (measured by ROA) as well as firm value (measured by Tobin's Q) using a sample of 348 Australian large listed companies. Cheng (2008) finds that firms with larger boards have lower variability of corporate performance, indicating that it takes more compromises for a larger board to reach consensus, and consequently, decisions of larger boards are less extreme, leading to less variable corporate performance.

In relation to the association between board independence and firm performance/firm value, some studies report a positive association (Rosenstein & Wyatt, 1990; Brickley, Coles, & Terry, 1994; Kiel & Nicholson, 2003), some studies find a negative association (Yermack, 1996; Klein, 1998; Christensen, Kent, & Stewart, 2010), while others find no

association (Hermalin & Weisbach, 1988; Bhagat & Black, 2002). It is worthwhile to note that some researchers also use indirect methods to test the association between board independence and firm value, and suggest that board independence increases firm value. For example, Rosenstein and Wyatt (1990) find significantly positive share-price reaction upon the appointment of outside directors and conclude that outside directors are chosen in the interest of shareholders. Nguyen and Nielsen (2010) draw similar conclusions that independent directors provide a valuable service to shareholders based on their findings that stock prices drop significantly following the sudden deaths of independent outside directors. Further, Anderson, Mansi, and Reeb (2004) suggest that the independence of audit committees is associated with a significantly lower cost of debt financing.

Board activity is another attribute that has been examined in the literature. Using the number of board meetings as a proxy for board activity, prior studies find that more active boards are associated with better firm performance. For example, Vafeas (1999) finds that more active boards are often associated with better future operating performance following poor performance. Brick and Chidambaran (2010) examine the determinants of board monitoring activity and its impact on firm value. The study shows that prior performance, firm characteristics and governance characteristics are important determinants of board activity. The study also finds that board activity has a positive impact on firm value. However, Christensen et al. (2010) report a negative association between the number of board meetings and firm performance for Australian companies.

Their explanation for the results is that boards may meet more frequently in response to poor performance.

Multiple directorships holding by directors are also found to be associated with firm performance/firm value. Falato, Kadyrzhanova, and Lel (2014) study stock market reaction to the sudden death of directors in director-interlocked firms. They conclude that directors' busyness is detrimental to shareholder value if they hold too many other directorships. Fich and Shivdasani (2006) find that firms with busy boards exhibit lower market-to-book ratios and weaker profitability. However, Field, Lowry, and Mkrtchyan (2013) suggest that the experience and contacts of busy directors make them excellent advisors and busy boards contribute positively to firm value to initial public offering (IPO) firms. Further, Larcker, So, and Wang (2013) find that firms with well-connected boards benefit from information and resources exchanged through boardroom networks, and they earn superior risk-adjusted stock returns and experience higher future return-on-assets growth and more positive analyst forecast errors.

The association between board gender diversity and firm performance has attracted attention in the more recent literature. Adams and Ferreira (2009) find that the overall effect of gender diversity on firm performance is negative and suggest that mandating gender quotas for directors in the US can reduce firm value for well-governed firms. Conversely, using a sample of the top 500 listed companies in Australia, Vafaei, Ahmed, and Mather (2015) find a positive association between gender diversity on corporate boards and financial performance.

As discussed above, numerous studies have been undertaken to investigate the association between board effectiveness and overall firm performance/firm value. Yet, the results are inconclusive as for the direction of the effects. There are two plausible explanations about the inconclusiveness of the findings: endogeneity (Bhagat & Black, 1999; Hermalin & Weisbach, 2003; Brown, Beekes, & Verhoeven, 2011) and theoretical/methodological issues (Huse, 2005; Roberts et al., 2005; Minichilli et al., 2009; Pugliese et al., 2009).

Accounting and finance literature generally emphasises the endogeneity issue in examining boards' effectiveness in improving firm performance/firm value. While boards may affect firm performance/firm value, the composition and size of boards may be affected by firm performance/firm value. For example, a firm may decide to appoint more independent directors following bad performance. Further, there may be other undetected or uncontrollable factors such as CEO's previous performance affecting both board composition and firm performance/firm value. Researchers have suggested various methods to eliminate or mitigate endogeneity (Larcker & Rusticus, 2010; Brown et al., 2011).

A different explanation comes from the managerial literature. Scholars suggest that the inconclusiveness of findings on board effectiveness and firm performance/firm value are due to researchers' theoretical and methodological choices (Daily et al., 2003; Hermalin & Weisbach, 2003; Roberts et al., 2005; Minichilli et al., 2009). They conclude that research on boards has been over-reliant on agency theory which is based on the

assumption that managers are self-interested and opportunistic. Agency theory ignores the cooperative potentials of agency and frequent isomorphism between managers' and shareholders' interest. This theoretical choice leads researchers to take a narrow view of boards as monitors while they have a broader, more inclusive role as strategic decision makers. Therefore, scholars call for theoretical pluralism in studies of boards. Following their suggestion, this study examines board effectiveness relying on agency theory, resource dependence theory, and Forbes and Milliken's (1999) theoretical model.

Management scholars also argue that researchers' attempts to directly link attributes of boards to firm performance/firm value may be problematic because there are potentially large number of intervening variables between the board and firm performance/firm value (Roberts et al., 2005). They suggest including dynamics of board behaviours and processes besides boards' demographic features when studying board effectiveness (Forbes & Milliken, 1999; Minichilli et al., 2009). Accordingly, this study attempts to capture board processes in firm investment decision-making when investigating board attributes that may affect board processes, such as board size, board activity, knowledge and skills and board tenure.

2.2.3 Boards' role in monitoring managers

Boards' monitoring role reflects investors' needs for boards to monitor management to eliminate or minimise managerial misbehaviour and opportunism (Huse, 2005). Guided by agency theory, success in this role is largely achieved through increasing

independence in boards and various committees to resist managerial dominance (Jensen & Meckling, 1976; Fama & Jensen, 1983).

Some studies investigate CEO turnover to evaluate boards' monitoring ability because firm performance generally improves following a CEO turnover, especially a forced turnover (Denis & Denis, 1995). The literature shows that CEO turnover-firm performance sensitivity is higher in outside director dominant firms than insider director dominant firms (Weisbach, 1988). Outsider-dominated boards are more likely than insider-dominated boards to replace a CEO with someone from outside the firm (Borokhovich, Parrino, & Trapani, 1996; Huson, Parrino, & Starks, 2001). Further, smaller boards are more effective overseers of the CEO than larger boards (Yermack, 1996).

Another group of research studies boards' role in setting and overseeing firms' policies for compensating management. Core, Holthausen, and Larcker (1999) suggest that firms with weaker governance structures and a lack of board involvement tend to pay their CEOs more. Interestingly, Hermalin and Weisbach's (1988) model predicts that a successful CEO can effectively bargain both for less board scrutiny and greater compensation. Consistent with this model, Choe, Tian, and Yin (2014) find that CEO pay is positively associated with managerial bargaining power. Kim, Mauldin, and Patro (2014) find that outsider directors' ability to monitor CEO excess compensation is positively related to directors' tenure.

Researchers also investigate earnings management to evaluate board effectiveness in

monitoring. As management has an incentive to manage earnings to maximise their performance related compensation, effective boards are expected to reduce the level of earnings management. Klein (2002a) finds that audit committee and board independence reduce abnormal accruals and suggests that boards structured to be more independent of the CEO are more effective in monitoring the corporate financial accounting process. Similarly, Davidson, Goodwin-Stewart, and Kent (2005) find that the independence of the board and its audit committee has an inverse relationship with the level of earnings management among Australian firms. Xie, Davidson Iii, and DaDalt (2003) suggest that the frequency of board and audit committee meetings and audit committee members' financial expertise are important factors in constraining the propensity of managers to engage in earnings management. Badolato, Donelson, and Ege (2014) examine the joint effects of audit committee financial expertise and status on earnings management. Using directors' contemporaneous directorships and degrees from elite institutions to measure their status, they find that audit committees with both financial expertise and high relative status are associated with lower level of earnings management, as measured by accounting irregularities and abnormal accruals.

In summary, prior research has examined boards' monitoring role extensively and reached a consensus that more independent boards are more effective in monitoring management. Boards' monitoring performance is also affected by board size, management bargaining power, the busyness of directors and directors' expertise. Apart from the monitoring role, boards also play an important role in advising and making

strategic decisions. The next section provides a review of studies on boards' role in advising and strategic decision-making.

2.2.4 Boards' role in strategic decision-making

Some researchers argue that boards' most important role is participating in firms' strategic decisions (Demb & Neubauer, 1992; Stiles & Taylor, 1996; Lawler Iii et al., 2002; Roberts et al., 2005). Boards work as partners of top management and create value through advising and counselling, networking and lobbying, and making investment decisions. Prior studies on boards' role in strategic decision-making either examine their general advisory role or focus on firm investment decisions.

Field et al. (2013) suggest that although busy directors may be less effective monitors, their experience and contacts arguably make them excellent advisors. They find busy boards to be common and to contribute positively to firm value to IPO firms, because these firms have minimal experience with public markets and are likely to rely heavily on their directors for advising. Their results indicate that these positive effects of busy boards extend to all but the most established firms, which are likely to require more monitoring than advising.

There is another research stream studying actions of boards during takeover events and evaluating relative merits of different kinds of directors. Shivdasani (1993) finds that when outside directors have more additional directorships, it is less likely that the firm

will be acquired in a hostile takeover. Cotter, Shivdasani, and Zenner (1997) suggest that, in the situation where a firm is being acquired, outside directors do a better job of negotiating on behalf of shareholders than do insiders. Moeller (2005) finds that in a friendly takeover environment, target firms with higher fractions of outside directors on boards receive higher takeover premiums.

Besides examining boards' general advisory roles, more research on boards' role in strategic decision-making focuses on their influence on firms' investment activities. One type of investment activity that has been studied extensively is acquisition. Byrd and Hickman (1992) find that upon the announcement of an acquisition, the stock price drops less for firms where the majority of directors on the board are independent than for firms where less than half the directors are independent. This finding indicates that the market perceives firms with independent boards as making better acquisitions (or at least fewer bad ones). Desai et al. (2005) examine the effects of outside board monitoring on acquisition outcomes for firms with different control structure: manager-controlled, owner-controlled and owner-manger-controlled. They find that outside board monitoring influences the economic outcomes of acquisitions of manager-controlled enterprises, but not the outcomes of owner-controlled or owner–manager-controlled firms. Walters et al. (2007) explore how the interaction of CEO tenure and board independence affects returns to shareholders arising from acquisition announcements. They find that in the absence of a vigilant board, CEO tenure is positively associated with performance at low to moderate levels of tenure, and negatively associated with performance when tenure

further rises to substantial levels. In the presence of a vigilant board, however, shareholder interests can be advanced even at high levels of CEO tenure. Huang et al. (2014) find that firms with investment bankers on the board have a higher probability of making acquisitions. Furthermore, acquirers with investment banker directors experience higher announcement returns, pay lower takeover premiums and advisory fees, and exhibit superior long-run performance. The results suggest that directors with investment banking experience help firms make better acquisitions, both by identifying suitable targets and by reducing the cost of the deals.

Prior studies also show that boards play an important role in making decisions about R&D investment. Baysinger, Kosnik, and Turk (1991) examine the extent to which the percentage of outside directors on a corporation's board, the concentration of equity ownership, and the roles of individual and institutional stockholders influence the company's R&D strategy. They find that high insider representation on a board and a concentration of equity among institutional investors positively affects corporate R&D spending. Kor (2006) examines the effects of top management team composition and board outsider composition, as well the interaction of the two factors, on R&D intensity. Testing on a longitudinal sample of technology-intensive firms that completed an IPO, they find that both top management team composition and board composition have direct and additive effects on R&D investment intensity. Specifically, firms opt for lower levels of R&D investment intensity when their outsider-rich board interacts with a team of managers who have high levels of firm tenure, shared team-specific experience, or

functional heterogeneity. Furthermore, monitoring by outsider directors does not constitute a universally effective governance mechanism with regard to a firm's R&D investment strategy. Chen (2014) examines the effect of board capital and the moderating effect of CEO power on R&D investment based on resource dependence theory. Sampling on a panel of electronics firms in Taiwan, the results indicate that board capital, measured by directors' educational level, directors' industry-specific experience, and interlocking directorate ties, has a positive effect on R&D investment and the effect is more pronounced when powerful CEOs are present.

Most studies on boards' role in firm investment decisions rely on agency theory and focus on the effect of board independence. This simplistic view of boards ignores other important attributes of directors such as their knowledge and skills as well as their professional and social links, which have been suggested by Chen (2014) as important features to make boards effective in their decision-making tasks. Moreover, the empirical evidence on boards' involvement in firm investment decision-making only covers acquisitions and R&D investments, without taking into account of capital expenditures. Without including capital expenditures, prior studies do not capture all the firm investment activities because acquisitions are only episodic and R&D investments only represent firms' innovative activities. Therefore, these studies do not provide comprehensive insights into boards' role in firm investment decision-making. To address these issues, this study uses a number of board attributes to measure board effectiveness relying on a various theories, and adopts a measure of overall investment performance,

namely firm investment efficiency, to examine boards' effectiveness in investment decision-making. The next section provides a review of firm investment efficiency literature.

2.3 Firm investment efficiency

Efficient firm investments are critical to firm growth and profitability. Investment theory suggests that in a perfect capital market, firms would invest in all the projects with positive net present value to maximise their value (Modigliani & Miller, 1958). However, frictions in the real world that result from information asymmetries and agency problems may affect firms' investment decisions and eventually lead to inefficient investment, either over-investment or under-investment (e.g. Myers & Majluf, 1984; Jensen, 1986).[2] This section reviews prior theoretical and empirical studies on firm investment efficiency. Section 2.3.1 discusses frictions caused by information asymmetries between capital providers and management. Section 2.3.2 reviews the literature related to frictions arising from agency problems. Section 2.3.3 reviews studies on mechanisms improving firm investment efficiency.

2.3.1 Information asymmetries and firm investment decisions

One typical source of capital market frictions is information asymmetries between

[2] There are other forms of market frictions that may also cause inefficient investment, such as transactions costs, taxes and regulations, asset indivisibility, and non-traded assets (DeGennaro & Robotti, 2007). They are not relevant to this study therefore are not discussed here because boards would not have much effect on them.

managers and capital providers. Information asymmetries may cause two types of commonly recognised capital rationing, moral hazard and adverse selection (Darrough & Stoughton, 1986). Moral hazard arises when the action undertaken by the agent is unobservable and has a differential value to the agent as compared to the principal (Darrough & Stoughton, 1986). This model assumes capital providers may reduce the amount of capital supplied *ex ante* due to information asymmetries between managers and them, and their' inability of monitoring managers' behaviour effectively.

Adverse selection, as the second type of capital rationing, arises when the managers have more information than investors as potential capital providers (Darrough & Stoughton, 1986). This model is proposed by Myers and Majluf (1984), assuming that managers act in the best interest of current shareholders. In this model, managers have more and accurate information than investors about a firm's prospects, and they tend to try to sell overpriced securities. Investors will judge the situation rationally and may be reluctant to provide capital at the inflated price. As a result, management of firms with a profitable project may choose not to issue new securities rather rely on internal funding.

In both situations of adverse selection and moral hazard, information asymmetries cause a reduction in the amount of external capital supplied to firms, and make their cash position matter in investment decisions. Firms that cannot generate enough cash internally may be forced to forgo a valuable investment opportunity, and hence under-invest. A large body of empirical research supports the association between market imperfection and investment by providing evidence that controlling for investment

opportunities, firms with more cash on hand and lower debt burdens invest more (Hubbard, 1998; Stein, 2003; Hugonnier, Malamud, & Morellec, 2015).

2.3.2 Agency problems and firm investment decisions

A second type of friction arises from agency problems when agency managers are self-interested and may not always act in the best interests of shareholders (Jensen & Meckling, 1976). A variety of models has been developed in the finance literature to illustrate investment inefficiency caused by agency problem. These models include empire building, reputational and concerns, a quiet life, and overconfidence (Stein, 2003).

Empire building

Managers may pursue perquisite consumption and ‘‘empire building’’ (i.e. an excessive taste for running large firms) rather than returning excess cash to investors, leading to over-investment. Empire building preferences will cause managers to spend essentially all available funds on investment projects, which leads to the prediction that investment will be increasing with internal resources (Jensen, 1986).

The literature has provided empirical evidence to support Jensen’s (1986) proposition. For example, Blanchard, Lopez-de-Silanes, and Shleifer (1994) document excessive investment and acquisition activity for eleven firms that experience a large cash windfall due to a legal settlement. Harford (1999) finds that cash-rich firms are more likely than

other firms to attempt acquisitions and the acquisitions are value decreasing. Moreover, cash-rich firms are more likely to make diversifying acquisitions that are less likely to attract other bidders and are followed by abnormal declines in operating performance. Using an accounting-based framework to measure both free cash flow and over-investment, Richardson (2006) finds a positive association between over-investment and free cash flow for firms with positive free cash flow for a large sample of 58,053 firm-years during the period from 1988 to 2002. He suggests over-investment of free cash flow is a systematic phenomenon across all types of investment expenditure.

Reputational and career concerns

Management may decide to over- or under-invest out of reputational and career concerns. (Stein, 2003). For example, managers who wish to promote their labour-market reputation may have incentives to take actions that boost short-term earnings or stock prices. Thus, they may try to increase reported earnings by underinvesting in hard-to-measure assets, such as maintenance, customer loyalty and employee training (Narayanan, 1985). Further, managers may try to build their reputations by avoiding risky investment, especially when firms are under financial stress (Hirshleifer & Thakor, 1992). In contrast, when investors can observe long-run investments but not their productivity, managers may over-invest to demonstrate their ability to generate good investment opportunities (Bebchuk & Stole, 1993).

Managers with career concerns may also exhibit an excessive tendency to “herd” in their investment decisions, with any given managers ignoring their own private information

about payoffs, and blindly copying the decisions of previous movers (Scharfstein & Stein, 1990). Consequently, managers may invest in projects with negative NPV. Beatty, Liao, and Yu (2013) provide indirect evidence for herding. They investigate how high-profile accounting frauds affect peer firms' investment and find peers react to the fraudulent reports by increasing investment during fraud periods and peers' investments increase in fraudulent earnings overstatements.

The quiet life

Bertrand and Mullainathan (2000) consider another form of agent conflict whereby managers prefer the "quiet life", by avoiding making tough decisions. On the one hand, this can lead to something that looks much like empire-building over-investment, if the decision at hand is whether to shut down an existing, poorly-performing plant. On the other hand, it can also lead to under-investment if the decision concerns whether to enter a new line of business.

Overconfidence

Roll (1986) argues that managerial "hubris" can explain a particular form of over-investment, which is the overpayment by acquiring firms in takeovers. This argument is supported by Malmendier and Tate (2008), who find overconfident CEOs over-estimate their ability to generate returns. Consequently, they overpay for target companies and undertake value-destroying mergers.

Sections 2.3.1 and 2.3.2 have discussed some market frictions related to information

asymmetries and agency problems. Theoretical models and empirical evidence for possible consequences (over- or under- investment) of these market frictions' effects on managers' investment decisions are also discussed. The next section reviews prior studies on mechanisms that improve firm investment efficiency.

2.3.3 Mechanisms improving firm investment efficiency

Prior studies find that certain institutional features may improve firm investment efficiency. These institutional features include governance mechanisms, financial reporting quality and information environment.

Many theoretical studies suggest that corporate governance mechanisms deal with agency problems and help facilitate efficient investment decisions (Jensen, 1986, 1993; Bertrand & Mullainathan, 2003). Empirical studies also provide evidence to support the contention that effective monitoring mechanisms improve firm investment efficiency. Chen and Chen (2012) find that diversified firms with more effective internal or external governance mechanisms experience more efficient investment allocations at both the firm and segment levels and show less diversification discount. They suggest that an effective governance structure driving capital allocation efficiency is featured with high board independence, low board busyness, high institutional ownership, high outside director ownership, high CEO equity-based pay, high audit quality and strong shareholder rights. Attig et al. (2012) provide empirical evidence that institutional investors with longer investment horizons have greater incentives and efficiencies to

engage in effective monitoring, which mitigates information asymmetries and agency problems, and in turn improves firm investment efficiency. Using data from Taiwan between 2008 and 2010, Li and Liao (2014) find better corporate governance mechanisms, such as director ownership, institutional shareholdings and insurer monitoring, help mitigate the over-investment problems caused by directors' and officers' directors and officers liability (D&O) insurance. Eisdorfer, Giaccotto, and White (2013) suggest that compensation structure with a lower gap between executive compensation leverage ratio and the firm leverage ratio can reduce agency costs by improving investment efficiency.

In relation to financial reporting quality, researchers argue that higher quality of financial reporting reduces information asymmetries between managers and capital providers. The lower information asymmetries enable capital providers to monitor better firms' investment decisions to limit over-investment. They also reduce under-investment through mitigating moral hazard and adverse selection issues. Some empirical studies examine the relationship between investment efficiency and financial reporting quality and find evidence supporting the above argument. For example, Biddle and Hilary (2006) find that firm investment-cash flow sensitivity is negatively associated with financial accounting quality. Biddle et al. (2009) find that high financial reporting quality reduce both over- and under- investment. Chen et al. (2011) examine the role of financial reporting quality in private firms from emerging markets and find similar results. Ramalingegowda, Wang, and Yu (2013) find that high-quality financial reporting

mitigates the conflict between firms' investment and dividend decisions and thereby reduces the likelihood that firms forgo valuable investment projects to pay dividends. Other studies investigate the impact of certain events on firm investment efficiency and draw the same conclusion. For example, using a sample of 420 companies listed on the Taiwan Stock Exchange, Hsu, Jung, and Pourjalali (2015) find a significant increase in firm investment efficiency after the adoption of International Accounting Standard (IAS) 27 *Consolidated and Separate Financial Statements*. They conclude that IAS 27 discourages firms' ability to manage earnings through the use of unconsolidated entities and reduces information asymmetry between managers and shareholders. Cheng, Dhaliwal, and Zhang (2013) examine the investment behaviour of a sample of US firms that disclosed internal control weaknesses under the Sarbanes-Oxley Act. They find that prior to the disclosure, these firms under-invest when they are financially constrained and over-invest when they are not financially constrained. After the disclosure, these firms' investment efficiency improves significantly.

Other than governance mechanisms and financial reporting quality mentioned above, firm investment efficiency can also be improved by the information environment of the firm. Large amounts and good quality of information enable investors to better understand firms' financial position and encourage them to provide capital. A better information environment also helps managers make better investment decisions. For example, Chen, Young, and Zhuang (2013) examine the externalities of mandatory International Financial Reporting Standards (IFRS) adoption on firms' investment

efficiency in 17 European countries. They find that increased disclosure by firms' foreign and domestic peers after the IFRS adoption has a spill-over effect on a firm's investment efficiency. Badertscher et al. (2013) argue that greater public firm presence in an industry reduces uncertainty in that industry because of the rich information provided by public firms and information intermediaries. They find that private firms are more responsive to their investment opportunities when they operate in industries with greater public firm presence.

In summary, the literature provides evidence that certain factors can drive managers to make better investment decisions. However, the effect of boards on firm investment efficiency is underexplored. As the formal link between the shareholders of a firm and the managers entrusted with the day-to-day functioning of the organisation, boards are directly involved in firm investment decision-making process. If boards are effectively executing their roles in strategic decision-making, they are expected to improve firm investment efficiency. The next section discusses the link between boards and firm investment efficiency and develops seven testable hypotheses.

2.4 Board of director's attributes and firm investment efficiency

As strategic decision makers, boards are involved in different stages of firms' investment decision-making process and have a direct influence on firms' investment decisions. Directors can exercise their influence in the early decision process through advising and consulting, to shape the preparation of capital investment proposals by management. At

the end of the capital investment decision process, directors control the decisions by accepting, rejecting or referring back to management to modify the capital investment proposals. More importantly, as a continuous process of influence, boards develop the context for strategic debate, establish a methodology for strategy development, monitor strategy content, and control the conduct of management about strategy (McNulty & Pettigrew, 1999).

The involvement of boards in strategy is consistent with agency theory that treats boards as an important mechanism of corporate control. As discussed above, boards can exert a controlling influence over executive management in different stages of decision-making. According to agency theory, effective boards can detect and deny managers' sub-optimal investment proposals caused by agency problems such as empire building, short-termism, quiet life, herding and overconfidence, and hence reduce both over- and under-investment. For example, by voting against negative NPV projects or high-risk projects, boards can limit management's ability to empire build and restrain over-investment (Desai et al., 2005). Boards may also limit under-investment to prevent managers' short-termism by encouraging long-term value-adding investment projects such as R&D (Kor, 2006). Boards' effective monitoring also facilitates better financial reporting quality (Xie et al., 2003) and reduces information asymmetries between management and shareholders (Kanagaretnam, Lobo, & Whalen, 2007), hence indirectly improve firm investment efficiency.

Boards' involvement in investment decision-making is also consistent with resource

dependence theory, which demonstrates that resources brought by boards to firms can affect firm investment. Apart from monitoring management, directors also work with management to shape best investment decisions with their knowledge and skills as well as links to the external environment. For example, directors with wide professional and social links will have better ability to identify investment opportunities and initiating investment proposals, encourage investment even when the firm is in financial constraint, and hence limit under-investment (Chen, 2014). Directors' extensive industry experience and functional expertise also enable them to make better decisions when choosing between investment alternatives and help management make better judgments (Huang et al., 2014). Further, directors with a good reputation and credibility will boost investors' confidence in firms' investment decision, mitigate adverse selection problem, and reduce under-investment (Musteen, Datta, & Kemmerer, 2010).

The board processes as suggested by Forbes and Milliken's (1999) model demonstrate good board practices that contribute to board effectiveness in investment decision-making. Consistent with the proposition about effort norms in Forbes and Milliken's (1999) model, empirical evidence supports that board members' commitment is a importance factor that positively affects board performance in all of their tasks (Minichilli et al., 2009). In the processes of investment decision-making, the time and efforts that boards devote to their tasks help them achieve effective advising, monitoring and strategic management. Cognitive conflict captures the critical debates between board members on investment proposals and alternatives (Minichilli et al., 2009). Boards may

question and challenge management's proposals, and request management to explain, justify, and possibly modify their position on important issues (Forbes & Milliken, 1999). This process leads to more careful consideration of investment proposals and hence may improve investment efficiency. The presence and use of knowledge and skills is the third process proposed by Forbes and Milliken's (1999) model that contributes to board effectiveness in strategic decision-making. This proposition is consistent with the view of resource dependence theory that boards' functional knowledge and firm specific knowledge can both affect firm investment decisions (Huang et al., 2014; Kim et al., 2014).

This study uses seven attributes to measure boards' effectiveness in their role of improving firm investment efficiency. These attributes affect boards' strategy involvement and strategic decision-making as suggested by the literature (e.g. Forbes & Milliken, 1999; Walters et al., 2007; Chen & Chen, 2012; Chen, 2014; Kim et al., 2014). They are board size, board knowledge and skills, board independence, multiple directorships, board activity, board tenure and directors' shareholdings. The rest of this section discusses how each of these attributes affects firms' investment efficiency and develops testable hypotheses.

2.4.1 Board size

Board size refers to the number of board members. There are conflicting views as to the effect of board size on board monitoring performance and firm performance. Agency

theory suggests that larger boards will be better monitors because a greater number of people will be reviewing management actions (Klein, 2002b). Resource dependence theory also argues that a larger board brings more links and more access to resources hence better firm performance (Kiel & Nicholson, 2003). However, a different view is taken when considering boards as decision-making groups. Forbes and Milliken's (1999) model proposes that smaller boards work better as strategic decision makers because smaller boards are more effective in information exchange and are easier to coordinate.

The conflicting theoretical perspectives are reflected in the empirical results on the association between board size and board performance. Yermack (1996) and Eisenberg et al. (1998) find larger boards relate to lower firm value in large and small US firms respectively. Their results suggest that coordination and communication issues in large boards may prevent directors from performing effectively in their roles (Eisenberg et al., 1998). The benefits brought by adding more board members (as suggested by agency theory and resource dependence theory) may not be justified by the additional costs involved (Yermack, 1996). Mak and Kusnadi (2005) support the negative association between board size and firm performance with their study on a sample of Singapore and Malaysian companies. In regards to board monitoring performance, Yermack (1996) suggests that smaller boards are more effective in monitoring because CEO performance incentives through compensation and the threat of dismissal become stronger as board size decreases. Beasley (1996) finds that when board size decreases, the likelihood of financial statement fraud decreases. Core et al. (1999) find excessive CEO compensation

is positively related to board size. Vafeas (2000) finds that earnings of firms with a smaller board are perceived as being more informative by market participants, which indicates better financial reporting quality.

In contrast to the empirical results that suggest smaller boards are more effective, Kiel and Nicholson (2003) find that board size is positively associated with both firm performance and firm value. Xie et al. (2003) report that larger boards may be more effective in mitigating earnings management because firms with larger boards have lower discretionary accruals. They argue that larger boards may have more experience and therefore be a better mechanism for improving financial reporting quality.

Consistent with Forbes and Milliken's (1999) model and the majority of empirical findings, this study expects that smaller boards work better as strategic decision makers. This view is also consistent with the results reported in a recent study of Gonzalez and Andr é (2014) that smaller boards make better investment decisions and are associated with lower levels of firms' short-term risk. If smaller boards are more effective in investment decision-making, they are expected to reduce both over- and under-investment.

H1: Smaller boards are more effective in reducing over-investment and under-investment.

2.4.2 Knowledge and skills

Boards need a high degree of specialised knowledge and skills to function effectively. This study uses directors' functional knowledge diversity as a proxy for board knowledge and skills. As proposed by Forbes and Milliken's (1999) model, the presence and use of diversified knowledge and skills enable boards' effective strategic decision-making. Prior research also suggests that more functional diversified teams are better linked to external networks and possess knowledge and perspectives with more breath, therefore, can make better quality decisions (Milliken & Martins, 1996).

The effects of directors' knowledge and skills to board monitoring performance are demonstrated in empirical studies. For example, Xie et al. (2003) find that audit committee members' financial expertise is an important factor in constraining earnings management. Badolato et al. (2014) find that audit committees with both financial expertise and high relative status can reduce earnings management.

Studies have also shown that directors' knowledge and skills help them to make better investment decisions. Huang et al. (2014) find that directors' investment banking experience help firms to achieve better acquisition performance through identifying suitable takeover targets and lowering acquisition costs. Chen (2014) suggests that directors' education level and industry-specific experience have a positive effect on R&D investment to enhance firms' innovative capabilities.

Although most research supports the contention that functional knowledge diversity has a

positive impact on team decision-making, some research suggests that more functionally diversified teams may suffer from larger "process losses" than less functionally diverse team (Cannella Jr, Park, & Lee, 2008). "Process losses" refer to the interaction difficulties that prevent groups from achieving their full potential (Forbes & Milliken, 1999). Bunderson and Sutcliffe (2002) suggest that functional knowledge diversity reduces information sharing and has a negative impact on team performance. It is suggested that the differences among members characterizing a diverse top management team can slow the speed of decision-making and are often associated with dysfunctional conflict (Chatman & Flynn, 2001; Harrison et al., 2002).

Consistent with Forbes and Milliken's (1999) model, this study expects that boards with broad knowledge and skills are more effective in making investment decisions. This expectation is also supported by agency theory and resource dependence theory. Based on agency theory, directors' knowledge and skills enable them to detect managers' self-interested conduct in firm investment proposals, such as negative NPV projects for the purpose of empire building, or under-investment in employee training due to short-termism. Further, directors' financial expertise is positively associated with better financial reporting quality, which can indirectly improve firm investment efficiency by reducing information asymmetries between managers and capital providers. According to resource dependence theory, directors with extensive industry and functional expertise can work with managers to identify good investment opportunities, and encourage investment even when firms are financially constrained. Therefore, it is predicted that:

H2: Boards with more diversified knowledge and skills are more effective in reducing over- and under-investment.

2.4.3 Board independence

Agency theory suggests that the role of boards in corporate governance is to monitor management to protect the shareholders' interest. Independent directors who share no interests with managers are in a better position to monitor directors than insider directors. Therefore board independence, measured by the proportion of independent directors on the board, is an important factor that may affect the monitoring function (Fama & Jensen, 1983).

Empirical studies generally agree that higher board independence level is associated with better monitoring performance. Firms with more independent boards perform better in CEO turnover (Weisbach, 1988; Borokhovich et al., 1996; Huson et al., 2001), restraining excess CEO compensation (Core et al., 1999; Kim et al., 2014), and ensuring financial reporting quality (Klein, 2002a; Xie et al., 2003; Davidson et al., 2005). Boards' monitoring role also contributes to firm investment decisions. For example, Desai et al. (2005) and Walters et al. (2007) find that outside board monitoring influence the economic outcomes of acquisitions in a positive way. Further, some studies report a positive association between board independence and firm performance/firm value (Rosenstein & Wyatt, 1990; Brickley et al., 1994; Kiel & Nicholson, 2003).

However, some prior studies find contradictive results against the effectiveness of independent boards. Baysinger et al. (1991) and Kor (2006) find that high insider representation on a board positively affects corporate R&D spending and R&D intensity. In relation to firm performance, some studies find board independence is negatively associated with firm performance (Yermack, 1996; Klein, 1998; Christensen et al., 2010). Bhagat and Black (2002) find that firms with more independent boards do not perform better than other firms. These studies argue that inside directors have greater firm-specific knowledge than independent directors and their superior knowledge leads to better decision-making therefore less independent boards may be associated with better firm performance (Fama & Jensen, 1983; Klein, 1998; Christensen et al., 2010).

Despite the mixed findings in the literature, this study expects a positive relationship between board independence and firm investment efficiency, based on agency theory. Independent directors are more effective than non-independent directors in monitoring mangers' behaviours in investment decision-making. Firms with more independent boards are expected to make better investment decisions in line with shareholders' value. Moreover, board independence is positively associated with firm financial reporting quality (Klein, 2002a), which can indirectly improve investment efficiency through reducing information asymmetries between managers and capital providers (Biddle & Hilary, 2006; Biddle et al., 2009). Therefore, it is predicted that:

H3: More independent boards are more effective in reducing over-investment and under-investment.

2.4.4 Multiple directorships

Multiple directorships refer to the situation when a director holds more than one directorship. Opposite views are held by agency theory and resource dependence theory as to the effect of multiple directorships on board performance. According to agency theory, overcommitted directors might not have their interests aligned with shareholders'. In particular, multiple directorships may result in directors being too busy to focus on maximising shareholders' wealth. However, according to resource dependence theory, directors add value to firms by bringing linkages, valuable information, skills, and other resources to the firm (Hillman et al., 2000). The directors who hold more directorships may have better intelligence, experience, and skills, which make them more popular for firms hiring directors (Cook & Wang, 2011). They may also have more social links as a result of the multiple directorships they hold (Field et al., 2013). Therefore, the more directorships held by boards, the better the boards can perform in a resource dependence role.

Prior studies find that multiple directorships have significant impact on firms' investment decisions. Ahn, Jiraporn, and Kim (2010) find that acquiring firms where directors hold more outside directorships experience more negative abnormal returns around the announcements of mergers and acquisitions. Chen and Chen (2012) suggest that board multiple directorships are negatively associated with capital allocation efficiency in diversified US firms. However, Chen (2014) finds that directors' interlocking directorate ties have a positive effect on R&D investment.

Both theories and empirical findings suggest the presence of multiple directorships is an important attribute of boards and may affect firms' investment decisions. This study takes the view point of resource dependence theory that directors with multiple directorships may help firms to acquire essential resources and diminish uncertainty in investment activities for three reasons. Sitting on the boards of several firms simultaneously permits directors to observe the decision-making process and the consequences of those decisions, and thus enables them to develop a comprehensive view of strategic and management issues and to generate innovative alternatives and solutions (Carpenter & Westphal, 2001). Further, multiple directorships provide directors with timely information about environmental events and trends (Kor & Sundaramurthy, 2009), as well as the viability and potential of alternative projects (Dalziel et al., 2011), and thus lessening the impact of uncertainty in the investment environment (Haynes & Hillman, 2010). Last, well-connected directors may facilitate access to financial resources outside the firm and thus reduce investment risks resulting from financial constraints (Hillman & Dalziel, 2003). Based on the above discussion, this study predicts that boards with more multiple directorships perform better in improving firm investment efficiency.

H4: Boards with more outside directorships are more effective in reducing over- and under-investment.

2.4.5 Board activity

The literature suggests that a higher level of board activity is associated with better board

performance. Board activity is commonly proxied by the frequency of board meetings, which are the formal occasions that directors interact with board members, exchange information, and opinions and make strategic decisions for the firms. Lipton and Lorsch (1992) argue that one common problem that restricts the effectiveness of the board is the lack of time to fulfil its responsibilities. They suggest boards should have an adequate number and length of the meetings to allow directors to carry out their functions.

Prior empirical studies find a positive effect of more frequent board meetings on firm performance or monitoring performance. Vafeas (1999) and Brick and Chidambaran (2010) find that board activity has a positive impact on firm performance and firm value. Anderson et al. (2004) and Lorca, Sánchez-Ballesta, and García-Meca (2011) find that firms' cost of debt is negatively associated with board meeting frequency. Xie et al. (2003) find that the frequency of board meetings is negatively associated with discretionary accruals, indicating more active boards can execute better their monitoring role.

In Forbes and Milliken's (1999) model, the effort put into performing their tasks by boards, such as preparation, participation, and analysis, are positively related to decision-making performance. This study uses board meeting frequency to proxy for boards' effort. It is anticipated that when boards meet more frequently, they have more time to monitor managers' investment behaviour and discuss proposed investment projects, and in turn be able to reduce both over- and under-investment.

H5: Boards meet more frequently are more effective in reducing over-investment and

under-investment.

2.4.6 Board tenure

Board tenure is the average number of years that directors have served on a firm's board. Some prior studies suggest long board tenure may lead to strategic persistence which deteriorates firms' ability to respond to environmental changes because greater tenure is associated with greater rigidity and increased insulation toward new ideas (Katz, 1982). This argument is supported by empirical findings that top management team tenure is negatively associated with strategic change, especially for firms with poor organizational performance (Finkelstein & Hambrick, 1990; Boeker, 1997). In addition, Vafeas (2003) argues that when directors server too long on a board, their independent status may be compromised, which may lead to less effective monitoring.

However, it is also argued that directors with longer tenure are able to acquire a high level of firm-specific knowledge and skills (Forbes & Milliken, 1999). The knowledge allows them to understand the operation, competition environment, and business opportunities of the firm. According to resource dependence theory, directors' firm-specific knowledge is a precious resource that directors possess, and it helps them make better judgements in identifying investment opportunities and providing better advice to managers in making investments (Hillman & Dalziel, 2003). For example, the board may make better decisions regarding diversification or acquisition if they have a detailed understanding of how new and existing businesses would complement one

another (Forbes & Milliken, 1999). According to agency theory, directors' firm-specific knowledge enhances their ability to monitor (Hillman & Dalziel, 2003). In the case of making firm investment decisions, the knowledge enables directors to evaluate better managers' investment proposals and deny those that may impair shareholders' value. Besides acquiring firm-specific knowledge and skills, long board tenure also reflects a high level of cohesiveness of a board, which encourages knowledge sharing and motivates directors to get involved in group decision-making, and hence leads to an effective board (Forbes & Milliken, 1999).

Consistent with theoretical arguments above, Golden and Zajac (2001) find that board tenure is positively associated with strategic change when average director tenure is less than 15 years. Kim et al. (2014) find that outside directors' tenure is positively associated with firm acquisition/investment policy advising performance and CEO compensation monitoring performance.

In sum, board tenure is found to be a board attribute that significantly affects board performance in their monitoring, advisory, and strategic roles. Boards with longer director tenure are expected to be more effective in investment decision-making, by both monitoring managers' investment behaviour and giving them better investment advice. Therefore, it is predicted that:

H6: Boards with longer average director tenure are more effective in reducing over-investment and under-investment.

2.4.7 Director shareholdings

The effect of director shareholdings on board effectiveness is grounded in agency theory. According to Jensen and Meckling (1976), the alignment of the interests of directors and shareholders may be achieved with the directors' holding shares. In this way, directors are encouraged to pursue activities in the interest of the firms' welfare.

Consistent with this argument, Yermack (2004) shows that greater performance incentives for outside directors, such as equity and stock options, significantly enhance firm performance. Chen and Chen (2012) find that firms with higher director ownership are more likely to make investment decisions that benefit shareholders. Bhagat and Bolton (2013) find that the dollar value of director stock ownership is positively related to operating performance and the probability of disciplinary CEO turnover when firm performance is poor. They also find that firms with greater director shareholdings are less likely to engage in a value-destroying activity such as acquisitions.

Based on the above discussion, directors with more shareholdings have more incentives to monitor managers' misconduct in investment decision-making, and firms with greater board shareholdings make better investment decisions consistent with shareholder value. Therefore, it is predicted that:

H7: Boards with more director shareholdings are more effective in reducing over-investment and under-investment.

2.5 Summary

This chapter summarises the theories and empirical studies that are relevant to this study. Specifically, the literature review first discusses the theories and empirical studies on boards' roles. Then it presents some theoretical models and empirical evidence of capital market frictions that impair firm investment efficiency. Based on the theories and prior literature, the chapter presents the argument that leads to the development of the seven testable hypotheses examining the relationship between board effectiveness and firm investment efficiency.

CHAPTER 3: RESEARCH DESIGN

3.1 Introduction

This chapter discusses the research method used in this study. Section 3.2 explains the regression model. Section 3.3 and Section 3.4 discuss the definitions and measures of the dependent variable and independent variables, and Section 3.5 discusses the control variables. Finally, Section 3.6 summarises the chapter.

3.2 Regression model

This study uses Biddle et al.'s (2009) conditional regression model (Biddle et al.'s (2009) model, hereafter) to study the association between board effectiveness and firm investment efficiency. Biddle et al.'s (2009) model tests the association between firms' investment level (*INVEST*) and board attributes conditioned by the likelihood of the firm to over- or under-invest (*OVERI*), measured by the firm's liquidity ranking. The model assumes that a firm is more likely to over-invest when it has a high level of cash on hand and a low level of leverage. In this circumstance, effective boards would detect the risks of excessive investments and prevent over-investment. Thus board attributes should be negatively associated with *INVEST*, holding all other variables constant. On the other hand, it is expected that a firm is more likely to under-invest when it has a low level of cash on hand and a high level of leverage. For this type of firm, effective boards would

consider the benefit of long-term value-adding and encourage raising extra capital to fund profitable investments. Thus board attributes for effective boards should be positively associated with *INVEST*, holding all other variables constant.

The ordinary least squares (OLS) regression is presented in Equation (1):

$$INVEST_{i,t+1} = \beta_0 + \beta_1 BA_{i,t} + \beta_2 BA_{i,t} * OVERI_{i,t+1} + \beta_3 SUBSHA_{i,t} + \beta_4 SUBSHA_{i,t} * OVERI_{i,t+1} + \beta_5 FRQ_{i,t} + \beta_6 FRQ_{i,t} * OVERI_{i,t+1} + \beta_7 OVERI_{i,t+1} + \sum \gamma_j Control_{j,i,t} + \varepsilon_{i,t+1} \quad (1)$$

Where:

- $INVEST_{i,t+1}$ is investment of firm *i* in year *t+1*;
- $BA_{i,t}$ is a board attribute of firm *i* in year *t*;
- $SUBSHA_{i,t}$ is percentage of ordinary shares held by substantial institutional shareholders of firm *i* in year *t*;
- $FRQ_{i,t}$ is financial reporting quality of firm *i* in year *t*;
- $OVERI_{i,t+1}$ is the likelihood of firm *i* to overinvest in year *t+1*

In Eq. (1), *INVEST* is defined as the level of total investment while *BA* denotes one of the board attributes representing board effectiveness. *OVERI* is a ranked variable (between zero to one) used to distinguish between settings where over- or under-investment is more likely. *OVERI* is increasing with the likelihood of over-investment. *SUBSHA* is the percentage of ordinary shares held by substantial institutional shareholders and *FRQ* is financial reporting quality (*SUBSHA* and *FRQ* are control variables, see section 3.5). *Control* is a set of control variables. Detail discussion on each of these variables is provided in the later sections.

The hypotheses are tested by examining the coefficients β_1 and β_2. For firms that are more likely to under-invest, the value of *OVERI* is low (close to zero), and the effect of

BA on investment is captured by β_1. If boards are effective in encouraging more investment, a positive β_1 is expected.

In contrast, for firms that are more likely to over-invest, the value of *OVERI* is high (close to one), and the effect of *BA* on investment is captured by β_2 on the interaction item *BA*OVERI*. If boards are effective in preventing excessive investment, a negative β_2 is expected. The expected signs of regression coefficients for all the board attributes being investigated in this study are listed in Table 1.

Table 1 – Expected signs for regression coefficients for board attributes

Board attribute	**Regression Coefficient**	**Expected sign**
Board size	β_1	−
	β_2	+
Board independence	β_1	+
	β_2	−
Multiple directorships	β_1	+
	β_2	−
Board activity	β_1	+
	β_2	−
Board tenure	β_1	+
	β_2	−
Knowledge and skill	β_1	+
	β_2	−
Director shareholdings	β_1	+
	β_2	−

3.3 Dependent variable

Taking a balance sheet approach, *INVEST* in a given firm-year is measured as the net increase of property, plant and equipment (*Δ*PPE) and intangible assets including goodwill (*Δ*Intangibles) of the firm during the year, scaled by lagged total assets. This measurement captures capital expenditures, acquisitions and capitalised R&D expenditures. Expensed R&D expenditures should have been included as part of investments because they reflect firms' strategic planning for innovation. However, the figures are not included in the investment measure because data are not available from the database and hand collection is not possible for this project due to time restriction to complete the thesis. *INVEST* for firm *i* in year *t* is computed as following:

$$INVEST_{i,t+1} = \frac{\Delta\text{PPE}_{i,t+1} + \Delta\text{Intangibles}_{i,t+1} + \text{Depreciation \& Amortisation}_{i,t+1}}{Total\ Assets_{i,t}} \quad (2)$$

3.4 Independent variables

There are three sets of independent variables in the regression model as discussed in section 3.2: (1) Board attributes; (2) Likelihood of over- or under-investment *(OVERI)*; and (3) The interaction term of (1) and (2). The measurement of board attributes and the method to construct variable *OVERI* are discussed in Sections 3.4.1 and 3.4.2 respectively.

3.4.1 Board attributes

Board size (SIZE)

Consistent with the literature (Yermack, 1996; Kiel & Nicholson, 2003; Mak & Kusnadi, 2005), this study uses the number of directors on the board to measure board size.[3]

Knowledge and skills (KNOW)

Prior studies measure boards' knowledge and skills differently according to their research questions. Some studies focus on a certain type of expertise such as financial expertise or banking expertise using a dummy variable to indicate the presence of the expertise (Xie et al., 2003; Huang et al., 2014). Other studies use proxies to measure board knowledge and skills, for example, Kim et al. (2014) use board tenure to proxy for directors' firm-specific knowledge and use outside directorships to proxy for directors' business skills. This study focuses on the diversity of expertise on boards and uses the number of different expertise presented on the board to measure board knowledge and skills.

Board independence (INDE)

Prior studies have used the proportion of independent directors on the board as a measure of board independence (Brickley et al., 1994; Christensen et al., 2010). This measure is consistent with the requirement in ASX (2014) Recommendation 2.1 which suggests that the board is independent if the majority of the board comprises independent directors. Consistent with prior studies and ASX recommendations, this study uses the same proxy for board independence.

[3] Some studies measure board size using its log transformation in order to make a more symmetrical distribution as required for ordinary least-square (OLS) regression analysis (e.g. Eisenberg et al., 1998).

Multiple directorships (MULTI)

Several measures of multiple directorships have been used in previous studies. For example, Kiel and Nicholson (2003) measure multiple directorships as the number of additional board positions held by directors. Fich and White (2005) use the reciprocal CEO interlock to proxy for multiple directorships, where reciprocal interlock is defined as the situation in which the CEO of a company sits on the board of another company and the CEO of the second company sits on the board of the first company. A third proxy for multiple directorships can be found in Chen, Dyball, and Wright (2009), as the ratio of the number of directors who hold multiple directorships to the total number of directors. Consistent with Kiel and Nicholson (2003), this study uses the number of additional board positions held by directors, scaled by the number of directors on the board to control for board size. The second measure is not suitable for this study because it only considers CEO interlocks rather than all the board members. The third measure is not used because it does not differentiate a director with one or more external directorships.

Board activity (MEET)

Consistent with prior studies, the number of board meetings in a year is used to measure board activity (Vafeas, 1999; Anderson et al., 2004; Brick & Chidambaran, 2010).

Board tenure (TENU)

Consistent with the literature, this study uses the average tenure of all the directors on the board to measure board tenure (Adams & Ferreira, 2008; Güner, Malmendier, & Tate,

2008; Ahn et al., 2010).

Director shareholdings (DIRSHA)

Directors' shareholdings can be measured by the percentage of shares owned by directors on the board (Chen & Chen, 2012; Gonzalez & Andr é, 2014) or dollar value of director ownership (Yermack, 2004; Bhagat & Bolton, 2013). While both measures reflect directors' incentives for making good decisions, the dollar value measure may be subject to the volatility of share prices. Therefore, this study uses the percentage of shares owned by directors on the board to measure director shareholdings.

The measurements of board attributes discussed above are summarised in Table 2.

Table 2 – Measurements of board attributes

Board Attributes	**Variable**	**Measurement**
Board size	*SIZE*	Number of directors on the board
Knowledge and skills	*KNOW*	Number of different expertise presented on the board
Board independence	*INDE*	Proportion of independent directors on the board
Multiple directorships	*MULTI*	Number of additional board positions held by directors, scaled by board size
Board activity	*MEET*	Number of board meetings in a year
Board tenure	*TENU*	Average tenure of all the directors on the board
Director shareholdings	*DIRSHA*	Percentage of shares owned by directors on the board

3.4.2 Likelihood of over- and under-investment

Following Biddle et al.'s (2009) model, two *ex-ante* firm-specific characteristics are used

to proxy for *OVERI*. They are firm cash balance and leverage (measured by debt to equity ratio). Firm cash balance is selected because firms without cash are more likely to be financially constrained whereas firms with large cash balances are more likely to over-invest (Jensen, 1986; Blanchard et al., 1994; Harford, 1999). Similarly, firms with high levels of leverage are more likely to suffer a debt overhang problem that will restrict them from investment (Myers, 1977).

To construct the variable *OVERI*, firms are first ranked into deciles by industry sectors based on their cash balance and their leverage.[4] Then the rankings are re-scaled to range between zero and one.[5] After that, a composite score measure, *OVERI*, is computed as the average of the two ranked values.

While both cash balance and leverage are measures of firm liquidity, using only one of them is likely to capture the liquidity of the firm with error (Biddle et al. 2009). Aggregating two sets of liquidity measures to construct variable *OVERI* has the advantage of reducing measurement error. Further, ranking firms by industry sectors effectively controls the possible variation of liquidity between different sectors.

3.5 Control variables

Other factors that affect firm investment efficiency are also controlled in the regression model. First, substantial institutional shareholders ownership (*SUBSHA*) and financial

[4] Leverage is multiplied by minus one before ranking so that, as for cash, it is increasing with the likelihood of over-investment.
[5] The ranking minus one and then divided by nine.

reporting quality (*FRQ*), as well as their interaction terms with the likelihood of over-investment (*SUBSHA*OVERI*, *FRQ*OVERI*), are included in the model as control variables because they can reduce both over- and under-investment as shown in Biddle et al. (2009). Prior studies argue that large shareholding is the most direct way to align cash flow and control rights of outside investors, effectively limiting management discretion and eliminating inefficiencies (Shleifer & Vishny, 1997). Therefore, the presence of substantial institutional shareholders is used as a proxy for governance mechanisms that influence firm investment efficiency (Chen & Chen, 2012). The variable *SUBSHA* is measured as the percentage of total shares held by substantial institutional shareholders who hold more than 5% of the outstanding ordinary shares of a firm.

Financial reporting quality is proxied by earnings quality and is measured by discretional accruals using a modified Dechow and Dichev (2002) model multiplied by negative one. Dechow and Dichev (2002) argue that the quality of accruals and earnings is decreasing in the magnitude of estimation error in accruals. Therefore, the calculation of discretional accruals involves two steps. First, the residuals are estimated from firm-specific regressions of changes in working capital on the past, present, and future operating cash flows, change in sales, and net PPE (Dechow & Dichev, 2002; Francis et al., 2005) as shown in Equation (3).

$$\Delta WC_{i,t} = \beta_0 + \beta_1 OCF_{i,t-1} + \beta_2 OCF_{i,t} + \beta_3 OCF_{i,t+1} + \beta_4 \Delta Sales_{i,t} + \beta_5 PPE_{i,t} + \varepsilon_{i,t} \quad (3)$$

Where,

- $\Delta WC_{i,t}$ is the changes in working capital of firm *i* in year *t*;

- $OCF_{i,t}$ is operating cash flow of firm *i* in year *t*;
- $\Delta Sales_{i,t}$ is the changes in sales of firm *i* in year *t*;
- $PPE_{i,t}$ is the net PPE of firm *i* in year *t*;
- $\varepsilon_{i,t}$ is the residual from Eq.(2) for firm *i* in year *t*

Then the standard deviation of the residuals scaled by average total assets of each firm during the years *t-5* to *t-1* is computed to represent discretional accruals for the firm year. The value of discretional accruals is multiplied by negative one to ensure the value of *FRQ* is increasing in financial reporting quality.

$$FRQ_{i,t} = -\frac{SD\left(\varepsilon_{i,t-5},\varepsilon_{i,t-4},\varepsilon_{i,t-3},\varepsilon_{i,t-2},\varepsilon_{i,t-1}\right)}{Mean\left(TA_{i,t-5},TA_{i,t-4},TA_{i,t-3},TA_{i,t-2},TA_{i,t-1}\right)} \quad (4)$$

Where,

- *FRQ* is financial report quality;
- *SD()* is the calculation of standard deviation;
- *Mean()* is the calculation of mean;
- *TAi,t* is the total assets of firm *i* in year *t*;
- $\varepsilon_{i,t}$ is the residual from Eq.(2) for firm *i* in year *t*

According to the discussion of the regression model in section 3.2, a higher level of external governance and better financial quality are expected to improve firm investment efficiency. Therefore, these two variables are expected to be positively associated with investment level, and their interaction terms with *OVERI* are expected to be negatively associated with investment level.

Further, investment opportunities, firm size, bankruptcy risk, investment volatility, dividend payout, tangibility, operation cash flow volatility, sales volatility, loss frequency, operation cycle, slack, and operation cash flow to sales ratio are also included as control variables because they affect firm investment level and may have confounding effects on

the dependent variable.[6]

Investment opportunities (T_Q)

As suggested by investment theory, firm investment is determined by investment opportunity (Hayashi, 1982). Following previous studies (Firth et al., 2012; Chen et al., 2013), this study uses Tobin's Q to proxy for investment opportunity. Tobin's Q is calculated as the sum of the market value of equity and the book value of liabilities divided by total assets. Investment level is expected to be positively associated with Tobin's Q.

Firm size (FSIZE)

Prior studies show that firms' investment level is positively associated with firm size since smaller firms have less access to external capital markets (Vogt, 1994; Kadapakkam, Kumar, & Riddick, 1998). Consistent with this view, firm size (the logarithm of market capital) is included in the regression model to control for its impact on firm investment decisions (Biddle et al., 2009).

Bankruptcy risk (Z_SC)

Evidence in the literature shows that firms' investment and capital structure are affected by bankruptcy risk (Castanias, 1983). Consistent with Biddle et al. (2009), this study includes bankruptcy risk as a control variable. Bankruptcy risk is measured by the Z-score computed with a few financial ratios based on a model developed by Altman

[6] Leverage and cash balance affect firms' investment decisions cost (Stiglitz & Weiss, 1981; Stein, 2003). However, similar to Biddle et al. (2009), as they are incorporated in the calculation of independent variable *OVERI*, they are not included in the regression as control variables.

(1968). The model is shown as following:

$$Z = 0.012X_1 + 0.014X_2 + 0.033X_3 + 0.06X_4 + X_5 \quad (5)$$

Where,

Z is the Z-score indicating bankruptcy risk;
X_1 = Working capital/Total assets;
X_2 = Retained earnings/Total assets;
X_3 = Earnings before interest and taxes/Total assets;
X_4 = Market value equity/Book value of total debt; and
X_5 = Sales/Total assets;

Altman (1968) suggests that firms with a Z-score higher than 2.99 are in the "non-bankrupt" sector, firms with a Z below 1.81 are in the “bankrupt” zone, while firms with a Z-score between 1.81 and 2.99 will be defined as the "zone of ignorance". Although the classification is not always accurate, the model suggests that the higher Z-score, the lower the bankruptcy risk. Therefore, it is expected that firm investment level is positively associated with Z-score (Castanias, 1983).

Investment volatility (VOL_I)

Following Biddle et al. (2009), this study also controls for investment volatility to ensure that the results are not simply capturing a relation between over- and under-investment and investment volatility. Investment volatility is calculated as the standard deviation of investment over past five years and expected to be positively associated with firm investment level.

Dividend payout (DIVID)

Dividend payout is also controlled as it has been found to be related to capital investment (Ramalingegowda et al., 2013). Dividend payout is an indicator variable that takes the

value of one if the firm paid a dividend. If firms pay a dividend, they may have less cash to put into investment. Therefore, dividend payout is expected to be negatively associated with firm investment level.

Other factors

Consistent with prior studies, some other control variables are also included in the regression model because they have been found to be related to firm investment level. These variables include tangibility, operation cash flow (OCF) volatility, sales volatility, loss frequency, operation cycle, slack, and OCF to sales ratio. Tangibility (*TANGI*) is computed as the ratio of net property, plant, and equipment (*PPE*) to total assets (Biddle et al., 2009) and is expected to be positively associated with investment as most investments will be realised in PPE form.

Firms with higher OCF volatility (*VOL_CF*) and sales volatility (*VOL_S*) may face more uncertainty in their business environment and be more careful with investment (Liu & Wysocki, forthcoming). Therefore, *VOL_CF* and *VOL_S* are expected to be negatively associated with investment level. Similarly, loss firms (*LOSS*) and firms with longer operation cycle (*CYCLE*) may also have more pressure with funding their investment and thus have lower investment level.

Further, slack (*SLACK*), computed as the ratio of cash balance to net *PPE* value, and *OCF* to sales ratio (*OCF_S*) are expected to be positively associated with investment level and are also controlled in the model. Finally, firm age (*F_AGE*) and industry leverage (*INDLEV*) are also controlled as they have been found be negatively related to

firm capital investment (Biddle & Hilary, 2006; Biddle et al., 2009).

3.6 Summary

This chapter discusses the research design of this study. The chapter starts with the regression model used to analyse the data. Then it discussed in detail the definition and measurement of all the independent, dependent and control variables in the model.

CHAPTER 4: SAMPLE SELECTION AND DATA COLLECTION

4.1 Introduction

This chapter considers the data sources, the sample collection method and the data description. Section 4.2 discusses the data sources and sampling procedures. Section 4.3 provides descriptive statistics of all the variables. Section 4.4 provides a correlation matrix for all the variables, and Section 4.5 summarises the chapter.

4.2 Data collection and sample description

The sample targets all the companies listed on the ASX and based in Australia with time series corporate governance available in SIRCA and financial data available in the DatAnalysis database. Banks and financial institutions, insurance and real estate companies are excluded from the sample because their investments are different from those in other industries. At the time of data collection, time series corporate governance data in SIRCA are only available from 2001 to 2014. Therefore the sample for this study covers this time period. Only company year observations with both available directors' data and financial data are included in the data analysis. The final test sample contains 5,138 observations, covering 814 companies from 2001 to 2014.

Table 3 summarises the number of firms within each sector and industry based on the Global Industry Classification Standard (GICS). The sample contains 814 companies

from nine sectors and 20 industries. Among the nine sectors, the largest number of firms is in the Materials sector (238 firms, 29.24%) while the smallest number of firms is in the Utilities sector (11 firms, 1.35%). The wide range of industries covered by the sample companies evidences the representativeness of the sample.

Table 3 – Summary of sample by GICS sector and industries

Sector	Industry	N by industry	N by sector	% by sector
Consumer Discretionary	Automobiles & Components	7	121	14.86
	Consumer Durables & Apparel	12		
	Consumer Services	37		
	Media	30		
	Retailing	35		
Consumer Staples	Food & Staples Retailing	6	42	5.16
	Food, Beverage & Tobacco	33		
	Household & Personal Products	3		
Energy	Energy	100	100	12.29
Health Care	Health Care Equipment & Services	31	73	8.97
	Pharmaceuticals, Biotechnology & Life Sciences	42		
Industrials	Capital Goods	76	137	16.83
	Commercial & Professional Services	46		
	Transportation	15		
Information Technology	Semiconductors & Semiconductor Equipment	2	74	9.09
	Software & Services	59		
	Technology Hardware & Equipment	13		
Materials	Materials	238	238	29.24
Telecommunication Services	Telecommunication Services	18	18	2.21
Utilities	Utilities	11	11	1.35
Grand Total		814	814	100.00

4.3 Descriptive statistics

The descriptive statistics are presented in Table 4. The mean (median) *INVEST* across all firm-years is 9.3% (2.66%), indicating that on average the firms put 9.3% (2.66%) of their total assets in next year's investments. The mean (median) firm in the sample has a board size (*SIZE*) of 6.1 (6) members. The largest board has 14 members while the smallest board has three members. On average the firms have 57.94% (median 60%) of independent directors presenting on their boards. Despite the ASX recommendation of a majority of independent directors, more than 25% of the firms have less than 50% independent directors (Min = 0%, 25% percentile = 42.86%). The boards of the sample firms have an average of 2.7865 (median = 3) different expertise. Each year, they hold 9.9067 board meetings on average (median = 9.83). As shown by the data, multiple directorships are popular in Australia. On average, each director in the sample holds 1.2649 outside directorships (median = 1.20). On boards with the most multiple directorships, each director has 3.67 outside directorships. The boards have an average board tenure of 6.7493 (median = 6.02) years, while the longest board tenure is 18.34 years and the shortest is 1.20 years. The sample firms have an average director shareholdings of 16.02% (median = 7.68%).

Table 4 – Descriptive statistics of variables

Variable	N	Mean	StDev	Min	p25	Median	p75	Max
INVEST	5138	0.0930	0.3056	-0.5411	-0.0023	0.0266	0.1121	1.8668
OVERI	5138	0.4782	0.2489	0.0000	0.2778	0.5000	0.6667	1.0000
SIZE	5138	6.1076	2.2288	3	5	6	7	14
INDE	5138	0.5794	0.2231	0.0000	0.4286	0.6000	0.7500	1.0000
KNOW	5138	2.7865	0.9809	1	2	3	3	5
MEET	5138	9.9067	4.0353	2.00	7.00	9.83	12.00	23.00
MULTI	5138	1.2649	0.9028	0.00	0.50	1.20	1.88	3.67
TENU	5138	6.7493	3.7234	1.20	3.99	6.02	8.75	18.34
DIRSHA	5138	0.1602	0.1974	0.0000	0.0108	0.0768	0.2429	0.8669
SUBSHA	5138	0.3476	0.2227	0.0000	0.1705	0.3204	0.4918	0.9259
FRQ	5138	-0.1098	0.1244	-0.7436	-0.1274	-0.0691	-0.0373	-0.0076
FSIZE	5138	18.3769	2.2008	13.9848	16.7259	18.2586	19.8274	24.0836
T_Q	5138	1.9654	2.0032	0.4428	0.9507	1.3360	2.1492	14.3223
Z_SC	5138	5.5486	18.7032	-72.0919	1.5892	3.6736	6.8975	113.1693
TANGI	5138	0.2478	0.2316	0.0007	0.0463	0.1714	0.4088	0.8347
VOL_I	5138	0.4251	1.0885	0.0021	0.0543	0.1241	0.3019	8.1322
DIVID	5138	0.4801	0.4997	0	0	0	1	1
VOL_CF	5138	0.1005	0.1069	0.0085	0.0350	0.0643	0.1216	0.6243
VOL_S	5138	0.2870	0.3302	0.0000	0.0686	0.1773	0.3884	1.7997
F_AGE	5138	18.6793	12.4869	5	10	15	23	66
CYCLE	5138	185.9600	583.1105	0	42	75	123	4789
LOSS	5138	0.3918	0.4882	0	0	0	1	1
INDLEV	5138	0.1285	0.0601	0.0639	0.0770	0.0817	0.1949	0.2817
SLACK	5138	13.4580	52.0991	0.0005	0.1173	0.5135	3.2677	392.9819
CFO_S	5138	-18.3441	100.8726	-861.2205	-0.2301	0.0515	0.1505	1.2869

Table 4 continued

Notes:

- All the continuous variables presented in above table have been winsorized at 1% and 99% levels;
- *INVEST* is a measure of total investment, computed as net increase in PPE and intangible assets, scaled by lagged total assets;
- *OVERI* is a measure of likelihood of over-investment based on liquidity (aggregating rankings of cash on hand and leverage);
- *SIZE* is the number of directors on the board;
- *INDE* is the proportion of independent directors on the board;
- *KNOW* is the number of different type of expertise presented on the board;
- *MEET* is the average number of board meetings available to all the directors in a year;
- *MULTI* is the number of additional board positions held by directors scaled by the number of directors on the board;
- *TENU* is the average of tenure of all the directors on the board;
- *DIRSHA* is the percentage of shares owned by directors on the board;
- *SUBSHA* is the percentage of ordinary shares held by substantial institutional shareholders;
- *FRQ* is a measure of financial reporting quality proposed by Dechow and Dichev (2002) and modified by (Francis et al., 2005);
- *FSIZE* is a measure of firm size, computed as the logarithm of market value of capital;
- *T_Q* is the sum of the market value of equity and the book value of liabilities divided by total assets;
- *Z_SC* is a measure of distress computed following the methodology in Altman (1968);
- *TANGI* is a measure of tangibility, computed as the ratio of PPE to total assets;
- *VOL_I* is the standard deviation of investment *(INVEST)* over year t-5 to year t-1;
- *DIVID* is an indicator variable that takes the value of one if the firm paid a dividend;
- *VOL_CF* is the standard deviation of net operating cash flow over year t-5 to year 5-1, deflated by average total assets;
- *VOL_S* is the standard deviation of sales revenue over year t-5 to year 5-1, deflated by average total assets;
- *F_AGE* is the number of years the firm listed on ASX (or its precedent);
- *CYCLE* is a measure of the operating cycle of the firm, computed as days of inventory turnover plus days of accounts receivable turnover;
- *LOSS* is an indicator variable that takes the value of one if the firm made a loss;
- *INDLEV* is the mean market leverage – the ratio of long-term debt to the sum of long-term debt and market value of equity - for firms in the same industry sector;
- *SLACK* is the ratio of cash on hand to PPE;
- *CFO_S* is the ratio of CFO to sales revenue.

4.4 Correlation matrix

Table 5 presents the correlation between all the dependent, independent and control variables. A few pairs of variables are moderately correlated and have an absolute value of their correlation coefficients greater than 0.5. However, none of the variables are highly correlated, indicating that the results of this study are not affected by multicollinearity.

In particular, board size *(SIZE)* and firm size *(FSIZE)* are positively correlated (correlation coefficient 0.6039), which is consistent with the expectation that larger firms have more directors appointed on their boards. The indicator variable of dividends payout *(DIVID)* is positively correlated (0.5524) with firm size *(FSIZE)* and negatively correlated (-0.6333) with loss firms *(LOSS)*, indicating that larger/profitable firms are more likely to pay dividends.

SLACK is positively highly correlated with *OVERI* (0.7539) and negatively correlated with *TANGI* (-0.8043), and *LOSS* is negatively correlated with *CFO_S* (-0.6276). Since *SLACK* is computed as the ratio of cash on hand to PPE and *OVERI* is computed as the ranking of liquidity, it is reasonable that these two variables are positively correlated. Similarly, since *TANGI* is computed as the ratio of PPE to total assets, the negative correlation between *TANGI* with *SLACK* is expected. The negative correlation between *LOSS* and *CFO_S* indicates that loss firms are more likely to have negative operating cash flow.

Table 5 – Correlation matrix of variables

	SIZE	*INDE*	*KNOW*	*MEET*	*MULTI*	*TENU*	*DIRSHA*	*SUBSHA*	*INVEST*	*OVERI*	*FRQ*	*FSIZE*	*T_Q*	*Z_SC*	*TANGI*	*VOL_I*	*DIVID*	*VOL_CF*	*VOL_S*	*F_AGE*	*CYCLE*	*LOSS*	*INDLEV*	*SLACK*	*CFO_S*
SIZE	1.0000	0.2352 (.0000)	0.3121 (.0000)	0.0717 (.0000)	0.2533 (.0000)	-0.1281 (.0000)	-0.2826 (.0000)	0.1625 (.0000)	0.0436 (.0018)	-0.2184 (.0000)	0.2168 (.0000)	0.5755 (.0000)	-0.0362 (.0094)	-0.0169 (.2266)	0.2266 (.0000)	0.0286 (.0401)	0.3537 (.0000)	-0.2699 (.0000)	0.0176 (.2071)	0.0433 (.0019)	0.0011 (.9355)	-0.2486 (.0000)	0.1333 (.0000)	-0.2555 (.0000)	0.2108 (.0000)
INDE	0.2285 (.0000)	1.0000	0.0875 (.0000)	0.1335 (.0000)	0.1947 (.0000)	-0.0567 (.0000)	-0.3452 (.0000)	-0.0815 (.0000)	0.0272 (.0508)	-0.1321 (.0000)	0.1055 (.0000)	0.2631 (.0000)	-0.0313 (.0247)	-0.0529 (.0001)	0.1388 (.0000)	-0.0174 (.2125)	0.1641 (.0000)	-0.1151 (.0000)	-0.0272 (.0511)	0.0624 (.0000)	0.0163 (.2427)	-0.1351 (.0000)	0.0271 (.0519)	-0.1530 (.0000)	0.1172 (.0000)
KNOW	0.3219 (.0000)	0.0963 (.0000)	1.0000	-0.0189 (.1748)	0.0724 (.0000)	-0.0416 (.0029)	-0.1336 (.0000)	0.0157 (.2592)	0.0435 (.0018)	-0.0441 (.0016)	0.0520 (.0002)	0.2300 (.0000)	-0.0482 (.0005)	0.0226 (.1051)	0.1062 (.0000)	0.0306 (.0285)	0.0732 (.0000)	-0.0821 (.0000)	-0.0257 (.0651)	0.0372 (.0077)	-0.0164 (.2410)	-0.0706 (.0000)	0.0347 (.0128)	-0.0770 (.0000)	0.0747 (.0000)
MEET	0.0435 (.0018)	0.1295 (.0000)	-0.0078 (.5750)	1.0000	0.0960 (.0000)	0.0774 (.0000)	-0.0795 (.0000)	0.0048 (.7298)	0.0552 (.0001)	-0.0931 (.0000)	0.0685 (.0000)	0.1903 (.0000)	-0.1111 (.0000)	-0.0048 (.7292)	0.0854 (.0000)	0.0251 (.0722)	0.2013 (.0000)	-0.0939 (.0000)	0.0901 (.0000)	-0.0756 (.0000)	0.0202 (.1471)	-0.1398 (.0000)	0.0815 (.0000)	-0.1201 (.0000)	0.1108 (.0000)
MULTI	0.2519 (.0000)	0.1794 (.0000)	0.0647 (.0000)	0.0892 (.0000)	1.0000	0.0452 (.0012)	-0.2231 (.0000)	0.0433 (.0019)	0.0770 (.0000)	-0.1243 (.0000)	0.1757 (.0000)	0.3830 (.0000)	-0.0369 (.0081)	0.0394 (.0047)	0.1427 (.0000)	-0.0332 (.0173)	0.2350 (.0000)	-0.1969 (.0000)	-0.0198 (.1554)	0.0730 (.0000)	-0.0284 (.0417)	-0.2086 (.0000)	0.0592 (.0000)	-0.1492 (.0000)	0.1613 (.0000)
TENU	-0.1583 (.0000)	-0.0852 (.0000)	-0.0766 (.0000)	0.0245 (.0787)	0.0104 (.4544)	1.0000	0.2190 (.0000)	0.0360 (.0099)	0.0512 (.0002)	0.0048 (.7286)	0.2504 (.0000)	0.1560 (.0000)	-0.0624 (.0000)	0.1796 (.0000)	0.0520 (.0002)	-0.2904 (.0000)	0.3288 (.0000)	-0.2194 (.0000)	-0.0101 (.4691)	0.1370 (.0000)	0.0421 (.0026)	-0.2997 (.0000)	0.0958 (.0000)	-0.0855 (.0000)	0.2502 (.0000)
DIRSHA	-0.1930 (.0000)	-0.2734 (.0000)	-0.1328 (.0000)	-0.1013 (.0000)	-0.1754 (.0000)	0.2407 (.0000)	1.0000	0.0670 (.0000)	-0.0334 (.0166)	0.1126 (.0000)	-0.1448 (.0000)	-0.3423 (.0000)	-0.0379 (.0065)	0.0246 (.0780)	-0.1937 (.0000)	-0.0023 (.8673)	-0.0581 (.0000)	0.1202 (.0000)	0.1040 (.0000)	-0.1178 (.0000)	0.0370 (.0080)	0.0424 (.0024)	0.0491 (.0004)	0.1437 (.0000)	-0.0499 (.0003)
SUBSHA	0.1591 (.0000)	-0.0961 (.0000)	0.0077 (.5827)	-0.0079 (.5713)	0.0261 (.0619)	0.0495 (.0004)	0.2080 (.0000)	1.0000	0.0195 (.1626)	-0.1063 (.0000)	0.0986 (.0000)	0.1447 (.0000)	-0.1260 (.0000)	-0.0131 (.3496)	0.1424 (.0000)	-0.0595 (.0000)	0.1626 (.0000)	-0.1388 (.0000)	0.0371 (.0078)	0.0543 (.0001)	-0.0169 (.2264)	-0.1798 (.0000)	0.1402 (.0000)	-0.1772 (.0000)	0.1512 (.0000)
INVEST	-0.0364 (.0091)	0.0101 (.4677)	0.0057 (.6842)	0.0094 (.4999)	0.0173 (.2160)	-0.0372 (.0077)	-0.0253 (.0703)	-0.0306 (.0284)	1.0000	0.0461 (.0010)	0.0341 (.0146)	0.2489 (.0000)	0.2234 (.0000)	0.1778 (.0000)	0.2007 (.0000)	0.0373 (.0075)	0.1674 (.0000)	-0.0035 (.8036)	0.1204 (.0000)	0.0025 (.8601)	-0.0693 (.0000)	-0.2493 (.0000)	0.0588 (.0000)	-0.1022 (.0000)	0.2298 (.0000)
OVERI	-0.2120 (.0000)	-0.1339 (.0000)	-0.0449 (.0013)	-0.0847 (.0000)	-0.1286 (.0000)	0.0152 (.2774)	0.0679 (.0000)	-0.0953 (.0000)	0.0891 (.0000)	1.0000	-0.1147 (.0000)	-0.1703 (.0000)	0.1739 (.0000)	0.3725 (.0000)	-0.3319 (.0000)	-0.1368 (.0000)	-0.1535 (.0000)	0.2466 (.0000)	-0.0060 (.6697)	-0.0550 (.0001)	-0.0839 (.0000)	0.1347 (.0000)	0.0542 (.0001)	0.6654 (.0000)	-0.1145 (.0000)
FRQ	0.1669 (.0000)	0.1045 (.0000)	0.0637 (.0000)	0.0848 (.0000)	0.1537 (.0000)	0.2258 (.0000)	-0.0266 (.0566)	0.0881 (.0000)	-0.0282 (.0435)	-0.0794 (.0000)	1.0000	0.3434 (.0000)	-0.0893 (.0000)	0.1188 (.0000)	0.1901 (.0000)	-0.2164 (.0000)	0.3013 (.0000)	-0.4965 (.0000)	-0.2617 (.0000)	0.1226 (.0000)	-0.0428 (.0022)	-0.2451 (.0000)	0.0978 (.0000)	-0.2140 (.0000)	0.2316 (.0000)
FSIZE	0.6039 (.0000)	0.2658 (.0000)	0.2383 (.0000)	0.1683 (.0000)	0.3897 (.0000)	0.0819 (.0000)	-0.2678 (.0000)	0.1213 (.0000)	0.0714 (.0000)	-0.1775 (.0000)	0.3112 (.0000)	1.0000	0.2270 (.0000)	0.2985 (.0000)	0.3271 (.0000)	0.0178 (.2031)	0.5564 (.0000)	-0.3368 (.0000)	0.0324 (.0202)	0.0720 (.0000)	-0.0274 (.0499)	-0.4895 (.0000)	0.0853 (.0000)	-0.2946 (.0000)	0.4610 (.0000)
T_Q	-0.1139 (.0000)	-0.0365 (.0089)	-0.0802 (.0000)	-0.1083 (.0000)	-0.0689 (.0000)	-0.0647 (.0000)	-0.0396 (.0045)	-0.1138 (.0000)	0.1331 (.0000)	0.1857 (.0000)	-0.2372 (.0000)	0.0311 (.0257)	1.0000	0.2580 (.0000)	-0.1140 (.0000)	0.0181 (.1957)	-0.0382 (.0062)	0.2304 (.0000)	0.0118 (.3972)	-0.1031 (.0000)	-0.1029 (.0000)	0.0642 (.0000)	-0.2212 (.0000)	0.2544 (.0000)	-0.0360 (.0099)
Z_SC	-0.0323 (.0206)	-0.0523 (.0002)	0.0060 (.6692)	-0.0361 (.0096)	0.0298 (.0326)	0.0636 (.0000)	-0.0042 (.7650)	-0.0310 (.0265)	0.0251 (.0722)	0.1999 (.0000)	0.1559 (.0000)	0.1727 (.0000)	0.0669 (.0000)	1.0000	-0.0818 (.0000)	-0.1907 (.0000)	0.2147 (.0000)	-0.0467 (.0008)	0.0222 (.1113)	0.0089 (.5249)	-0.0889 (.0000)	-0.2501 (.0000)	-0.0659 (.0000)	0.1646 (.0000)	0.1351 (.0000)
TANGI	0.1919 (.0000)	0.1215 (.0000)	0.1131 (.0000)	0.0650 (.0000)	0.1209 (.0000)	0.0020 (.8840)	-0.1103 (.0000)	0.1212 (.0000)	0.0433 (.0019)	-0.3246 (.0000)	0.1495 (.0000)	0.2797 (.0000)	-0.1347 (.0000)	-0.0942 (.0000)	1.0000	0.1750 (.0000)	0.1972 (.0000)	-0.1891 (.0000)	0.0085 (.5442)	0.1293 (.0000)	0.0160 (.2520)	-0.2417 (.0000)	0.2060 (.0000)	-0.8043 (.0000)	0.3786 (.0000)
VOL_I	0.0060 (.6687)	-0.0482 (.0005)	0.0444 (.0014)	0.0044 (.7499)	-0.0619 (.0000)	-0.2214 (.0000)	-0.0142 (.3097)	-0.0363 (.0093)	0.0108 (.4400)	-0.0416 (.0029)	-0.2482 (.0000)	-0.0527 (.0002)	0.0531 (.0001)	-0.0672 (.0000)	0.0300 (.0317)	1.0000	-0.1582 (.0000)	0.1849 (.0000)	0.2016 (.0000)	-0.1104 (.0000)	-0.0651 (.0000)	0.0942 (.0000)	-0.0916 (.0000)	-0.1197 (.0000)	0.0383 (.0060)
DIVID	0.3493 (.0000)	0.1640 (.0000)	0.0750 (.0000)	0.1723 (.0000)	0.2333 (.0000)	0.2888 (.0000)	0.0190 (.1732)	0.1513 (.0000)	0.0105 (.4522)	-0.1489 (.0000)	0.2920 (.0000)	0.5524 (.0000)	-0.1537 (.0000)	-0.0022 (.8724)	0.1198 (.0000)	-0.1446 (.0000)	1.0000	-0.3309 (.0000)	0.2208 (.0000)	0.1126 (.0000)	0.0340 (.0149)	-0.6333 (.0000)	0.2875 (.0000)	-0.3000 (.0000)	0.4630 (.0000)
VOL_CF	-0.2137 (.0000)	-0.0829 (.0000)	-0.0671 (.0000)	-0.0899 (.0000)	-0.1472 (.0000)	-0.1748 (.0000)	0.0181 (.1951)	-0.1122 (.0000)	0.0686 (.0000)	0.2121 (.0000)	-0.4274 (.0000)	-0.2703 (.0000)	0.2581 (.0000)	-0.1199 (.0000)	-0.1404 (.0000)	0.1719 (.0008)	-0.2787 (.0000)	1.0000	0.3215 (.0000)	-0.1675 (.0000)	-0.0661 (.0000)	0.2522 (.0000)	-0.2202 (.0000)	0.3108 (.0000)	-0.1418 (.0000)
VOL_S	-0.0419 (.0026)	-0.0662 (.0000)	-0.0309 (.0269)	0.0513 (.0002)	-0.0386 (.0057)	-0.0737 (.0000)	0.0528 (.0002)	-0.0091 (.5150)	0.0528 (.0002)	0.0426 (.0022)	-0.2242 (.0000)	-0.0537 (.0001)	0.0298 (.0324)	-0.1170 (.0000)	-0.1135 (.0000)	0.1531 (.0000)	0.1147 (.0000)	0.2962 (.0000)	1.0000	-0.0999 (.0000)	-0.0244 (.0803)	-0.2551 (.0000)	0.1864 (.0000)	-0.0560 (.0001)	0.1712 (.0000)
F_AGE	0.1496 (.0000)	0.0813 (.0000)	0.0410 (.0033)	-0.0274 (.0492)	0.1375 (.0000)	0.1675 (.0000)	-0.0698 (.0000)	0.0833 (.0000)	-0.0309 (.0268)	-0.0986 (.0000)	0.0945 (.0000)	0.2033 (.0000)	-0.1060 (.0000)	-0.0149 (.2854)	0.1644 (.0000)	-0.0737 (.0000)	0.2065 (.0000)	-0.1246 (.0000)	-0.1169 (.0000)	1.0000	0.0688 (.0000)	-0.0813 (.0000)	0.0807 (.0000)	-0.1282 (.0000)	0.0434 (.0019)
CYCLE	-0.0713 (.0000)	-0.0526 (.0002)	0.0047 (.7343)	-0.0526 (.0002)	-0.0622 (.0000)	-0.0408 (.0034)	-0.0107 (.4414)	-0.0641 (.0000)	-0.0071 (.6126)	0.0524 (.0002)	-0.0257 (.0650)	-0.0920 (.0000)	0.0561 (.0001)	0.0810 (.0000)	-0.0778 (.0000)	0.0469 (.0008)	-0.1486 (.0000)	0.0309 (.0267)	-0.0900 (.0000)	-0.0077 (.5826)	1.0000	-0.0043 (.7577)	0.0466 (.0008)	-0.1024 (.0000)	-0.0855 (.0000)
LOSS	-0.2438 (.0000)	-0.1358 (.0000)	-0.0684 (.0000)	-0.1122 (.0000)	-0.2042 (.0000)	-0.2613 (.0000)	-0.0356 (.0107)	-0.1725 (.0000)	-0.0646 (.0000)	0.1292 (.0000)	-0.2616 (.0000)	-0.4806 (.0000)	0.1945 (.0000)	-0.0132 (.3434)	-0.1693 (.0000)	0.1178 (.0000)	-0.6333 (.0000)	0.2295 (.0000)	-0.1290 (.0000)	-0.1478 (.0000)	0.1797 (.0000)	1.0000	-0.2701 (.0000)	0.3044 (.0000)	-0.6276 (.0000)
INDLEV	0.1488 (.0000)	0.0318 (.0225)	-0.0195 (.1628)	0.0907 (.0000)	0.0533 (.0001)	0.0881 (.0000)	0.1197 (.0000)	0.1388 (.0000)	-0.0193 (.1658)	0.0670 (.0000)	0.0788 (.0000)	0.0706 (.0000)	-0.1757 (.0000)	-0.1081 (.0000)	0.0801 (.0000)	-0.0256 (.0665)	0.3130 (.0000)	-0.1779 (.0000)	0.1566 (.0000)	0.0440 (.0016)	-0.0879 (.0000)	-0.2938 (.0000)	1.0000	-0.3130 (.0000)	0.0932 (.0000)
SLACK	-0.1308 (.0000)	-0.0708 (.0000)	-0.0544 (.0001)	-0.0658 (.0000)	-0.0268 (.0545)	-0.0355 (.0109)	-0.0075 (.5920)	-0.0948 (.0000)	0.0455 (.0011)	0.2436 (.0000)	-0.1018 (.0000)	-0.1581 (.0000)	0.0998 (.0000)	0.1671 (.0000)	-0.2628 (.0000)	-0.0217 (.1192)	-0.1749 (.0000)	0.1327 (.0000)	-0.0279 (.0457)	-0.0279 (.0453)	0.0587 (.0000)	0.1929 (.0000)	-0.1521 (.0000)	1.0000	-0.3067 (.0000)
CFO_S	0.0851 (.0000)	0.0780 (.0000)	-0.0242 (.0826)	0.0673 (.0000)	0.0448 (.0013)	0.0864 (.0000)	0.0394 (.0047)	0.0717 (.0000)	-0.0178 (.2028)	-0.1077 (.0000)	0.0498 (.0004)	0.0975 (.0000)	-0.1478 (.0000)	-0.1512 (.0000)	0.1280 (.0000)	-0.0271 (.0525)	0.1731 (.0000)	-0.0913 (.0000)	0.1071 (.0000)	0.0058 (.6757)	-0.3572 (.0000)	-0.2174 (.0000)	0.1346 (.0000)	-0.1409 (.0000)	1.0000

Table 5 continued

Notes:

1. All the continuous variables presented in above table have been winsorized at 1% and 99% levels;
2. Top part presents Spearman correlation, and bottom part presents Pearson correlation;
3. Cell information:

Correlation coefficient (*p-value*)

4. The definition of the variables are as following:
   - *INVEST* is a measure of total investment, computed as net increase in PPE and intangible assets, scaled by lagged total assets;
   - *OVERI* is a measure of likelihood of over-investment based on liquidity (aggregating rankings of cash on hand and leverage);
   - *SIZE* is the number of directors on the board;
   - *INDE* is the proportion of independent directors on the board;
   - *KNOW* is the number of different type of expertise presented on the board;
   - *MEET* is the average number of board meetings available to all the directors in a year;
   - *MULTI* is the number of additional board positions held by directors scaled by the number of directors on the board;
   - *TENU* is the average of tenure of all the directors on the board;
   - *DIRSHA* is the percentage of shares owned by directors on the board;
   - *SUBSHA* is the percentage of ordinary shares held by substantial institutional shareholders;
   - *FRQ* is a measure of financial reporting quality proposed by Dechow and Dichev (2002) and modified by (Francis et al., 2005);
   - *FSIZE* is a measure of firm size, computed as the logarithm of market value of capital;
   - *T_Q* is the sum of the market value of equity and the book value of liabilities divided by total assets;
   - *Z_SC* is a measure of distress computed following the methodology in Altman (1968);
   - *TANGI* is a measure of tangibility, computed as the ratio of PPE to total assets;
   - *VOL_I* is the standard deviation of investment *(INVEST)* over year t-5 to year t-1;
   - *DIVID* is an indicator variable that takes the value of one if the firm paid a dividend;
   - *VOL_CF* is the standard deviation of net operating cash flow over year t-5 to year 5-1, deflated by average total assets;
   - *VOL_S* is the standard deviation of sales revenue over year t-5 to year 5-1, deflated by average total assets;
   - *F_AGE* is the number of years the firm listed on ASX (or its precedent);
   - *CYCLE* is a measure of the operating cycle of the firm, computed as days of inventory turnover plus days of accounts receivable turnover;
   - *LOSS* is an indicator variable that takes the value of one if the firm made a loss;
   - *INDLEV* is the mean market leverage – the ratio of long-term debt to the sum of long-term debt and market value of equity - for firms in the same industry sector;
   - *SLACK* is the ratio of cash on hand to PPE;
   - *CFO_S* is the ratio of CFO to sales revenue.

4.5 Summary

This chapter describes the sample selection and data collection process. A total of 814 firms listed on the ASX were selected in the sample with data collected for 2001 and 2014. Descriptive statistics and correlation analysis of variables used in further data analysis are presented and discussed.

CHAPTER 5: RESULTS

5.1 Introduction

This chapter shows the results of data analysis. Section 5.2 presents and discusses the main results of hypothesis tests. Section 5.3 presents the results of robustness test. Section 5.4 presents the results of further tests on the effect of the GFC on the association between board effectiveness and firm investment efficiency, and Section 5.5 summarises the chapter.

5.2 Regression results

This section reports the results with regards to the association between firm investment efficiency and board effectiveness using the OLS regression presented in Section 3.2. Seven board attributes representing board effectiveness are examined. In particular, it is expected that small size boards, with a high proportion of independent directors, diversified functional expertise, frequent meetings, multiple outside directorships, long-tenured directors, and high shareholding directors can improve firm investment efficiency by reducing both over- and under-investment. Detailed results are presented in Table 6.

Board size

As shown in Table 6, the coefficient on *SIZE* is negative as expected and is significant (*p-value* = 0.001) but the coefficient on the interaction term *SIZE*OVERI* is not significant (*p-value* = 0.296). Thus the results partially support *H1* that smaller boards are only able to reduce under-investment but not over-investment.

As suggested by Forbes and Milliken's (1999) model, the advantages of smaller boards are more effective communication and easier coordination. Therefore, it is easier for smaller boards to reach consensus on critical decisions, especially for decisions that involve complexity and ambiguity, such as strategy change (Goodstein, Gautam, & Boeker, 1994). Firms that are short of cash and have limited access to credit face the challenges of raising external capital. If they have a high level of debts, the pressure of saving cash to repay debts and interests may also prevent them from investing in profitable projects. Under these circumstances, smaller boards are more efficient in making critical decisions such as changing strategic directions and taking up extra investments, to lead companies actively seeking opportunities to improve their financial position. This explains the results that smaller boards are more effective in reducing under-investment.

On the other hand, firms with large amounts of cash and low levels of leverage may be very passionate about investments due to empire building and over confidence suggested by agency theory. The findings of this study show that smaller boards are unable to constrain empire building and over confidence and thus reduce over-investment. It is

consistent with the view that although smaller boards are more efficient in strategic decision-making, their monitoring ability is reduced when smaller boards have to limit the number of independent directors (Klein, 2002b).

Knowledge and skills

In regard to board knowledge and skills, results are opposite to the expectation of *H2*. The results suggest that boards with concentrated functional knowledge and skills are more able to reduce both over- (*p-value* = 0.071) and under-investment (*p-value* = 0.044).

The results in relation to board knowledge and skills do not seem to support either agency theory, resource dependence theory, or Forbes and Milliken's (1999) model. However, this finding is consistent with the view that more functionally diverse teams may suffer from larger "process losses" than less functionally diverse teams (Cannella Jr et al., 2008). Diversity within boards may lead to less information sharing, slow decision-making and more dysfunctional conflict and thus significantly constrain boards efforts to take decisive action, especially in an environment with great uncertainty (Goodstein et al., 1994; Chatman & Flynn, 2001; Bunderson & Sutcliffe, 2002; Harrison et al., 2002). The results indicate that the costs of "process losses" are significant and, to some extent, overweigh the benefits of diversified knowledge. Therefore, boards are more effective in investment decision-making when there are fewer functional expertise presented.

Notably, the results should not be interpreted as boards' knowledge and skills being not

important or even harmful to board effectiveness. This is because the proxy used in this study only represents one aspect of board knowledge and skill, which is the diversity of functional expertise presented on boards. The results may be different if other proxies, such as depth of knowledge, richness of experience and how the knowledge and skills are utilised, are used for boards' knowledges and skills.

Board independence

No significant results are found between board independence and firm investment efficiency (for under-investment *p-value* = 0.278; for over-investment *p-value* = 0.296) so *H3* is not supported.

Although the literature generally supports that more independent boards are more effective in their monitoring tasks, some studies suggest that more independent boards are associated with worse firm performance because independent directors do not have enough firm-specific knowledge (Klein, 1998; Christensen et al., 2010). Therefore, the insignificant results on board independence may indicate that benefits of effective monitoring by more independent boards are offset by the shortcoming of independent directors' lacking firm-specific knowledge (CAMAC, 2010).

Multiple directorships

There is no significant association between multiple directorships and firm investment

efficiency (for under-investment *p-value* = 0.282; for over-investment *p-value* = 0.229), therefore *H4* is not supported.

As suggested by the literature, directors who hold multiple directorships may have better intelligence, experience, skills and social links, and hence can bring more precious resources to the firms they serve (Cook & Wang, 2011; Field et al., 2013). However, directors with multiple directorships may be too busy to perform their monitoring role effectively (Fich & Shivdasani, 2006; Falato et al., 2014). As boards play both monitoring and resource dependence roles in firm investment decision-making (Adams & Ferreira, 2007), a plausible explanation for the insignificant association between multiple directorships and firm investment efficiency may be that the positive effect of more resources brought by directors and the negative effect of director busyness on firm investment efficiency cancelling out each other. However, further investigation is needed to confirm this explanation.

Board activity

The number of board meetings in a year is not found to be significantly associated with firm investment efficiency (for under-investment *p-value* = 0.695; for over-investment *p-value* = 0.359). Thus, *H5* is not supported.

The insignificant results may be attribute to that the number of board meetings is not an effective proxy for board activity. This measure may ignore some important factors such as

how long the meetings last, whether directors prepare for the meetings and how directors are engaged in the meetings (Forbes & Milliken, 1999). A better measure for board activity can be used in future studies to examine the relationship between board activity and firm investment efficiency.

Board tenure

Long-tenured boards are found to be able to prevent firms from over-investment (*p-value* = 0.001) but have limited capability to reduce under-investment (*p-value* = 0.358). Thus, *H6* is partially supported.

The results indicate that boards with long serving directors can identify projects with negative NPV and avoid investing surplus cash in these projects. However, their firm-specific knowledge accumulated from their long years of service may not increase their willingness and/or ability to raise external capital if the firm does not have cash to fund a good project. The results indicate that long-tenured boards can improve firm investment efficiency under certain circumstances, which are consistent with the findings of Kim et al. (2014) that directors' tenure is positively associated with their advisory performance in acquisitions and improving investment efficiency.

Director shareholdings

Highly consistent with expectations, director shareholdings are found to be effective in

reducing both over- (*p-value* = 0.002) and under-investment (*p-value* = 0.042). Thus, *H7* is supported.

The ASX CGPR recommendation 2.1 states that "the holding of securities in the entity may help to align the interests of a director with those of other security holders, and such holdings are therefore not discouraged" (ASX, 2014, p. 17). Prior academic studies also provide evidence that more director shareholdings is associated with higher firm performance (Yermack, 2004). Consistent with the ASX recommendation and the literature, this study finds that boards with higher director shareholdings are associated with lower over-investment and under-investment, indicating that boards work effectively when their interests are aligned with shareholders' interests.

Table 6 – Regression results for firm investment efficiency

	Expected Sign of β	Model (2)	Model (3)	Model (4)	Model (5)	Model (6)	Model (7)	Model (8)
Intercept		-0.1290*	-0.0497	-0.0296	-0.0607	-0.0882*	-0.0835	-0.1000
		(0.072)	(0.368)	(0.637)	(0.341)	(0.083)	(0.208)	(0.100)
SIZE	β_1 –	-0.0145***						
		(0.001)						
*SIZE*OVERI*	β_2 +	0.0093						
		(0.296)						
INDE	β_1 +		-0.0473					
			(0.278)					
*INDE*OVERI*	β_2 –		0.0933					
			(0.296)					
KNOW	β_1 +			-0.0199**				
				(0.044)				
*KNOW*OVERI*	β_2 –			0.0399*				
				(0.071)				
MEET	β_1 +				-0.0012			
					(0.695)			
*MEET*OVERI*	β_2 –				0.0047			
					(0.359)			
MULTI	β_1 +					0.0113		
						(0.282)		
*MULTI*OVERI*	β_2 –					-0.0213		
						(0.229)		

Table 6 continued

	Expected Sign of β	Model (2)	Model (3)	Model (4)	Model (5)	Model (6)	Model (7)	Model (8)
TENU	β_1 +						0.0023	
							(0.358)	
*TENU*OVERI*	β_2 –						-0.0111***	
							(0.001)	
DIRSHA	β_1 +							0.1040**
								(0.042)
*DIRSHA*OVERI*	β_2 –							-0.2090***
								(0.002)
SUBSHA		-0.0317	-0.0517	-0.0486	-0.0442	-0.0420	-0.0466	-0.0617
		(0.485)	(0.252)	(0.284)	(0.334)	(0.363)	(0.318)	(0.131)
*SUBSHA*OVERI*		0.0110	0.0368	0.0316	0.0255	0.0218	0.0299	0.0604
		(0.909)	(0.694)	(0.737)	(0.788)	(0.822)	(0.755)	(0.502)
FRQ		0.2100***	0.2170***	0.2170***	0.2120***	0.1950***	0.1720**	0.2110***
		(0.007)	(0.006)	(0.004)	(0.004)	(0.008)	(0.025)	(0.004)
*FRQ*OVERI*		-0.4750***	-0.4690***	-0.4690***	-0.4640***	-0.4310***	-0.3620**	-0.4600***
		(0.001)	(0.001)	(0.001)	(0.001)	(0.003)	(0.013)	(0.001)
OVERI		-0.0058	-0.0053	-0.0578	0.00676	0.0832	0.1410**	0.0785
		(0.931)	(0.935)	(0.443)	(0.916)	(0.161)	(0.012)	(0.143)
FSIZE		0.0150***	0.0078***	0.0082***	0.0073***	0.0073***	0.0067***	0.0082***
		(0.000)	(0.001)	(0.000)	(0.001)	(0.001)	(0.008)	(0.000)
T_Q		0.0161***	0.0175***	0.0176***	0.0178***	0.0175***	0.0178***	0.0175***
		(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)

Table 6 continued

	Expected Sign of β	Model (2)	Model (3)	Model (4)	Model (5)	Model (6)	Model (7)	Model (8)
Z_SC		-0.0003	-0.0001	-0.0001	-0.0001	-0.0001	-0.0001	-0.0001
		(0.479)	(0.736)	(0.691)	(0.783)	(0.738)	(0.759)	(0.668)
TANGI		0.1160***	0.1210***	0.1190***	0.1210***	0.1190***	0.1210***	0.1230***
		(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.000)	(0.000)
VOL_I		-0.0007	-0.0011	-0.0008	-0.0010	-0.0009	-0.0021	-0.0009
		(0.905)	(0.856)	(0.895)	(0.861)	(0.875)	(0.706)	(0.877)
DIVID		-0.0229	-0.0238	-0.0239	-0.0246	-0.0243	-0.0176	-0.0236
		(0.176)	(0.154)	(0.146)	(0.140)	(0.145)	(0.310)	(0.138)
VOL_CF		0.0677	0.0722	0.0748	0.0714	0.0708	0.0629	0.0725
		(0.405)	(0.377)	(0.354)	(0.380)	(0.377)	(0.423)	(0.374)
VOL_S		0.0399***	0.0413***	0.0408***	0.0410***	0.0416***	0.0402***	0.0414***
		(0.005)	(0.004)	(0.006)	(0.005)	(0.004)	(0.007)	(0.004)
F_AGE		-0.0008**	-0.0008**	-0.0009**	-0.0008**	-0.0009**	-0.0008**	-0.0008**
		(0.025)	(0.020)	(0.018)	(0.023)	(0.016)	(0.044)	(0.019)
CYCLE		-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000
		(0.914)	(0.933)	(0.933)	(0.978)	(0.971)	(0.986)	(0.959)
LOSS		-0.0622***	-0.0691***	-0.0686***	-0.0691***	-0.0688***	-0.0729***	-0.0694***
		(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
INDLEV		-0.1010	-0.1390	-0.1530	-0.1380	-0.1370	-0.1470	-0.1440
		(0.364)	(0.190)	(0.156)	(0.201)	(0.201)	(0.168)	(0.179)
SLACK		0.0003**	0.0003**	0.0003**	0.0003**	0.0003**	0.0003**	0.0003**
		(0.025)	(0.023)	(0.024)	(0.025)	(0.026)	(0.022)	(0.025)

Table 6 continued

	Expected Sign of β	Model (2)	Model (3)	Model (4)	Model (5)	Model (6)	Model (7)	Model (8)
CFO_S		-0.0001	-0.0001	-0.0000	-0.0001	-0.0000	-0.0000	-0.0000
		(0.431)	(0.444)	(0.464)	(0.444)	(0.459)	(0.516)	(0.473)
N		5138	5138	5138	5138	5138	5138	5138
R^2		0.053	0.050	0.050	0.050	0.050	0.052	0.051
F-test		10.25	9.102	9.209	9.142	9.110	9.624	9.118
p-value		0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***

Notes:

1. All the models control for the cluster effects of firms and years;
2. All the continuous variables presented in above table have been winsorized at 1% and 99% levels;
3. Models (2)-(8) represent below model, where *BA* is replaced by independent variables *SIZE*, *INDE*, *KNOW*, *MEET*, *MULTI*, *TENU*, and *DIRSHA* respectively, and *Control* is a number of control variables:

$$INVEST_{i,t+1} = \beta_0 + \beta_1 BA_{i,t} + \beta_2 BA_{i,t} * OVERI_{i,t+1} + \beta_3 SUBSHA_{i,t} + \beta_4 SUBSHA_{i,t} * OVERI_{i,t+1} + \beta_5 FRQ_{i,t} + \beta_6 FRQ_{i,t} * OVERI_{i,t+1} + \beta_7 OVERI_{i,t+1}$$
$$+ \sum \gamma_j Control_{j,i,t} + \varepsilon_{i,t+1}$$

Where,

- *INVEST* is a measure of total investment, computed as net increase in PPE and intangible assets, scaled by lagged total assets;
- *OVERI* is a measure of likelihood of over-investment based on liquidity (aggregating rankings of cash on hand and leverage);
- *SIZE* is the number of directors on the board;
- *INDE* is the proportion of independent directors on the board;
- *KNOW* is the number of different type of expertise presented on the board;
- *MEET* is the average number of board meetings available to all the directors in a year;
- *MULTI* is the number of additional board positions held by directors scaled by the number of directors on the board;
- *TENU* is the average of tenure of all the directors on the board;

Table 6 continued

- *DIRSHA* is the percentage of shares owned by directors on the board;
- *SUBSHA* is the percentage of ordinary shares held by substantial institutional shareholders;
- *FRQ* is a measure of financial reporting quality proposed by Dechow and Dichev (2002) and modified by (Francis et al., 2005);

4. Below variables are included in *Control* variables as in the models:
   - *FSIZE* is a measure of firm size, computed as the logarithm of market value of capital;
   - *T_Q* is the sum of the market value of equity and the book value of liabilities divided by total assets;
   - *Z_SC* is a measure of distress computed following the methodology in Altman (1968);
   - *TANGI* is a measure of tangibility, computed as the ratio of PPE to total assets;
   - *VOL_I* is the standard deviation of investment *(INVEST)* over year *t-5* to year *t-1*;
   - *DIVID* is an indicator variable that takes the value of one if the firm paid a dividend;
   - *VOL_CF* is the standard deviation of net operating cash flow over year *t-5* to year *t-1*, deflated by average total assets;
   - *VOL_S* is the standard deviation of sales revenue over year *t-5* to year *t-1*, deflated by average total assets;
   - *F_AGE* is the number of years the firm listed on ASX (or its precedent);
   - *CYCLE* is a measure of the operating cycle of the firm, computed as days of inventory turnover plus days of accounts receivable turnover;
   - *LOSS* is an indicator variable that takes the value of one if the firm made a loss;
   - *INDLEV* is the mean market leverage – the ratio of long-term debt to the sum of long-term debt and market value of equity - for firms in the same industry sector;
   - *SLACK* is the ratio of cash on hand to PPE;
   - *CFO_S* is the ratio of CFO to sales revenue.
5. Standard errors for heteroscedasticity, serial and cross-sectional correlation are adjusted using a two-dimensional cluster at the firm and year level. This technique is proposed by Petersen (2009) as the preferred method for estimating standard errors in corporate finance applications using panel data.
6. *p-value* marked by *,**, or *** indicates significant result at 10%, 5%, 1% level respectively.

5.3 Robustness test

To demonstrate the validity of the main results, further statistical analyses are conducted using a different measurement of investment. Recall that a balance sheet approach is taken in the main test to measure the level of investment. The drawback of this approach is expensed R&D expenditures are not covered. Thus, an alternative measure – cash flow approach – is used in the robustness test to measure the level of investment. Under the cash flow approach, investment is measured as net cash flows related to capital expenditure, acquisitions and R&D expenditure. Compared to the balance sheet approach, this measurement has the potential to capture spending on exploration and R&D activities even if it is not ultimately capitalised. However, since this measurement is derived from cash flows, the possible limitation of this approach is that it may not cover acquisitions funded by means other than cash.

Regression results using cash flow measure of investment are listed in Table 7. Consistent with the main results, director shareholdings are completely consistent with the expectation in terms of reducing both over- (*p-value* = 0.000) and under-investment (*p-value* = 0.037). Smaller boards are only able to reduce under-investment (*p-value* = 0.002) but not over-investment (*p-value* = 0.706). Similarly, boards with longer tenure are able to reduce over-investment (*p-value* = 0.004) but their ability to reduce under-investment (*p-value* = 0.168) is limited. Also consistent with the main results while opposite to expectations, boards with more concentrated functional expertise are more effective in reducing both

over-investment (*p-value* = 0.024) and under-investment (*p-value* = 0.042). The results for board activity and multiple directorships are not significant. Overall, the robustness test supports the results found in the main test. The only difference from the main results is that less independent boards are unexpectedly more effective in reducing over-investment (*p-value* = 0.048) and under-investment (*p-value* = 0.026), while no significant results are found in the main test on board independence.

Table 7 – Regression results for firm investment efficiency (robustness test)

	Expected Sign of β	Model (2)	Model (3)	Model (4)	Model (5)	Model (6)	Model (7)	Model (8)
Intercept		-0.0981	-0.0152	-0.0009	-0.0373	-0.0426	-0.0523	-0.0414
		(0.109)	(0.780)	(0.988)	(0.432)	(0.443)	(0.393)	(0.505)
SIZE	β_1 –	-0.0089***						
		(0.002)						
*SIZE*OVERI*	β_2 +	0.0021						
		(0.706)						
INDE	β_1 +		-0.0593**					
			(0.026)					
*INDE*OVERI*	β_2 –		0.0934**					
			(0.048)					
KNOW	β_1 +			-0.0141**				
				(0.042)				
*KNOW*OVERI*	β_2 –			0.0392**				
				(0.024)				
MEET	β_1 +				-0.0013			
					(0.446)			
*MEET*OVERI*	β_2 –				0.0012			
					(0.728)			
MULTI	β_1 +					-0.0012		
						(0.828)		
*MULTI*OVERI*	β_2 –					0.0053		
						(0.665)		

Table 7 continued

	Expected Sign of β	Model (2)	Model (3)	Model (4)	Model (5)	Model (6)	Model (7)	Model (8)
TENU	β_1 +						0.0019	
							(0.168)	
*TENU*OVERI*	β_2 –						-0.0085***	
							(0.004)	
DIRSHA	β_1 +							0.0636**
								(0.037)
*DIRSHA*OVERI*	β_2 –							-0.1920***
								(0.000)
SUBSHA		-0.0595***	-0.0771***	-0.0698***	-0.0684***	-0.0676***	-0.0687***	-0.0779***
		(0.007)	(0.001)	(0.002)	(0.003)	(0.003)	(0.003)	(0.000)
*SUBSHA*OVERI*		-0.0321	-0.0133	-0.0223	-0.0260	-0.0257	-0.0234	0.00817
		(0.516)	(0.789)	(0.645)	(0.601)	(0.600)	(0.637)	(0.863)
FRQ		0.0011	0.0168	0.0159	0.0065	0.0055	-0.0227	0.0086
		(0.984)	(0.758)	(0.771)	(0.903)	(0.916)	(0.671)	(0.874)
*FRQ*OVERI*		-0.1270	-0.1390	-0.1360	-0.1230	-0.1220	-0.0495	-0.1250
		(0.250)	(0.201)	(0.208)	(0.240)	(0.236)	(0.628)	(0.241)
OVERI		0.1150**	0.0706	0.0216	0.1190***	0.1250***	0.1990***	0.1540***
		(0.024)	(0.132)	(0.638)	(0.001)	(0.000)	(0.000)	(0.000)
FSIZE		0.0126***	0.0075***	0.0068**	0.0072***	0.0069**	0.0064**	0.0063**
		(0.000)	(0.008)	(0.013)	(0.005)	(0.013)	(0.017)	(0.025)
T_Q		0.0107***	0.0117***	0.0122***	0.0117***	0.0119***	0.0120***	0.0119***
		(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)

Table 7 continued

	Expected Sign of β	Model (2)	Model (3)	Model (4)	Model (5)	Model (6)	Model (7)	Model (8)
Z_SC		0.0003	0.0004	0.0004	0.0004	0.0004	0.0004*	0.0004*
		(0.232)	(0.110)	(0.105)	(0.109)	(0.103)	(0.088)	(0.093)
TANGI		0.1480***	0.1510***	0.1490***	0.1510***	0.1510***	0.1510***	0.1520***
		(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
VOL_I		0.0445**	0.0447**	0.0456**	0.0450**	0.0453**	0.0433**	0.0456***
		(0.012)	(0.012)	(0.011)	(0.012)	(0.012)	(0.017)	(0.010)
DIVID		-0.0363**	-0.0363**	-0.0359**	-0.0360**	-0.0364**	-0.0319*	-0.0343**
		(0.027)	(0.025)	(0.028)	(0.027)	(0.026)	(0.053)	(0.034)
VOL_CF		-0.0030	0.0020	0.0044	-0.0007	0.0002	-0.0060	0.0016
		(0.946)	(0.965)	(0.922)	(0.987)	(0.997)	(0.893)	(0.972)
VOL_S		-0.0002	0.0001	0.0001	0.0012	0.0006	-0.0002	0.0006
		(0.986)	(0.991)	(0.992)	(0.920)	(0.960)	(0.987)	(0.962)
F_AGE		-0.0004	-0.0004	-0.0004	-0.0004	-0.0004	-0.0004	-0.0004
		(0.212)	(0.228)	(0.211)	(0.192)	(0.209)	(0.298)	(0.179)
CYCLE		-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000
		(0.311)	(0.304)	(0.303)	(0.330)	(0.336)	(0.345)	(0.333)
LOSS		-0.0312***	-0.0367***	-0.0366***	-0.0360***	-0.0365***	-0.0394***	-0.0382***
		(0.003)	(0.001)	(0.001)	(0.001)	(0.001)	(0.000)	(0.000)
INDLEV		-0.332***	-0.365***	-0.375***	-0.361***	-0.364***	-0.372***	-0.364***
		(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
SLACK		0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002
		(0.123)	(0.118)	(0.122)	(0.129)	(0.131)	(0.115)	(0.130)

Table 7 continued

	Expected Sign of β	Model (2)	Model (3)	Model (4)	Model (5)	Model (6)	Model (7)	Model (8)
CFO_S		-0.0001	-0.0001	-0.0001	-0.0001	-0.0001	-0.0001	-0.0001
		(0.379)	(0.390)	(0.427)	(0.393)	(0.393)	(0.437)	(0.430)
N		5138	5138	5138	5138	5138	5138	5138
R^2		0.109	0.105	0.107	0.105	0.105	0.107	0.107
F-test		22.23	21.41	21.52	21.69	21.52	21.89	21.64
p-value		0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***

Notes:

1. All the models control for the cluster effects of firms and years;
2. All the continuous variables presented in above table have been winsorized at 1% and 99% levels;
3. Models (2)-(8) represent below model, where *BA* is replaced by independent variables *SIZE*, *INDE*, *KNOW*, *MEET*, *MULTI*, *TENU*, and *DIRSHA* respectively, and *Control* is a number of control variables:

$$INVEST_{i,t+1} = \beta_0 + \beta_1 BA_{i,t} + \beta_2 BA_{i,t} * OVERI_{i,t+1} + \beta_3 SUBSHA_{i,t} + \beta_4 SUBSHA_{i,t} * OVERI_{i,t+1} + \beta_5 FRQ_{i,t} + \beta_6 FRQ_{i,t} * OVERI_{i,t+1} + \beta_7 OVERI_{i,t+1} + \sum \gamma_j Control_{j,i,t} + \varepsilon_{i,t+1}$$

Where,

- *INVEST* is a measure of total investment, computed as net cash flows used in purchasing PPE and subsidiaries, scaled by lagged total assets;
- *OVERI* is a measure of likelihood of over-investment based on liquidity (aggregating rankings of cash on hand and leverage);
- *SIZE* is the number of directors on the board;
- *INDE* is the proportion of independent directors on the board;
- *KNOW* is the number of different type of expertise presented on the board;
- *MEET* is the average number of board meetings available to all the directors in a year;
- *MULTI* is the number of additional board positions held by directors scaled by the number of directors on the board;
- *TENU* is the average of tenure of all the directors on the board;

Table 7 continued

- *DIRSHA* is the percentage of shares owned by directors on the board;
- *SUBSHA* is the percentage of ordinary shares held by substantial institutional shareholders;
- *FRQ* is a measure of financial reporting quality proposed by Dechow and Dichev (2002) and modified by (Francis et al., 2005);

4. Below variables are included in *Control* variables as in the models:
   - *FSIZE* is a measure of firm size, computed as the logarithm of market value of capital;
   - *T_Q* is the sum of the market value of equity and the book value of liabilities divided by total assets;
   - *Z_SC* is a measure of distress computed following the methodology in Altman (1968);
   - *TANGI* is a measure of tangibility, computed as the ratio of PPE to total assets;
   - *VOL_I* is the standard deviation of investment *(INVEST)* over year *t-5* to year *t-1*;
   - *DIVID* is an indicator variable that takes the value of one if the firm paid a dividend;
   - *VOL_CF* is the standard deviation of net operating cash flow over year *t-5* to year *t-1*, deflated by average total assets;
   - *VOL_S* is the standard deviation of sales revenue over year *t-5* to year *t-1*, deflated by average total assets;
   - *F_AGE* is the number of years the firm listed on ASX (or its precedent);
   - *CYCLE* is a measure of the operating cycle of the firm, computed as days of inventory turnover plus days of accounts receivable turnover;
   - *LOSS* is an indicator variable that takes the value of one if the firm made a loss;
   - *INDLEV* is the mean market leverage – the ratio of long-term debt to the sum of long-term debt and market value of equity - for firms in the same industry sector;
   - *SLACK* is the ratio of cash on hand to PPE;
   - *CFO_S* is the ratio of CFO to sales revenue.
5. Standard errors for heteroscedasticity, serial and cross-sectional correlation are adjusted using a two-dimensional cluster at the firm and year level. This technique is proposed by Petersen (2009) as the preferred method for estimating standard errors in corporate finance applications using panel data.
6. *p-value* marked by *,**, or *** indicates significant result at 10%, 5%, 1% level respectively.

5.4 Further tests for the effect of the GFC

Although the GFC did not hit the Australian economy as hard as the US and some European countries, the shock in international markets was still quickly felt in Australia due to the globally connected nature of financial markets (McDonald & Morling, 2011). During the GFC, business and consumer confidence fell, external demand reduced, and domestic spending weakened. In November 2008, Australian equity prices had fallen by about 50 per cent from their peak a year earlier, and they fell further in early 2009. Over the course of the December 2008 and March 2009 quarters, both the terms of trade and the Australian dollar fell by around 10 per cent (McDonald & Morling, 2011).

The serious hit in global economy during the GFC had inevitably influenced firms' investment activities (Campello, Graham, & Harvey, 2010). In the survey conducted by Campello et al. (2010), it shows that during the GFC, firms had to cut their technology spending, employment, and capital spending. Some firms bypassed attractive investment opportunities due to their inability to borrow externally, some cancelled or postponed their planned investments, and some even sold assets to get cash.

Moreover, regulators and professional bodies all over the world have reviewed corporate governance practices to investigate potential weakness in governance systems (CAMAC, 2010). In a report entitled *Guidance for Directors* issued by the Australian Government Corporations and Markets Advisory Committee (CAMAC), several changes are suggested to the ASX to update the ASX CGPR (CAMAC, 2010). Among them, changes to executive

remunerations are made in the 2nd version of ASX CGRP in 2010 and changes to risk management are made in the 3rd version in 2014.

Since the GFC caused the change in firm investment behaviour and corporate governance regulations, it may have also affected boards' role in firm investment decision-making. To examine the effect of the GFC on the association between board effectiveness and firm investment efficiency, regression analyses are conducted separately in the pre-GFC (2001-2007) and post-GFC period (2011-2014) to see if the impact of board effectiveness on firm investment efficiency has changed before and after the GFC period. The regression results are presented in Table 8.[7]

The results show that before the GFC, board effectiveness had a limited contribution to firm investment efficiency. Out of the seven board attributes, only director shareholdings are associated with better firm investment efficiency for firms that are more likely to over-invest. Other board attributes have no significant impact on firm investment efficiency. However, a different story is presented after the GFC. Smaller board size is found to be associated with better firm investment efficiency for firms that are more likely to under-invest. Longer board tenure is able to restrict over-investment while a higher level of director shareholdings reduces both over- and under-investment. Further, although opposite to the hypotheses, a lower level of board independence and fewer multiple directorships also contribute to constraining under-investment. More concentrated expertise is also able to reduce both over- and under-investment. Overall, the results for the

[7] Table 7 only lists results for independent variables – board attributes – that are of interest. The results for control variables are not included as they are not the focus of this study.

post-GFC sub-sample are highly consistent with the main results.

Table 8 – Regression results for sub-samples before and after GFC

		Pre-GFC		Post-GFC	
Variables	Expectation	Coefficient	*p-value*	Coefficient	*p-value*
SIZE	β_1 –	-0.0063	(0.161)	-0.0143***	(0.000)
*SIZE*OVERI*	β_2 +	-0.0045	(0.521)	0.0101	(0.195)
INDE	β_1 +	-0.0512	(0.149)	-0.0930*	(0.080)
*INDE*OVERI*	β_2 –	0.0587	(0.394)	0.1440	(0.108)
KNOW	β_1 +	-0.0149	(0.300)	-0.0140*	(0.068)
*KNOW*OVERI*	β_2 –	0.0572	(0.143)	0.0332**	(0.029)
MEET	β_1 +	-0.0007	(0.788)	-0.0014	(0.326)
*MEET*OVERI*	β_2 –	0.0030	(0.599)	0.0013	(0.659)
MULTI	β_1 +	0.0025	(0.767)	-0.0153**	(0.035)
*MULTI*OVERI*	β_2 –	0.0023	(0.907)	0.0164	(0.212)
TENU	β_1 +	0.0020	(0.461)	0.0028	(0.155)
*TENU*OVERI*	β_2 –	-0.0069	(0.268)	-0.0086**	(0.015)
DIRSHA	β_1 +	0.0185	(0.661)	0.1260***	(0.002)
*DIRSHA*OVERI*	β_2 –	-0.1650**	(0.018)	-0.2440***	(0.001)

Notes:

1. All the models control for the cluster effects of firms and years;
2. All the continuous variables presented in above table have been winsorized at 1% and 99% levels;
3. Pre-GFC period refers to years 2001-2007; Post-GFC period refers to years 2011-2014;
4. The results are based on below model, where *BA* is replaced by independent variables *SIZE*, *INDE*, *KNOW*, *MEET*, *MULTI*, *TENU*, and *DIRSHA* respectively, and *Control* is a number of control variables. Refer to notes of Table 6 in Section 5.2 for the definition of dependent, independent and control variables.

$$INVEST_{i,t+1} = \beta_0 + \beta_1 BA_{i,t} + \beta_2 BA_{i,t} * OVERI_{i,t+1} + \beta_3 SUBSHA_{i,t} + \beta_4 SUBSHA_{i,t} * OVERI_{i,t+1} + \beta_5 FRQ_{i,t} + \beta_6 FRQ_{i,t} * OVERI_{i,t+1} + \beta_7 OVERI_{i,t+1} + \sum \gamma_j Control_{j,i,t} + \varepsilon_{i,t+1}$$

5. Standard errors for heteroscedasticity, serial and cross-sectional correlation are adjusted using a two-dimensional cluster at the firm and year level. This technique is proposed by Petersen (2009) as the preferred method for estimating standard errors in corporate finance applications using panel data.
6. *p-value* marked by *, **, or *** indicates significant result at 10%, 5%, 1% level respectively.

The results of the pre- and post-GFC periods show that the main results of this study are driven by the data after the GFC. The significant difference in the results between the pre- and post-GFC periods indicates that boards generally have little influence on firm investment efficiency before the GFC, possibly due to their insufficient involvement in

firm investment decisions (Clarke, 2010).[8] However, after the GFC, the association between board effectiveness and firm investment efficient became significant. There are a few reasons for this change.

First, boards realise that their stakeholders' primary interest is not in compliance with corporate governance regulations, but in the performance of the firm (UNCTD, 2010). When the economic conditions tightened during the GFC, boards had to work harder and increase their strategic involvement to guide firms through the economic downturn. The GFC pushed boards to look into firms' financials in more details, put more effort to balance sheet management, and re-examine their risk management and general processes (Clarke & Klettner, 2010). The evolved focus on sustainability and long-term value creation after the GFC also pushed boards to focus more on a performance-based perspective to corporate governance (Clarke, 2010).

Second, the changes in corporate governance regulations may have put pressure on boards to improve their performance. After the GFC, there are significant changes to the ASX CGPR rules about executive remunerations. A new recommendation is inserted in the ASX CGPR Principle 8, suggesting that the remuneration committee of company boards should consist of a majority of independent directors, be chaired by an independent chair, and have at least three members (ASX, 2010). Moreover, the Corporation Act was amended and the "two-strikes" law came into effect on 1st July 2011 to hold directors accountable

[8] The ASX CGRP was firstly issued in 2003. To address the concern that the insignificant results in the pre-GFC may be driven by the observations in a period when the ASX CGRP were not applied, tests are conducted for pre-GFC samples covering only 2004-2007 observations and similar results are found.

for executive remunerations (Monem & Ng, 2013). Under the new legislation, if the remuneration report of a firm receives 25% or more dissent votes for two consecutive years, the board of directors except the CEO may face re-election. These changes potentially grant shareholders the power to replace the entire board under certain circumstances.

Finally, the benefits of board performance evaluation may have been realised after the GFC. The ASX CGPR requires that firms should disclose board performance evaluation processes. This requirement was first introduced in the 2nd version of the ASX CGPR (ASX, 2007). Prior research finds that board evaluations may improve board effectiveness in various ways, for example, the smoothness of board meetings, the quality of information provided to directors, directors' influence on management, and directors' attention to long-term corporate strategy (Conger, Finegold, & Lawler, 1998). Further, the GFC encouraged boards to self-evaluate their performance, particularly regarding whether the company's risk management systems were robust enough (Clarke & Klettner, 2010). Consequently, this process of evaluation and self-evaluation may have improved boards strategic involvement after the GFC.

5.5 Summary

This chapter discusses the findings of the study. In particular, this chapter presents the data analysis results testing the seven hypotheses developed in Chapter 2 in examining the association between board attributes and firm investment efficiency. The results suggest that boards with more director shareholdings and more concentrated functional expertise

are able to reduce both over- and under-investment, smaller boards are able to overcome under-investment, while boards with longer average director tenure are able to restrict over-investment. Overall, the results provide answers to the research question that board effectiveness is significantly associated with firm investment efficiency. The results of robustness tests using alternative measurement for investment level are largely consistent with the main results. Further, the chapter also discusses the results of further tests investigating the effect of the GFC on the association between board effectiveness and firm investment efficiency. The findings indicate that after GFC, board effectiveness has more influence on firm investment efficiency than before the GFC. The next chapter presents the discussion of these findings and their implication, as well as the limitation of this study.

CHAPTER 6: DISCUSSIONS, IMPLICATIONS AND LIMITATIONS

6.1 Introduction

This chapter provides an overall conclusion for the study. Section 6.2 provides further discussion of the results. Section 6.3 discusses the implications of this study. Section 6.4 discusses the limitations of the study and suggestions for future research.

6.2 Discussions of results

This study investigates the association between board effectiveness variables and firm investment efficiency across 816 Australian firms over a period from 2001 to 2014. The data analysis relies on Biddle et al.'s (2009) model that allows the examination of board effectiveness in reducing over- and under-investment. Understanding the boards' role in improving firm investment efficiency is important because boards' decisions in firm investment affect not only the financial success of the firm in long-term but also the welfare of the society as a whole.

The findings confirm that boards are playing important roles in firm investment decision-making, and effective boards can improve firm investment efficiency. Specifically, the results suggest that boards with more director shareholdings and more concentrated functional expertise are able to reduce both over- and under-investment, smaller boards are able to overcome under-investment, while boards with longer average director tenure are

able to restrict over-investment.

The findings on board size and knowledge and skills reflect the importance of including board processes in board effectiveness studies. The results are consistent with the views that large boards suffer from inefficient communication and coordination and expertise diversified boards experience "process losses". When boards work as group decision makers, the cost of inefficient information exchange (Bunderson & Sutcliffe, 2002) and dysfunctional conflicts (Chatman & Flynn, 2001; Harrison et al., 2002) may overweigh the benefit of knowledge brought in by large and diversified teams.

The results also reinforce the claim that encouraging director shareholding adds value to firms. In Australia, some listed companies are encouraging or making it compulsory for directors to hold a certain amount of shares of the companies they serve. For example, Suncorp announced that directors must own at least $200,000 of Suncorp shares, and AMP Capital encourages directors to hold ordinary shares in their companies. While most evidence supports that directors should have a real interest in the company to align their personal interest to the company's interest, there is still concern that holding company shares can compromise a director's independence (Stuart, 2014). The results of this study show that in terms of investment decision-making, boards with higher director shareholdings are able to reduce both over- and under-investment, while directors' independence does not contribute to board effectiveness.

Further, the results emphasise the benefit of long serving board members. Among the

concerns that long director tenure may compromise their independence and entrenched directors may hinder innovation and strategy change, evidence shows that longer board tenure is associated with better monitoring and advisory performance (Kim et al., 2014) and more strategy change (Golden & Zajac, 2001). In a comprehensive study of the effect of board destaggering, Ge, Tanlu, and Zhang (2016) find that this attempt to shorten board tenure is detrimental to firm performance and innovation. The results of this study are consistent with these findings and suggest boards with longer tenure are associated with better firm investment efficiency.

While no significant results are found on board independence, multiple directorships and board activity, the results should be interpreted with cautions. First, while these attributes may not significantly affect firm investment efficiency, they may still be important to boards' other roles. Next, results may be different if the board attributes are measured with other proxies. Future research on the association between board effectiveness and firm investment efficiency is expected to enrich our understanding of this topic.

6.3 Implications of the study

The findings of the study confirm that board effectiveness is significantly associated with firm investment efficiency and reveal the important board attributes contribute board effectiveness in firm investment decision-making. This study provides some important implications to firms, regulators and researchers.

Firstly, the results of study have a number of implications for firms. First, in relation to board size, knowledge and skills, if a board wishes to add directors for the benefits of extra knowledge and expertise, the potential cost of inefficient communication and decision-making should be considered. Second, although the literature suggests long director tenure may compromise directors' independence status, long serving boards are more effective in investment decision-making. Based on the insignificant results found for board independence, board independence is not a critical attribute contributing to firm investment efficiency. Further, firms should encourage directors to hold their own shares. In sum, for the purpose of making good investment decisions, firms can consider setting up an investment subcommittee with features consistent with the findings of this study.

The findings on board independence also have important implications for regulators. Board independence and board committee independence are emphasised in the ASX CGPR (ASX, 2014). However, prior studies show that independence is not a panacea (Christensen et al., 2010). While independent directors may play a valuable monitoring role (Kim et al., 2014), they may not have enough industry and firm knowledge and experience to assist them in dealing with strategic issues and commercial decisions effectively (CAMAC, 2010). Consistent with this argument, this study finds that more independent boards do not improve firm investment efficiency. The findings support the view that there should be a balance between formal independence and relevant industry expertise on a board and companies should be encouraged to choose the governance structures that best allow them to find an appropriate balance between monitoring and performance (UNCTD, 2010).

Finally, the findings of this study have some implications for researchers. First, the results emphasise the need of integrating multiple theories in board research. Boards are complex constructs that have a broad variety of attributes. They are also dynamic working groups whose performance is affected by the interaction between the members (Minichilli et al., 2009). A single theory may not be sufficient in explaining board effectiveness in fulfilling their roles. For example, agency theory which suggests that larger boards will be better monitors may not be able to explain the findings that smaller boards are more effective in reducing under-investment. However, the results can be explained by social-psychological theories on working groups. Therefore, a theoretical approach that integrates a number of theories can add a depth to board research and provide richer results in board studies. Next, the findings of this study emphasises boards' strategic role by showing the increased involvement of boards in strategic planning after the GFC. The change of boards' influence on firm investment efficiency reflects the need for greater corporate accountability and a performance-based perspective of corporate governance (UNCTD, 2010). The development in boards' roles in strategic involvement encourages board researchers to direct greater attention to the strategic function of the board and the effects of board structure on strategic decisions.

6.4 Limitations and future studies

There are a few limitations with the current study. The first limitation is the measurement of total investment. As discussed in Chapter 3, this study aims to include all types of

investments, the same way as Biddle et al. (2009) do. However, due to data availability and time restriction to complete this study, the measurement used in this study does not include R&D expenditures that are not capitalised. Future studies may include expensed R&D expenditures in the measurement of investments through better access to databases or hand-collected data.

The second limitation rests with the proxies for board knowledge and board activity. There are limited available proxies for these two constructs in archival data. Knowledge and skills have various dimensions, such as depth of knowledge, richness of experience and how the knowledge and skills are utilised. Similarly, the length of board meetings, whether directors prepare for the meetings and how directors are engaged in the meetings are all important factors that should be included in the measurement of board activity. All these factors may contribute to board effectiveness but are difficult to measure, especially with archival data which are sourced from publicly available annual reports. Future studies can consider using other research methods, such as survey or questionnaires, to construct better measurement of these two concepts.

Finally, this study investigates board effectiveness in firm investment decision-making based on Australian data only. The results are subject to the influence of culture and the business, investment and regulatory environments specific to Australia. When applied to other countries, the implications of the results should be interpreted with caution. Future research may extend the research topic to an international level by using international samples.

APPENDIX A: Definitions of variables calculated from financial data

Variable	Variable Description	Definition
INVEST (balance sheet approach)	Investment - increased PPE & Intangible	(PPE_t-PPE_{t-1}+$DEPR_t$+$INTANG_t$-$INTANG_{t-1}$+$ARMOT_t$) scaled by lagged Total Assets
INVEST (cash flow approach)	Investment – net cash flows purchasing PPE and subsidiaries	(Net CF PPE + Net CF Subsidiary) scaled by lagged Total Assets
OVERI	Likelihood of over-investment	Combined ranking of Leverage and Cash/Total Assets
FSIZE	Firm size	Log (Market Capital)
T_Q	Tobin's Q	(Market Capital + Total Liabilities)/Total Assets
Z_SC	Measure of bankruptcy risk Z-Score = 1.2A + 1.4B + 3.3C + 0.6D + 1.0E	A = Working Capital/Total Assets; B = Retained Earnings/Total Assets; C = Earnings Before Interest & Tax/Total Assets; D = Market Value of Equity/Total Liabilities; E = Sales/Total Assets; Working Capital = = Current Assets – Current Liabilities
TANGI	Tangibility	Net PPE/Total Assets
VOL_I	Investment volatility	Standard deviation of *INVEST* for year *t-1* to *t-5*
DIVID	Dividend payout	1 if paid dividend; 0 if no dividends paid
VOL_CF	Operation cash flow volatility	Standard deviation of Net Operating Cash Flow for year *t-1* to *t-5*, scaled by average Total Assets
VOL_S	Sales volatility	Standard deviation of Sales for year *t-1* to *t-5*, scaled by average Total Assets
F_AGE	Firm age	Balance Date - Listing Date in years
CYCLE	Length of operating cycle	Log(Days Inventory Turnover + Days Accounts Receivables Turnover)
LOSS	Frequency of losses	1 if Net Income before Extraordinary <0; 0 otherwise
INDLEV	Industry leverage	Average of (Long-term Debts/(Long-term Debts + Market Capital)) by industry sector
SLACK	Slack	Cash/Net PPE
CFO_S	CFO to sales ratio	Operating Cash Flow/Sales
FRQ	Discretional accruals	Standard deviation of Residuals of regression ΔWC_t on CFO_t, CFO_{t-1}, CFO_{t+1}, $\Delta Sales_t$, and Net PPE for year *t-5* to *t-1*, scaled by Total Assets

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