Master Thesis

Accounting and Finance

The relation between corporate governance and firm (non) financial performance: An empirical study focusing on high tech firms

Abstract: This thesis examines the relation between board structure and firm (non) financial performance. Guided by prior theoretical work, I find that optimal board structure varies by industry. High tech firms, for which firm-specific knowledge of inside directors is relatively important and monitoring costs are high, benefit in terms of financial performance (Tobin's Q) from having a smaller board consisting of more insiders. Board leadership also positively affects Tobin's Q for firms operating in the high tech industry that is in accordance with the stewardship theory. Consistent with the predictions I find strong evidence that investment in innovation, which is key for the sustainability of R&D intensive firms, increases with the fraction of insiders and managerial ownership and decreases with board size and director's age for high tech firms. My findings challenge the agency theory and the notion that restrictions on board composition necessarily improve firm (non) financial performance.

Keywords: Corporate governance; Board composition; High tech; Tobin's Q; Innovation

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1. Introduction

The impact of board composition and board characteristics on firm performance has been a widely discussed topic. Previous literature argues that boards are endogenously determined (Linck et al., 2008; Boone et al., 2007; Coles et al., 2008). The "endogenous determinants" hypothesis states that firms seek the perfect board structure with a trade-off between the costs and benefits of outside monitoring (Wintoki, 2007). "Boards are a market solution to an organizational design problem, an endogenously determined institution that helps to ameliorate the agency problems that plague any large organization (Hermalin & Weisbach, 2001)." Prior studies show that several firm characteristics and board characteristics appear to be important determinants of board structure. Where Linck et al. (2008) find that board structures are dramatically different between small and large firms, Boone et al. (2007) argue that besides firm size, a firm's complexity and specific monitoring requirements also determine board composition.

With the rise of high tech firms, it is becoming more interesting whether these companies benefit in terms of financial performance from certain board compositions. In addition, previous studies argue that high R&D firms have distinct characteristics and may rely more on ownership than on board governance (Cui & Mak, 2002). High tech firms tend to possess information sensitive intangibles, which are key for the sustainability of the firm. This firm specific knowledge is unknown to the outside and therefore the monitoring role of outside directors seems to be undermined by the advisory role of the insiders. Where most of prior literature advocates for a small board consisting of outside directors because small groups are more effective in monitoring (Yermack, 1996; Lipton and Lorsch, 1992), innovative technology firms could improve financial performance by increasing the percentage of insiders on the board (Coles et al., 2008). Moreover, many high tech firms are characterized as high growth firms and product differentiability. Boards of such firms may enjoy higher levels of discretion, thereby exerting a stronger influence on firm value (Hambrick & Abrahamson, 1995). Because of the different board requirements for high tech and low tech firms, financial performance is expected to be affected by different determinants for these firms. In addition, high tech firms rely heavily on innovation and research and development. For these firms, innovation is crucial to the development and performance of the organisation (Francis et al., 2015). Hall et al. (2005) show a significant positive relation between patent citations and firm performance. They underline the importance of innovation by showing that an extra citation per patent boosts the market value by 3% (Hall, Jaffe, & Trajtenberg, 2005). Both financial performance and non-financial performance tend to be important for the sustainability of high tech firms. Therefore, the following research question is developed:

RQ: "What is the relation between board structure and (non) financial performance for high tech and low tech firms?"

Even though the role of the board is not always visible in the financial reports, it does affect several stakeholders. Gaining access to the internal workings of the board of directors remains difficult due to the potential for legal exposure (Leblanc & Schwartz, 2007). Because of this so-called "black box", studies about the role of the board remain academically interesting. The findings of this research are interested for multiple stakeholders. The results disclose essential information to companies about the optimal board structure for high tech and low tech firms. Furthermore, it provides shareholders with useful information to properly use their voting rights to choose qualified board members. Also, policymakers should be aware of the consequences of putting restrictions on the ability to endogenously choose the board of directors. For instance, on average the benefits of the Sarbanes-Oxley Act, that puts in place some of these restrictions, did not outweigh the costs of implementing it, particularly among smaller companies (high tech firms) where the start-up costs are proportionately larger (Alexander et al., 2013).

If firm characteristics such as R&D intensity and board characteristics are important determinants of board structure, then there should be an observable relation between board structure and financial firm performance for high tech and low tech firms.

This thesis targets US based listed firms. I examine the hypotheses using a sample of firm-year observations from ISS (formerly RiskMetrics), and Compustat. Further, to reduce endogeneity concerns I include year and industry fixed effects (3-digits SIC codes) and standard OLS regression will be used to estimate the unknown parameters.

The corporate governance literature shows that board size is negatively related to a firm's financial performance whereas outside directors have a positive influence on financial performance (Yermack, 1995). Similar results have been found when examining high tech start-ups funded by venture capitalists (Clarysse et al. 2007; Rosenstein 1988). However, there is relatively limited research on the effect of board structure on firm performance in high tech and low tech US based listed firms. This thesis aims to elaborate the pros and cons of certain board characteristics in a high and low technology environment. Moreover, this study extends this literature by providing additional empirical evidence on the relationship between board involvement with strategy and firm performance.

By using Tobin's Q as proxy for financial performance and R&D intensity as proxy for innovation, I find that board structure is related to Q and R&D intensity for high tech firms. Consistent with hypotheses 1-3 and 5 relating to financial performance, the empirical results indicate that insiders and CEO duality significantly enhance Tobin's Q for high tech firms in accordance with the stewardship theory. Board size and director's age appear to negatively affect financial performance. The results related to innovation are in line with some of the hypotheses. While I find strong supporting evidence for the prediction that insiders increase innovation, board size and director's age negatively affect innovation consistent with the hypotheses. In contrast with the prediction, board ownership tends to negatively affect innovation. However when I use CEO ownership as alternative to board ownership, I observe a strong positive significant effect on innovation investment for high tech firms.

The remainder of this research is structured as follows. Section 2 discusses the underlying theory and related literature followed by the hypotheses development. Section 3 describes the data and the corresponding theoretical constructs. Section 4 and 5 discuss the empirical results and robustness checks respectively, followed by the conclusions in section 6.

2 Literature Review

In this chapter the theoretical background is provided. First the most relevant theories and concepts will be explained and the need for an effective board. Second, the findings of recent important related literature will be discussed followed by the hypotheses development derived from the background discussion.

2.1 Underlying Theory

The agency problem is a much debated management control conflict in firms between the manager and the shareholders. In this situation, the desires of an agent (manager) are different than those of the principal (shareholders). Where shareholders strive for maximizing their shareholder portfolio, company executives could be prone to management entrenchment and personal benefits at cost of the shareholders. Executives have an incentive to divert resources from shareholders by investing in unprofitable projects (empire building), perquisite consumption and even outright theft (Michaely & Michael, 2006). Furthermore when an executive is utilizing resources of a principal, it could affect his risk appetite. The manager could be willing to take more risk in undertaking projects when he incurs little to no risk because all losses will be the burden of the principal (Nyberg, Gerhart, Fulmer, & Carpenter, 2010). This problem arises with the existence of information asymmetry. Information asymmetry occurs when one party's knowledge is inferior to that of the other party. Examples are the lack of knowledge of investors about the true firm value and boards that lack in properly estimate a CEO's ability and a firm's resources (Dehlen et al., 2014). Therefore the principal cannot observe the actions of the agent in full detail.

Because of the conflict of interest, the board of directors is appointed to monitor and advice the agent (manager) in order to embrace the shareholders (principal) interests. By aligning these interests, the board has the power to hire, fire, and compensate the top-level managers and to ratify and monitor important decisions (Huse, 2008). "Exercise of these top-level decision control rights by a group (the board) helps to ensure separation of decision management and control (that is, the absence of an entrepreneurial decision maker) even at the top of the organization (Fama & Jensen, 1983)."

The need for an effective board has been confirmed by the corporate scandals (e.g. Enron and Worldcom) around the turn of the century. Lack of control over the executives has been determined to be the major cause. These corporate scandals have led to an important security legislation affecting listed firms. The Sarbanes-Oxley Act (SOX) of 2002 was partially designed to modify the behaviour of the board of directors. One of the key features of SOX is that it mandates an increase of the monitoring role by outside or independent directors because of the failing internal and external controls (Klein, 2003). The imposed regulation suggests that a board of directors consisting of a majority of independent directors is beneficial for all companies.

Alternative to the agency theory is the stewardship theory that highlights some of the shortcomings of the agency theory. Where agency theory assumes the executive manager to be an opportunistic shirker, stewardship theory holds that there is no inherent, general problem of executive motivation. The manager essentially wants to be a good 'steward' and properly allocate corporate assets. The degree a manager is able to attain superior performance depends on the structural situation. The issue becomes whether or not the organisation structure facilitates effective action by the manager. "Structures will be facilitative of this goal to the extent that they provide clear, consistent role expectations and authorise and empower senior management (Donaldson & Davis, 1991)."

For this research it is important to notice that the sample consists of US based listed firms. In the US, the regulation mandates a firm to have a board following a one-tier structure. This means that US companies can only be governed by a unitary board of directors. A unitary board is generally composed of at least three and no more than 24 directors, both executive and non-executive. Executive board members typically participate in the daily management while the non-executive directors have an advisory and monitoring role (Millet-Reyes & Zhao, 2010). The advantages of a unitary board of directors can be categorized as: (1) superior inflow of information, (2) faster decision making and (3) better understanding and involvement in the business by the board (Jungmann, 2006).

In contrast, for example the German Vorstand/Aufsichstrat structure compels firms to have a two-tier board consisting of a supervisory board and a management board that separates the monitoring and advising function respectively. Hence, the role of the supervisory board is mainly to oversee the executive directors that run the day-to-day operations. The supervisory board also selects a presiding member from among the members of the management board and is appointed and dismissed at shareholder meetings (Millet-Reyes & Zhao, 2010). The main advantage of this dual board system is the strict separation of control and managerial tasks. However, in practice the members of the supervisory board are often chosen by the executive directors, which increases the power of the management board over the supervisory board (Jungmann, 2006).

Following Adams and Ferreira (2007), this study classifies a board's activities into two functions: advising and monitoring. A CEO faces a trade-off in disclosing information to the board of directors. On the one hand, disclosing information results in better advice from the board. On the other hand, an informed board will monitor him more intensively (Adams & Ferreira, 2007). Where the dual board system separates the two roles of the board and the CEO does not face this trade-off, the sole board system that will be examined in this thesis combines the advisory and monitoring functions of the board.

In spite of the fact that a one-tier board advocates a board composition with a combined CEO and chairman (CEO Duality), this phenomenon does not always occur in the US. Approximately 50% of American boards have a separate chairman, while the remaining 50% have designated their CEO also as chairman of the board (Block & Gerstner, 2016). Also Linck et al. (2007) do not come across any difficulties by examining several board characteristics using similar datasets and regressions. Therefore I do not expect any difficulties or biases in regressing certain board characteristics on firm (non) financial performance.

Prior research confirms some firm characteristics to be determinant for observed board structure. Raheja (2005) argues that insiders are better informed and thus better advisors, whereas outsiders play more an effective monitoring role (Raheja, 2005). This suggests that knowledge-intensive firms prefer inside directors while companies that are in need of an effective monitoring board will prefer outside directors. Firm's complexity and private benefits also appear to be important determinants of board structure. When a firm becomes older and more complex in terms of operations or moves into new business areas, it benefits from having more outside directors on the board (Lehn et al., 2009). Furthermore, firms where CEOs are able to obtain high private benefits of control are better off with an outside monitoring board (Raheja, 2005; Linck et al., 2008). Prior research has shown that the board is endogenously determined by additional firm characteristics including monitoring costs, CEO ownership, outside directors' ownership, CEO tenure, and CEO age (see, e.g. Adams and Ferreira 2007; Fama and Jensen 1983).

Early studies show conflicting findings regarding the relation between board characteristics and firm financial performance. Yermack (1995) finds evidence consistent with the general consensus that a small board of directors is more effective for value maximization firms (Yermack, 1995). However, a later study shows a U-shaped relation between Tobin's Q and board size, suggesting that either a very small or a very large board is optimal to the firm. Moreover, this relation depends on the complexity (simplicity) of firms and is driven by the number of outside directors (Coles et al., 2008).

2.2 Board independence

The first board characteristic that will be examined is board independence that is described as the percentage of outside directors on the board. The Sarbanes-Oxley Act of 2002 (SOX) requires firms to have a higher percentage of outside directors on the board. This regulation incorporates the idea that outside directors are independent from management and therefore important custodians of shareholder interests (Duchin et al., 2010). Also, both the Nasdaq and New York Stock Exchange require listed firms to use a majority of independent directors on the board (Coles et al., 2008). These regulations stimulate the monitoring role of the board and are in line with the agency theory.

These implemented regulations are backed up by several researches. Conventional wisdom suggests that a greater proportion of outside directors allows for more effective monitoring and improves firm financial performance. Borokhovich et al. (1996) finds a strong positive relation between the percentage of outside directors and the frequency of outside CEO succession. Evidence from stock returns around succession announcements shows that shareholders benefit from CEO replacements (Borokhovich et al., 1996). Board independence also helps control agency problems between shareholders and managers when firms are targets of tender offer bids (Cotter et al., 1998). More recent literature also shows a positive relationship between the fraction of independent directors and firm financial performance. Duchin et al. (2010) find that performance increases when outside directors are added to the board, when the cost of acquiring information is low. Another study finds evidence from Colombian business groups that outside busy directors turned out to be key drivers of improved firm financial performance. The degree of board interlocks also positively affects firm return-on-assets (Pombo & Gutiérrez, 2011).

In contrast, Coles et al. (2008) find a positive relation between the fraction of insiders on the board and the financial performance Tobin's Q for high tech firms. Innovative technology firms seem to benefit from more firm-specific knowledge possessed by insiders (Coles et al., 2008). Further, Masulis & Mobbs (2011) offer new insights on the role of inside directors on corporate boards. Inside directors seem to be well-informed, highly skilled decision managers who improve board decision-making and enhance board disciplinary power over a CEO, especially in firms in which monitoring is more costly for independent directors due to information asymmetry (Masulis & Mobbs, 2011). For firms operating in uncertain environments, insiders are also preferred to apply appropriate strategies (Williamson, 1975; Baysinger and Hoskisson, 1990). High tech firms generally invest greatly in R&D. These investments are a high risk – high return strategy. This is attractive to shareholders because they are able to mitigate their down risk exposure by diversifying their portfolio (Hay & Morris, 1979). Kor (2006) emphasizes the relation between inside directors and investment in R&D. Managers' shared team-specific knowledge positively influences R&D investment intensity (Kor Y. Y., 2006). In addition, insiders' firm-specific experience positively moderates the relationship between R&D deployment intensity and economic returns (Kor & Mahoney, 2005). Therefore, based on the advisory role of the board, a positive relation would be expected between the fraction of insiders and high tech firms. Consequently, the first hypothesis based on the advisory role of the board is as follows:

H1a: The fraction of insiders positively affects firm financial performance for high tech firms.

Moreover, verification costs harm the effectiveness of the board. Firms for which it is difficult to verify projects, such as high tech firms, optimally have a higher proportion of inside directors on the board. When it is difficult to motivate outside directors to verify projects, the firm benefits from relying on competition among insiders, even though the incentives of insiders are distorted by private benefits (Raheja, 2005). Harris and Raviv (2008) also show that outside board control may in fact be value-reducing. Particularly when information asymmetry is high, giving control to outsiders results in a loss of information that is more costly than the agency cost associated with inside control (Harris & Raviv, 2008). Hereby, based on the monitoring role of the board there is a negative relation expected between the fraction of outsiders and high tech firms. Accordingly, the alternative sub-hypothesis based on the monitoring function of the board is as follows:

H1b: The fraction of outsiders negatively affects firm financial performance for high tech firms.

2.3 CEO Duality

The second board characteristic that will be a part of this research is CEO duality, also known as board leadership. “CEO duality exists when a firm’s chief executive also serves as Chairman of the board of directors (Boyd, 1995).” Regarding the agency theory, board leadership is expected to negatively affect firm financial performance. When the CEO and Chairman positions are combined in one person, the internal control of the board will be weakened. Moreover, board leadership promotes CEO entrenchment by reducing board monitoring effectiveness (Finkelstein & D'Aveni, 1994). Board leadership has also been blamed for the governance failures in corporate giants (e.g. Worldcom and Enron) and therefore, most of the governance reforms worldwide have pressured firms to split the CEO and chairman roles (Jackling & Johl, 2009). Braun & Sharma (2007) find evidence in line with the agency theory. For firms where family ownership is low, the separation of CEO and board chair roles is beneficial in terms of shareholders returns. Having different persons occupy the chairman and CEO positions is a useful governance control as the risk of family entrenchment increases (Braun & Sharma, 2007).

However the stewardship theory proposes contrary outcomes. As discussed earlier, according to this theory an executive left on their own will act as a responsible steward of the assets he controls. The more the firm facilitates effective action by the executive, the more it will assist him to attain superior performance. It would be optimal to the extent that the CEO exercises complete authority over the firm and that their role is unchallenged and unambiguous. Accordingly the most preferable situation would be where the CEO is also chair of the board. The unity of power and authority will lead to clearer corporate leadership and will be more consistent for other board members (Donaldson & Davis, 1991). Separating the roles of CEO and chair limits the manager's autonomy to shape and execute the firm's strategy. This lack of authoritative decision-making is likely to negatively affect a firm's financial performance (Corbetta & Salvato, 2004). Summarized, the incumbency of the roles of CEO and chair will enhance effectiveness and produce superior shareholder returns. Adams et al. (2005) developed and tested the hypothesis that firms whose executive managers have more decision-making power should experience more variability in performance. They find that CEO power over the board and other top executives is positively associated with stock-return variability. Their results suggest that firms with powerful CEOs are the ones with both the worst and best performances. In spite of the fact that there is no evidence found that powerful CEOs perform on average worse than other firms, diluting CEO power leads to less variable and less spectacular performance (Adams et al., 2005).

Relating these theories to the technology environment, stewardship theory is expected to be most likely in line with this research. As previous stated, CEOs have unparalleled firm-specific knowledge that is important for the success of the company (Linck et al., 2008). In order to optimally exploit this knowledge, duality would increase chief executive discretion by providing a broader power base (Adams et al., 2005). Elsayed (2007) shows consistent results with the stewardship theory. He included interaction terms between industry dummy variables and CEO duality and found a positive significant relation with Tobin's Q for firms operating in innovative industry segments (Elsayed, 2007).

Furthermore, Brickley, Coles and Jarrel (1997) argue that prospects of being promoted to chairmanship potentially provide important incentives to new CEOs. In presence of an independent chairman, these incentives go to waste (Brickley et al., 1997). Hence, succession processes also appear to be a determinant of board leadership.

Accordingly, the following hypothesis is developed:

H2: CEO duality positively affects financial performance for high tech firms.

2.4 Board size

The general notion is that board size negatively affects firm performance. Smaller groups tend to be more effective at monitoring whereas large boards raise free-riding problems. The evidence of Yermack (1995) presenting an inverse association between board size and firm financial performance is believed to be empirical support. Problems of poor communication and decision-making overwhelm the effectiveness of large boards (Yermack, 1995). Moreover, Lipton et al. (1992) constructed a proposal that a board should be limited to a maximum of ten directors with a ratio of at least two independent directors to any director who has a connection with the firm. When a board exceeds the number of ten members, it becomes more difficult for them all to express their opinions in the limited time available (Lipton & Lorsch, 1992).

However, Klein (1998) suggests that board size depends on a firm's complexity along different dimensions, such as size, scope of operations and the extent of reliance on leverage (Klein, Firm Performance and Board Committee Structure, 1998). Boone et al. (2007) translated this into the *'scope of operations hypothesis'*. This implies that diversified firms that operate into new production segments require knowledge of additional board members to help oversee managers' performance (Boone et al., 2007). Firm size also appears to be an important determinant for board size. Consistent with this hypothesis, Yermack (1995) finds a positive relation between board size and firm size. Third, companies with a high leverage ratio rely heavily on external resources and are in need of greater advisory, which is expected to come from additional directors (Coles et al., 2008; Klein, 1998).

I assume R&D intensive firms to be high-growth opportunity firms because R&D expenditures are standard measures in the literature to proxy for growth opportunities. Although investing in research and development reduces short-term profits, it can significantly boost long-term financial performance (Pearl, 2001). Since monitoring costs increase with a firm's growth opportunities because of specific information unknown to the outside world (Boone et al., 2007), an inverse relation between growth opportunities and board size is expected. Second, firms with high growth opportunities generally require leaner governance structures. These companies usually operate in more volatile business environments and therefore require governance structures that facilitate rapid decision-making (Lehn et al., 2009). Given these two arguments the third hypothesis is as follows:

H3: Board size negatively affects financial performance for high tech firms.

2.5 Board ownership

As earlier discussed, solving the agency problem can be done through monitoring or through ownership by directors. By aligning the interests, inside directors are less likely to engage in managerial entrenchment and will not deploy corporate actions to obtain personal benefits. Also, by increasing board ownership, the directors are entitled to a share of the final value of the firm and therefore are more likely to strive for shareholder value maximization (Raheja, 2005).

Yermack (1995) finds that director stock ownership has a positive association with firm value. Furthermore he states that there are some determinants of board ownership. Directors of small boards and small firms appear to have greater level of stock ownership because directors on small boards are more likely to receive performance-based director fees in the form of stock options, as firms grow over time they become more widely held and dispersed, and small boards are more common in companies controlled by founding families (Yermack, 1995). Bhagat and Black (2002) find similar results. Their findings show a positive association between stock ownership by outside directors and financial performance. They argue that directors with substantial stock ownership act more quickly to replace the CEO (Bhagat & Black, 2002).

As explained above monitoring by the board and board ownership are substitutes to align the interests of shareholders and board members. As previous stated verification costs for outsiders are increasing for high tech firms. Therefore monitoring by the board is more likely to be ineffective. For these firms, board ownership appears to be a better tool to incentivize insiders. Kor (2006) argues that when a firm's competitiveness relies on continuous investments in R&D, it is crucial for organisations to promote a healthy dialogue between the executives and the board. Substituting board monitoring with top management ownership appears to be more effective (Kor Y. Y., 2006). Furthermore, Cui and Mak (2002) find that the relationship between Tobin's Q and managerial ownership is a W-shaped function for high tech firms. First Q falls, then rises and falls and rises again. They show that director ownership already plays a greater role for high R&D firms. In order to align interest it requires significantly higher managerial ownership (Cui & Mak, 2002). Hence, I expect a positive relation between board ownership and firm financial performance for R&D Intensive firms. This leads to the fourth hypothesis:

H4: Board ownership positively affects financial performance for high tech firms.

2.6 Director's age

Another board characteristic that could affect firm performance is the average age of the directors. As discussed earlier, a firm's complexity is an important determinant for board structure. Large firms with more complex production processes lead to more hierarchy within the firm (Fama & Jensen, 1983). More hierarchical structure of large companies subsequently results into a need for senior directors consisting of more experience (Rajan & Zingales, 2001).

Besides a firm's complexity, the industry in which a firm operates also appears to be an important determinant of board structure. In particular the technology industry tends to affect board composition (Boone et al., 2007; Forbes & Milliken, 1999). Kotz (1998) proposes that if boards are to assess the competence of management and provide advice, their members must have firm-specific knowledge that exceeds the ordinary requirements of board service. Therefore, high tech firms are willing to enhance the firm-specific knowledge of their boards by adding insiders to the board and favouring young directors with current technological knowledge over older directors with prestigious appointments (Kotz, 1998). A more recently study shows similar results. Francis et al. (2015) examine the effect of having academic professors in the boardroom on firm (non) financial performance. They find a positive association, however after controlling for director age they find a negative relation between director age and firm performance measured by Tobin's Q. This indicates that firms with younger academics perform better than firms with older academic directors (Francis et al., 2015). Accordingly, I expect an inverse relation between the average age of the board and firm performance for high tech firms.

H5: The average director's age negatively affects financial performance for high tech firms.

2.7 Non-financial performance

I also examine the influence of 'the usual suspects' (board independence, CEO duality, and board size), board ownership, and director's age on the non-financial performance measure innovation. As stated in chapter 1, following Kor (2006) I use R&D intensity as a proxy for innovation. One of the key drivers of sustainability for high tech firms is investing in innovation. High tech firms need to produce a steady stream of innovations in order to survive in hypercompetitive technology markets (Balkin et al., 2000). Prior literature shows clear examples of how boards of directors can significantly influence firm innovation by shaping the context for executives' behaviour (Stiles, 2001). As discussed earlier, inside directors own proprietary high tech expertise. Therefore managers are inclined to invest in R&D projects that will ensure firm long-term performance (Choi et al., 2012). Hence, I expect a positive relation between the fraction of insiders on the board and investment in innovation (H1).

Innovation also tends to be affected by the size of the board. As already explained, larger groups are prone to poor decision-making and free-riding problems. Reaching a compromise becomes especially difficult when directors must deal with firm-specific knowledge and riskiness of innovation project (Zano et al., 2013). Therefore, I expect a negative relation between board size and innovation (H2).

Opportunities move quickly for firms operating in fast-paced environments. CEOs of high tech firms are aware that once a firm is behind its competitors, it is difficult to catch up. In line with the reasoning above, such firms benefit from quick decision-making. Powerful CEOs minimize the potential for conflicts and encourage directors with human and social capital to provide on-going advice and resources for R&D investment to enhance firms' innovation capabilities (Chen, 2014). Chen (2014) finds that board capital has a positive effect on R&D investments and that CEO power (indicator: CEO duality) positively moderates this effect. Based on prior literature I expect innovation to be positively affected by CEO Duality (H3).

One way to incentivize executive directors to invest in innovation is to incorporate innovation measures in their compensation contracts. Holthausen et al. (1995) argue that firms confronting substantial growth opportunities will attempt to provide executive directors with greater incentives to invest in innovation. Therefore compensation in the form of stock options should be tied to long-term performance (Holthausen et al., 1995). Besides, executive directors of R&D intensive firms are often already rewarded in the form of stocks or stock options. In this way they are more likely to invest in R&D investments that increases long-term performance (Cui & Mak, 2002). Furthermore, non-executive directors with high share ownership are likely to insist on good environmental management because they are more likely to recognize the benefits in the long run of investing in innovation. Hence, based on the monitoring role, high ownership motivates directors to pursue green products and process innovations to enhance shareholder value in the long run (de Villiers et al., 2011). I therefore expect a positive effect of director ownership on investment in innovation (H4). Finally I hypothesize that director's age negatively affects investment in innovation (H5) for the same reasons as above that high tech firms prefer younger inside directors with current technological knowledge.

2.8 Summary

To summarize, in this thesis the effect of several board characteristics on (non) financial performance will be investigated. Following prior literature, I use Tobin's Q and R&D intensity as proxies for financial and non financial performance respectively (Coles et al., 2008; Kor, 2006). I will emphasize the two roles of the board in high tech firms. Based on the monitoring and advisory role I developed six hypotheses as shown in table 1. According to the stewardship theory and the required firm-specific knowledge is a positive relation expected between the fraction of insiders and (non) financial performance. The same arguments hold for CEO duality. Since monitoring costs increase with growth opportunities and growth firms benefit from rapid-decision making, an inverse relation between board size and (non) financial performance is expected. Director ownership seems to be more effective than monitoring by the board for R&D intensive firms. Therefore a positive relation is expected between board ownership and (non) financial performance. Finally the effect of director's age on financial performance will be examined. High tech firms tend to prefer younger directors on the board with current technological knowledge to older directors with prestigious appointments. Therefore a negative relation is expected between director age and financial performance.

Table 1: Summary hypotheses

Hypotheses	Dependent variable:	Expected Relation
H1a: "The fraction of insiders has a positive association with firm financial performance for high tech firms."	(non) Financial Performance	+
H1b: "The fraction of outsiders has a negative association with firm financial performance for high tech firms."	(non) Financial Performance	-
H2: "CEO duality improves financial performance for high R&D firms."	(non) Financial Performance	+
H3: "There is an inverse relation between high tech firms and board size that improves firm performance."	(non) Financial Performance	-
H4: "Board ownership has a positive effect on firm financial performance for R&D Intensive firms."	(non) Financial Performance	+
H5: "The average director's age is negatively related to firm financial performance for high tech firms."	(non) Financial Performance	-

3. Research Design

This part of the thesis describes the sample and data. The regression models that are used will be provided with the corresponding link between these models and the hypotheses. Furthermore, the theoretical constructs that are tested will be discussed and how they can be operationalized. Finally the control variables that need to be included are given and the internal and external validity of the thesis is discussed.

3.1 Theoretical constructs and regression models

The dependent variable of interest for the first five hypotheses is the financial performance measure Tobin's Q. The first hypothesis argues that inside directors positively affect Tobin's Q for high tech firms. Executive directors serve an advisory role and consequently enhance financial performance for R&D intensive firms. Therefore the main explanatory variable in the first regression model is the fraction of inside directors. To capture the sole effect of having insiders on the board on Tobin's Q for high tech firms, I introduce an interaction term of the percentage of insiders with the dummy variable 'HTdummy'. This interaction term is expected to be positive. The specification for hypothesis 1a is:

$$Q = \alpha + \beta 1 Fraction\ Insiders + \beta 2 Fraction\ Insiders * HTdummy + \delta\ HTdummy + Controls + \varepsilon$$

While independent directors are viewed as effective monitors, the monitoring function by outsiders tends to be ineffective for R&D intensive firms. Hypothesis 1b argues that outsiders negatively affect financial performance for high tech firms. The specification for hypothesis 1b is:

$$Q = \alpha + \beta 1 Fraction\ Outsiders + \beta 2 Fraction\ outsiders * HTdummy + \delta\ HTdummy + Controls + \varepsilon$$

The variable of interest for both hypotheses is $\beta 2$. Hypothesis 1a predicts that inside directors enhance financial performance for high tech firms, hence $\beta 2$ should be positive. In contrary, hypothesis 1b predicts that outside directors negatively affect financial performance for R&D intensive firms. Subsequently, $\beta 2$ should be negative. The radical switch to more board independence around the turn of the century and the implemented regulation (SOX) imply that independent directors enhance effective monitoring and increase financial performance. Accordingly, by examining the effect of outsiders on the whole sample as captured by $\beta 1$, I expect a positive coefficient that is in line with the agency theory.

Hypothesis 2 predicts that board leadership improves firm financial performance for R&D intensive firms. According to the stewardship theory and the existence of information asymmetry particularly in high tech firms, a combined chair and CEO will increase financial performance. To isolate the effect of board leadership on the financial performance for high tech firms, I will again include the variable HTdummy to capture the interaction effect. The specification is as follows:

$$Q = \alpha + \beta 1 DUALITY + \beta 2 DUALITY * HTdummy + \delta\ HTdummy + Controls + \varepsilon$$

Hypothesis 2 predicts that $\beta 2$ is positive which is in line with the stewardship theory. According to the agency theory, board leadership promotes managerial entrenchment causing agency costs. Therefore by examining board leadership on the full sample I expect $\beta 1$ to be negative that is in line with the agency theory.

The third hypothesis predicts a negative relation between board size and financial performance for high tech firms. Since monitoring costs increase with a firm's growth opportunities because of information asymmetry, Tobin's Q is expected to be negatively affected by additional board members. The specification for hypothesis 3 is as follows:

$$Q = \alpha + \beta 1 BOARDSIZE + \beta 2 BOARDSIZE * HTdummy + \delta\ HTdummy + Controls + \varepsilon$$

While prior literature also shows a negative relation between board size and financial performance (Yermack, 1995), I expect this negative relation to be stronger for R&D intensive firms. Therefore both $\beta 1$ and $\beta 2$ should show a negative relation with Q, however I expect $\beta 2$ to be smaller than $\beta 1$.

The fourth hypothesis argues that director ownership positively affects financial performance for high tech firms. Board ownership tends to be a more effective substitute than board monitoring for growth firms due the existence of verification costs (Raheja, 2005). The specification for the fourth hypothesis is as follows:

$$Q = \alpha + \beta 1 BOARDOWNERSHIP + \beta 2 BOARDOWNERSHIP * HTdummy + \delta\ HTdummy + Controls + \varepsilon$$

Board ownership appears to be an effective tool to align interests, especially for firms where firm-specific knowledge of inside directors is relatively important. Therefore according to the agency theory, I expect both $\beta 1$ and $\beta 2$ to be positive. However I expect this effect to be stronger for high tech firms. Hence, $\beta 2$ should be bigger than $\beta 1$.

Finally, hypothesis five examines the effect of director's age on financial performance. Large firms with subsequently more hierarchical structures result in a need for senior directors consisting of more experience (Rajan & Zingales, 2001). However, R&D intensive firms appear to benefit from younger directors with current technological knowledge (Kotz, 1998; Francis et al., 2015). The specification for hypothesis five is as follows:

$$Q = \alpha + \beta 1 DIRAGE + \beta 2 DIRAGE * HTdummy + \delta\ HTdummy + Controls + \varepsilon$$

The explanatory variable of interest is the interaction term $\beta 2$ that reflects the isolate effect of director's age on Q in high tech firms, which I expect to be negative. Furthermore, $\beta 1$ is expected to be positive in line with previous literature.

To investigate the effect of board structure on innovation I perform similar regressions based on the existing regression models. However I replace the dependent variable Tobin's Q with the proxy for innovation: R&D investment intensity. R&D investment intensity is here calculated as R&D expenditures over the firm's assets. The specifications for examining the effect of board structure on innovation are shown in table 2. The predicted signs of the variables of interest are the same as under the hypotheses regarding firm financial performance. High tech firms are assumed to benefit from investment in innovation. Every investment in innovation for R&D intensive firms is expected to increase Q.

Table 2: Regression models with as dependent variable 'Innovation'

Innovation = $\alpha + \beta 1$*Fraction Insiders +* $\beta 2$*Fraction Insiders*HTdummy + δ HTdummy + Controls +* ε	*(1a&b)*
Innovation = $\alpha + \beta 1$*DUALITY +* $\beta 2$*DUALITY*HTdummy + δ HTdummy + Controls +* ε	*(2)*
Innovation. = $\alpha + \beta 1$*BOARDSIZE +* $\beta 2$*BOARDSIZE*HTdummy + δ HTdummy + Controls +* ε	*(3)*
Innovation = $\alpha + \beta 1$*BOARDOWNERSHIP +* $\beta 2$*BOARDOWNERSHIP*HTdummy + δHTdummy + Controls +* ε	*(4)*
Innovation = $\alpha + \beta 1$*DIRAGE +* $\beta 2$*DIRAGE*HTdummy + δ HTdummy + Controls +* ε	*(5)*

3.2 Explanation and operationalization of the variables

This research is interested in the effect of several board characteristics on firm (non) financial performance for high tech firms. The preference of Tobin's Q as financial performance measure over an accounting performance measure such as Return on Assets (ROA) is because of the particularly interest in R&D intensive firms. The high business risk and uncertainty for these firms result in significant variation in their profits, making accounting numbers less informative about financial performance. Hence, ROA is a poor predictor of future earnings for high tech firms (Cui & Mak, 2002). Following Coles et al. (2008) Tobin's Q is measured as book assets minus book equity plus market value of equity all divided by book assets. Because data on replacement cost of assets or market value of debt is unavailable, it only is an approximation. However this calculation is consistent with much of prior literature. In addition, Chung and Pruitt (1994) show that this estimate explains at least 96.6% of the variability of the Tobin's Q obtained via Lindenberg and Ross' (1981) more theoretically correct model (Chung & Pruitt, 1994).

The main explanatory variables of interest are: fraction of insiders and outsiders, CEO duality, board size, board ownership, and director's age. The measure for insiders is the percentage of inside directors over the total board members. Similarly, the measure for outsiders is the percentage of outside directors over the total board members. CEO duality is the explanatory dummy variable of interest that is defined as one when the CEO is also the Chairman of the Board (COB) and otherwise zero. Board size is simply measured as the number of directors on the board. Board ownership is measured as the average shares held by the directors per firm over the total shares outstanding. Finally, director's age is measured as the average age of the directors per firm.

In order to capture high tech firms I use Standardized Industry Classification (SIC) codes based on 3 digits that indicate the industry group. Following prior literature I define all firms with the SIC codes 283, 366, 367, or 737 as high tech firms, which is widely applied in empirical research (Barron et al., 2002; Bowen et al., 2005; Guo et al., 2005). The dummy variable 'HTdummy' equals one if the firm has a SIC code of either one of the above and otherwise zero. By using this method, 19.5% of the sample is identified as high tech firms and subsequently 85.5% is identified as low tech firms.

To check whether the results are robust I include several control variables based on prior literature that are expected to influence either Tobin's Q or the board characteristics. A firm's profitability has a significant impact upon its market value and therefore ROA is included in the regression model as explanatory variable (Yermack, 1995). Other control variables that are expected to affect either (non) financial performance or board structure are firm size, as the logarithm of sales, growth opportunities as the market to book ratio (MTB) and R&D expenditures, firm age, CEO ownership, CEO age, CEO tenure, and the leverage ratio (Linck et al., 2008; Bhagat and Black, 2001; Hermalin and Weisbach, 2001). Furthermore to mitigate endogeneity concerns I include year and industry fixed effects.

Finally I will perform an additional test to examine the effect of several board characteristics on firm non-financial performance. The importance of innovation for high tech firms has already been extensively discussed. Therefore the second dependent variable of interest is innovation. Following Kor (2006) I will use R&D investment intensity to capture innovation. R&D investment intensity is typically calculated as the level of R&D expenditures divided by the organisation's assets (Kor Y. Y., 2006).

As alternatives to the dependent variables Tobin's Q and R&D investment intensity, I will also use ROA and R&D expenditures divided by a firm's sales respectively. Standardizing R&D investments by total assets seems to be preferred since some firms do not have sales in the early years of product development (Kor Y. Y., 2006).

3.3 Data and sample

I start with all US based publicly listed firms from the ISS Directors (formerly RiskMetrics) database between 2007 and 2015. From this sample, I select all firms with information available on board composition and board size for more than two years. Firms with fewer than three board members are excluded to eliminate potential data errors. ISS Directors identifies whether the director is an employee/insider, an independent director, or linked to the firm. I classify all board members that are officers at the firm as insiders and combine affiliated and independent directors as outsiders, as is common in previous literature (Lehn et al., 2009; Coles et al., 2008).

Hereafter the population is matched to Compustat and the sample consists of 6,174 firm-year observations. Following Yermack (1995), I omit utility and financial companies (sic codes 4900-4950) because of concerns that government regulation leads to more limited roles for their directors and consequently lose 354 observations. Subsequently, the final sample includes 5,820 firm-year observations.

3.4 Internal and external validity

In order to discuss the internal and external validity of this research I use the predictive validity framework, best known through its visual representation in "Libby Boxes" (Libby, 1981). The top boxes in figure 1 in the appendix are the underlying constructs and the bottom boxes represent the proxy measures for each construct. This framework clarifies the relations of the models described earlier.

Internal validity is the confidence one can have in inferring a causal relationship among variables while simultaneously eliminating rival hypotheses. Generally, internal validity focuses on whether the independent variable is the cause of the dependent variable (Heppner, Kivlighan, & Wampold, 1992). Internal validity can visually be determined through arrow four from the Libby Boxes in figure 1 of the appendix. Prior literature questions the informativeness of a standard empirical design that regresses board structure on performance. Typically it is difficult for such designs to solve the standard endogeneity and causation problems since board characteristics, in turn, are determined by Tobin's Q (Bhagat & Black, 2002; Coles et al., 2008). Moreover, a firm's performance is influenced by numerous factors. I try to address this concern by employing various control variables and year and industry fixed effects in order to increase the internal validity. However it is nearly impossible to incorporate all variables that influence either board structure or (non) financial performance in the models. The omitted variables and causation problems contribute to the low internal validity of this research.

External validity refers to the generalizability of the findings. Since I use real world data obtained from ISS Directors and Compustat that covers a relatively large sample of US listed companies, I expect a relatively high level of external validity. However this thesis focuses on R&D intensive firms and therefore I expect these results to be generalizable within the high tech industry.

4. Empirical results and analysis

This chapter describes the statistical tests and results in detail and the explanation of how to account for outliers. It starts in section 4.1 with descriptive statistics consisting of board structure, firm and CEO characteristics for high tech firms and the full sample. Hereafter in section 4.2-4.4 the OLS regression analysis is presented and the results are provided.

4.1 Descriptive statistics

Table 3 provides summary statistics on board structure and firm and CEO characteristics. The average board has 9 board members, consisting of insiders and outsiders for 16.7% and 83.3% respectively. Previous studies show similar numbers regarding the percentage of insiders and outsiders with an insider fraction of approximately 0.20 (Coles et al., 2008; Bhagat & Black, 2001). However, Yermack (1996) reports that the average firm has 12 board members with an insider fraction of 0.33. This shows the shift towards a more independent board after the major corporate scandals around the turn of the century. The average director is 63 years old and has an ownership of 0.6%.

The average firm in the sample has sales of $7.1 billion and total assets of $7.9 billion. Mean leverage to book value of assets is 0.495 and the average firm has R&D expenditures to book value of assets (R&D intensity) of 2.96%. The mean CEO ownership is 2.58% and is also comparable with Coles et al. (2008) and Bhagat and Black (2001). Because this sample is obtained from Compustat it includes relatively large firms for which CEO ownership is relatively low. The number of firm-year observations for the CEO characteristics is slightly lower compared to the number of observations for board and firm characteristics because ISS Directors does report that some firms in a given year are lacking a CEO. This causes no issues regarding the regression models, since the CEO characteristics are not the coefficients of interest but are instead used as control variables. Moreover the number of firm-year observations of the CEO characteristics is still having a significant magnitude.

Table 3: Summary statistics

Variables	(1) N	(2) Mean	(3) Min	(4) Max	(5) Median	(6) 25th percentile	(7) 75th percentile
Board characteristics							
Board size	5,820	9	4	23	9	8	10
Fraction insiders (%)	5,783	16.7	5.9	60	14.3	11.1	20
Director's age (average)	5,811	63	46	79	63	60	65
CEO duality (dummy) (%)	5,820	8	0	1	0	0	0
Fraction outsiders (%)	5,783	83.3	40	94.1	85,7	80	88.9
Board ownership (%)	5,820	0.007	0	43.3	0.005	0.000	0.005
Firm characteristics							
Total assets ($millions)	5,818	8,867.92	44.31	797,769	1,868.65	711.50	5,760
R&D expenditures ($millions)	5,820	189.51	0	10,991	3.3	0	61.55
ROA	5,820	0.05	-1.7	0.51	0.06	0.03	0.10
ROE	5,818	0.11	-49.52	70.38	0.12	0.05	0.19
Tobin's Q	5,785	4.84	1.02	72.1	3.17	2.11	5.36
MTB	5,813	918.98	-357,008	1,020,718	150.53	58.59	477.45
Firm age (years)	5,820	4.24	2	8	4.00	3.00	6.00
MVE ($millions)	5,816	9350.23	24.68	626,550.	1916.82	724.77	6114.77
Leverage ratio	5,790	0.495	0.0392	2.310	0.50	0.35	0.62
High tech dummy	5,820	0.195	0	1	0	0	0
Employees (millions)	5,820	24.91	1	2200	6.3	2.2	18.8
Sales ($millions)	5,820	7,960	2.96	467,231	1,783	707	5,425
R&D Intensity (%)	5,818	2.96	0	60.1	0.3	0.00	3.9
CEO characteristics							
CEO age	4,656	56	33	97	56	52	61
CEO tenure (years)	4,656	11	1	39	7	3	13
CEO ownership (%)	4,656	2.66	0	25.9	1.00	0.39	2.4

I compare board structure across various subsamples of firms to provide an initial assessment of the hypotheses using a t-test. Table 4 presents the results. As previous stated I distinguish board composition and characteristics between high R&D firms and low R&D firms based on industry group using SIC codes. Under the assumption that firms choose board structure to maximize firm (non) financial performance (Wintoki, 2007), I should observe a difference between board composition and leadership across the two different subsamples.

Table 4: Comparing the means between High tech and low tech firms

	High tech		Low tech			
Variables	N	Mean	N	Mean	Difference	*t*-statistic
Board characteristics						
Board size	1,136	8.34	4,684	9.19	0.85	12.35***
Fraction Insiders (%)	1,125	17.31	4,658	16.59	-0.73	-2.53***
Director's Age (average)	1,136	62.25	4,675	62.64	0.39	2.98***
CEO Duality (dummy) (%)	1,136	6.95	4,684	8.24	1.29	1.43*
Fraction Outsiders (%)	1,125	82.69	4,658	83.41	0.73	2.53***
Board Ownership (%)	1,134	0.54	4,673	0.68	0.14	2.68***

*** Significance at 1% level

In line with hypothesis 1, I observe a higher (lower) fraction of insiders (outsiders) for high tech (low tech) firms. The difference of 0.73% is significantly different from zero (t=2.53) at the 1 percentage level. Board leadership appears to be more common in low R&D firms compared to high R&D firms, which is the contrary of the prediction of hypothesis 2. The prediction of hypothesis 3 that high tech boards should be smaller than low tech boards is consistent with the results above. The average board size of high tech and low tech firms is 8.34 and 9.19 respectively and this difference is statistically significant (p=0.00). While the results above reject hypothesis 4 that board ownership should be higher for high tech firms than for low tech firms ($p<0.01$), hypothesis 5 that the average age of the board is lower for high tech firms is confirmed by the results.

4.2 Empirical Analysis

Section 4.1 provided an initial analysis and compared board structure using descriptive statistics across the two subsamples. However, the initial assessment that produced mixed results does not control for other determinants of board characteristics, Q, and innovation. This section extends the analysis by using ordinary least squares (OLS) estimations of the specifications provided in section 3. I will first examine the influence of board characteristics on the financial performance measure Tobin's Q and isolate the effect for high tech firms. Thereafter, Tobin's Q will be replaced by innovation as the dependent variable to investigate the effect of board structure on non-financial performance.

First in order to properly use OLS I test whether the dependent variables Tobin's Q and R&D intensity (innovation) are normally distributed. Figure 2 and 3 in the appendix show the distribution of the dependent variables. Tobin's Q appears to be highly skewed (Kurtosis value of 28.92), which can be observed in figure 2a. To overcome this problem I take the logarithm of Q. Figure 2b shows a normal distribution of Q with a corresponding Kurtosis value of 3.49. Moreover it is preferred to use the logarithm of Q since Q depends on market value of equity that in turn is influenced by stock prices that are normally distributed. R&D intensity (innovation) is also highly skewed since approximately 40-50% of the firm-year observations have zero R&D expenditures. Figure 3 shows the density plot of innovation. Where figure 3a shows signs of skewness (Kurtosis value of 18.53), figure 3b shows a much more normal distribution of innovation when log(Innovation) is been used (Kurtosis value of 4.15). Therefore the logarithm of both Q and innovation will be used in the regressions below. Since 40-50% of the firm-year observations have zero R&D expenditures, I lose approximately 2,700 observations when regressing board structure on log(Innovation).

Because the variables of interest are the interaction terms in the regression models, multicollinearity is cause for concern. In order to resolve this issue I follow the method of Kor (2006) where centered values of variables are used for the estimation of interaction effect models. The corresponding correlation matrix is given in table 15 in the appendix.

4.3 Effect of board structure on Tobin's Q

Table 5 reports the results of the OLS regression models given in section 3. Hypothesis 1a argues that executive directors enhance financial performance for R&D intensive firms due the existence of information asymmetry particularly in this industry. The regression coefficient of the interaction term 'Fraction Insiders x HTdummy' ($\beta 2$=1.153; p<0.01) in model 1 is significantly positive indicating that an increase in the fraction of insiders leads to an increase in financial performance for high tech firms. Moreover hypothesis 1a predicts that this effect is stronger for high tech firms. Consistent with the results of Coles et al. (2008), I find that $\beta 2 > \beta 1$. Consequently, the complete opposite effect is observed in model 2 when the fraction of outsiders is tested on Tobin's Q. Hypothesis 1b argues that independent directors are ineffective monitors particularly in the high tech environment. Hence, I observe that $\beta 2' < \beta 1'$ and statistically significant. Furthermore, according to the agency theory $\beta 1'$ should be positive indicating that outside directors are effective monitors and solve agency costs for low tech firms. This predicted relation is also observed ($\beta 1'$=0.083), yet not of statistical significance.

Model 3 examines the effect of board leadership on financial performance. Hypothesis 2 predicts, in line with the stewardship theory, that high tech firms benefit from strong leadership and forecasts a positive regression coefficient ($\beta 2^*$). Consistent with the predictions, I find a positive significant effect of CEO duality on a firm's financial performance ($\beta 2^*$=0.091; p<0.10). Furthermore when regressing the role of a combined CEO and chair on low tech firms, a significant negative relation is observed ($\beta 1^*$=-0.073; p<0.01) that is line with the agency theory. Hence hypotheses 1a, 1b and 2 are accepted.

Table 5: Does Tobin's Q increase with the fraction of insiders and CEO duality for high tech firms?

		Dependent Variable: Log(Tobin's Q)		
		(1)	(2)	(3)
Independent Variables		Model 1	Model 2	Model 3
Fraction Insiders	$\beta 1$	-0.083		
		(0.0875)		
Fraction Insiders x HTdummy	$\beta 2$	1.153***		
		(0.168)		
R&D Expenditures		0.001***	0.001***	0.001**
		(0.001)	(0.001)	(0.001)
ROA		1.702***	1.702***	1.643***
		(0.053)	(0.053)	(0.053)
MTB		0.001**	0.001**	0.001**
		(0.001)	(0.001)	(0.001)
Firm Age		0.027***	0.027***	0.026***
		(0.007)	(0.007)	(0.007)
Firm Size		-0.044***	-0.044***	-0.048***
		(0.005)	(0.005)	(0.005)
CEO Age		-0.001**	-0.001**	-0.001***
		(0.001)	(0.001)	(0.001)
CEO Tenure		-0.001	-0.001	-0.001
		(0.001)	(0.001)	(0.001)
CEO Ownership		-0.004	-0.004	0.038
		(0.115)	(0.115)	(0.113)
Leverage Ratio		-1.998***	-1.998***	-2.000***
		(0.033)	(0.033)	(0.033)
HTdummy		-0.063	1.090***	0.124
		(0.099)	(0.170)	(0.096)
Fraction Outsiders	$\beta 1'$		0.082	
			(0.087)	
Fraction Outsiders x HTdummy	$\beta 2'$		-1.153***	
			(0.168)	
CEO Duality	$\beta 1^*$			-0.073***
				(0.025)
CEO Duality x HTdummy	$\beta 2^*$			0.091*
				(0.050)
Constant		2.515***	2.432***	2.580***
		(0.115)	(0.129)	(0.114)
Observations		5,733	5,733	5,768
R-squared		0.709	0.709	0.703
Industry FE		YES	YES	YES
Year FE		YES	YES	YES
Adjusted R-squared		0.700	0.700	0.691
Model F-value		60.00***	60.00***	58.56***

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 6: Does Tobin's Q decrease in board size and increase in board ownership and director's age for high tech firms?

		Dependent Variable: Log(Tobin's Q)		
		(1)	(2)	(3)
Independent Variables		Model 1	Model 2	Model 3
Board Size	$\beta 1$	0.009**		
		(0.003)		
Board Size x HTdummy	$\beta 2$	-0.061***		
		(0.007)		
R&D Expenditures		0.001***	0.001**	0.001*
		(0.001)	(0.001)	(0.001)
ROA		1.636***	1.646***	1.657***
		(0.052)	(0.053)	(0.052)
MTB		0.001**	0.001**	0.001**
		(0.001)	(0.001)	(0.001)
Firm Age		0.026***	0.026***	0.028***
		(0.006)	(0.007)	(0.007)
Firm Size		-0.047***	-0.049***	-0.045***
		(0.005)	(0.005)	(0.005)
CEO Age		-0.001***	-0.001***	-0.001***
		(0.001)	(0.001)	(0.001)
CEO Tenure		-0.001	-0.001	-0.001
		(0.001)	(0.001)	(0.001)
CEO Ownership		0.034	0.047	0.046
		(0.113)	(0.114)	(0.113)
Leverage Ratio		-1.999***	-1.995***	-1.993***
		(0.033)	(0.033)	(0.033)
HTdummy		0.656***	0.128	0.702***
		(0.115)	(0.097)	(0.220)
Board Ownership	$\beta 1'$		-0.310	
			(0.381)	
Board ownership x HTdummy	$\beta 2'$		-0.649 (1.107)	
Director's Age	$\beta 1^*$			-0.007***
				(0.002)
Director's Age x HTdummy	$\beta 2^*$			-0.010*** (0.003)
Constant		2.446***	2.574***	2.951***
		(0.114)	(0.114)	(0.156)
Observations		5,768	5,768	5,768
R-squared		0.706	0.703	0.705
Industry FE		YES	YES	YES
Year FE		YES	YES	YES
Adjusted R-squared		0.694	0.691	0.693
Model F-value		59.49***	58.46***	59.21***

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 6 reports the results of hypotheses 3 to 5. Model 1 measures the impact of board size on Q and reports a positive significant effect ($\beta 1$=0.009) at the 10 percent level indicating that financial performance increases with board size for low tech firms. Further, the coefficient on the interaction ($\beta 2$) of board size and HTdummy is significantly negative ($\beta 2$=-0.061; p=0.00), which supports hypothesis 3 that a large board is ineffective especially for high tech firms where monitoring costs increase with growth opportunities. Therefore $\beta 2 < \beta 1$ and hypothesis 3 is accepted.

In model 2, I find a negative effect of board ownership on financial performance Q ($\beta 1'$=-0.310) for the full sample. Monitoring by outside directors appears to be more effective than director's ownership for low tech firms, as is observed in table 5. Surprisingly, the coefficient on the interaction of board ownership and HTdummy is negative suggesting that ownership by the directors is also an ineffective tool to align interests for high tech firms. However both the coefficients ($\beta 1'$& $\beta 2'$) are not of statistical significance.

Model 3 provides the results of regressing the average age of the board on the financial performance measure Q. Hypothesis 5 argues that R&D intensive firms favor younger directors with current technological knowledge over older directors with prestigious appointments. Consistent with Francis et al. (2015) I find that the coefficient of director's age ($\beta 1^*$=-0.007; p=0.00) is significantly negative suggesting that older directors harm financial performance for low tech firms. The coefficient on the interaction term ($\beta 2^*$=-0.010) is also significantly negative at the 1 percent level. I observe that $\beta 2^* < \beta 1^*$. Hence, hypothesis 5 predicting that the negative relation between director's age and financial performance is larger for high tech firms is accepted. Furthermore the control variable CEO Age influences Q significantly negatively, suggesting that firms do benefit from having a younger CEO. However this effect is not of economically significance.

4.4 Effect of board structure on innovation

This section provides the results of the regression models given in section 3 related to innovation. Table 7 reports the results of the first 3 models. The predicted signs of the models are the same as for the models with dependent variable Q, since I hypothesize that innovation key is for the profitability and sustainability of high tech firms (Balkin et al., 2000). Model 1 measures the effect of the fraction of inside directors on innovation and reports a positive significant interaction coefficient ($\beta 2$=0.853; p<0.05) indicating that insiders enhance firm innovation for R&D intensive firms. A negative relation (β1=-0.470) is observed between insiders and innovation on the full sample suggesting that inside directors do not increase innovation for low tech firms, yet this effect is not statistically significant. Therefore $\beta 2 > \beta 1$ and hypothesis 1 is accepted.

In model 2 CEO duality is included in the regression. The value of the variable of interest is positive (β2'=0.024) and confirms the prediction that innovation increases with CEO duality for high tech firms, in line with the stewardship theory. The regression coefficient β1' also appears to be positive suggesting that board leadership positively affects investment in innovation for the full sample. However both the regression coefficients are not statistically significant.

Model 3 provides regression results of the effect of board size on the non-financial performance measure innovation. Since monitoring costs increase in growth opportunities and these R&D intensive firms generally require leaner governance structures, I hypothesize that board size negatively affects a firm's innovation for high tech firms. Consistent with this prediction, the regression coefficient on the interaction term ($\beta 2*$=-0.070; p=0.00) is significantly negative. The regression coefficient ($\beta 1$*=0.029; p<0.01) appears to be significantly positive indicating that an increase in board members leads to an increase in innovation for low tech firms. Accordingly, Hypothesis 3 that $\beta 2* < \beta 1*$ is accepted.

Table 7: Does innovation increase in insiders and CEO duality and decrease in board size for high tech firms?

		Dependent Variable: Log(Innovation)		
		(1)	(2)	(3)
Independent Variables		Model 1	Model 2	Model 3
Fraction Insiders	$\beta 1$	-0.478		
		(0.303)		
Fraction Insiders x HTdummy	$\beta 2$	0.853**		
		(0.405)		
ROA		-0.277**	-0.324***	-0.337***
		(0.126)	(0.123)	(0.123)
MTB		0.001	0.001	0.001
		(0.001)	(0.001)	(0.001)
Firm Age		0.004	0.001	0.001
		(0.017)	(0.017)	(0.017)
Firm Size		-0.047***	-0.047***	-0.042***
		(0.012)	(0.011)	(0.014)
CEO Age		0.0019*	0.003***	0.002***
		(0.001)	(0.001)	(0.001)
CEO Tenure		-0.009***	-0.009***	-0.009***
		(0.002)	(0.002)	(0.002)
CEO Ownership		1.367***	1.367***	1.331***
		(0.427)	(0.424)	(0.423)
Leverage Ratio		-0.328***	-0.301***	-0.348***
		(0.086)	(0.085)	(0.085)
HTdummy		-0.328	-0.231	0.420
		(0.286)	(0.281)	(0.315)
CEO Duality	$\beta 1'$		0.059	
			(0.089)	
CEO Duality x HTdummy	$\beta 2'$		0.024	
			(0.124)	
Board Size	$\beta 1^*$			0.029***
				(0.011)
Board Size x HTdummy	$\beta 2^*$			-0.070***
				(0.015)
Constant		-2.058***	-2.115***	-2.421***
		(0.327)	(0.319)	(0.325)
Observations		2,986	3,002	3,002
R-squared		0.686	0.685	0.687
Industry FE		YES	YES	YES
Year FE		YES	YES	YES
Adjusted R-squared		0.671	0.669	0.672
Model F-value		43.52***	43.48***	43.92***

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

The remaining regression models are reported in table 8. The average shares held by the board are regressed on innovation in model 1. Since I predict that investing in R&D creates shareholder value in the long run, board ownership is expected to positively affect innovation. Moreover (executive) directors of high tech firms are likely to be rewarded in stock (options) and are therefore stimulated to produce a steady stream of innovations (Cui & Mak, 2002). Surprisingly I observe opposite effects. The interaction term ($\beta 2$) is significantly negative suggesting that ownership by the board negatively affects investment in innovation for high tech firms. Further $\beta 1$ appears to be significantly positive suggesting that innovation increases with board ownership for low tech firms. Consequently, hypothesis 4 that board ownership is positively related with innovation especially for high tech firms is rejected. Yet both coefficients are significant only at the 10 percent level. An alternative explanation for this phenomenon could be that incentive alignment through ownership effective is particularly for executive directors (Kor Y. Y., 2006). Subsequently, I observe that CEO ownership significantly positively associated is with innovation at the 1 percent level for all 5 models that supports the assumption that incentive alignment through managerial ownership increases investing in innovation.

Finally, model 2 reports the findings from the effect of the average director's age on innovation. Consistent with the theory of Kotz (1998) that high tech firms prefer younger directors with current technological knowledge to enhance long-term firm value, I find a significantly negative relation between director's age and innovation for R&D intensive firms ($\beta 2'$=-0.026; p<0.01). The coefficient representing the effect of director's age on innovation for the full sample ($\beta 1$) appears to be positive but is not statistically significant. Therefore, this model finds strong supporting evidence for the hypothesis that younger directors enhance innovation for high tech firms.

Table 8: Does innovation increase in board ownership and decrease in director's age for high tech firms?

		Dependent Variable: Log(Innovation)	
		(1)	(2)
Independent Variables		Model 1	Model 2
Board Ownership	$\beta 1$	3.523*	
		(2.022)	
Board Ownership x HTdummy	$\beta 2$	-4.857*	
		(2.893)	
ROA		-0.322***	-0.291**
		(0.123)	(0.123)
MTB		0.001	0.001
		(0.001)	(0.001)
Firm Age		0.001	0.001
		(0.017)	(0.017)
Firm Size		-0.047***	-0.047***
		(0.011)	(0.011)
CEO Age		0.002***	0.002**
		(0.001)	(0.001)
CEO Tenure		-0.010***	-0.008***
		(0.002)	(0.002)
CEO Ownership		1.296***	1.224***
		(0.425)	(0.424)
Leverage Ratio		-0.305***	-0.283***
		(0.085)	(0.085)
HTdummy		-0.250	-0.278
		(0.281)	(0.280)
Director's Age	$\beta 1'$		0.002
			(0.006)
Director's Age x HTdummy	$\beta 2'$		-0.026***
			(0.008)
Constant		-2.079***	-2.141***
		(0.318)	(0.317)
Observations		3,002	3,002
R-squared		0.685	0.687
Industry FE		YES	YES
Year FE		YES	YES
Adjusted R-squared		0.685	0.671
Model F-value		43.54***	43.84***

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

5. Additional robustness checks

In this section I will perform additional tests to check whether the results of the previous section are robust. The additional regression models include alternative (non) financial performance measurements, a new proxy for insiders and outsiders, an alternative proxy for high tech firms (HTdummy), the highly skewed innovation proxy as dependent variable, and an alternative ownership proxy. The results of the regression models can be found in table 9, 10, 12, 13, 14, 16, and 18 in the appendix.

5.1 ROA and R&D expenditures divided by sales as dependent variable

I first perform the same OLS regressions with different dependent variables. ROA is used as financial performance measure to replace Tobin's Q. Results of the regression models are reported in table 9 in the appendix. The results are generally consistent with the results above. Besides, model 4 with board ownership included in the regression shows a positive association with the financial performance measure ROA consistent with hypothesis 4. The regression coefficient on the interaction term of board ownership and HTdummy is positively significant at the 5 percent level.

As alternative proxy for innovation I use R&D expenditures to sales instead of R&D expenditures to total assets. Table 10 in the appendix provides the results. The results are robust to using total sales as replacement for total assets. I obtain similar results as in section 4.4, which are consistent with the hypotheses provided in section 3 except for hypothesis 4.

5.2 New proxy for board independence

While earlier the effect of the fraction of insiders and outsiders is examined on (non) financial measures, this section uses a new proxy for inside and outside directors. Following Linck et al. (2008) I create a new dummy variable that identifies whether insiders or outsiders dominate a firm's board based on the median fraction insiders/outsiders. The median firm consists of 14,29% (85,71%) of inside directors (outside directors). The dummy variable INSIDEDOM (OUTSIDEDOM) equals 1 if the percentage insiders (outsiders) is above (below) the median of 14,29%. I control for the fraction of insiders and outsiders in both regression models. Specifications are provided in table 11 in the appendix. Table 12 in the appendix reports the results. Model 1 and 2 both provide strong supporting evidence for the hypotheses that an insider (outsider) dominated board positively (negatively) affect financial performance for high tech firms. After controlling for the fraction of insiders and outsiders I observe statistically significant effects consistent with the predicted signs (β2=0.166) at the 1% level. Similar results supporting the hypotheses are obtained when regressing the new proxies on innovation (table 13).

5.3 Alternative proxy for the HTdummy (R&D to assets ratio)

In order to capture high tech firms I use the alternative proxy R&D to assets ratio. Following Coles et al. (2008) I define all firms that have a R&D to assets ratio greater than the 75th percentile in a given year as high tech (HT) firms. The dummy variable 'HTdummy' equals one if the firm has R&D to assets ratio greater than the 75th percentile in a given year and otherwise zero. The 75th percentile seems to be a proper benchmark since the R&D expenditures are skewed with approximately 50% of the observations having zero R&D expenses. The results of the regression models with dependent variable Q are provided in table 16 in the appendix. With the use of R&D intensity as proxy for high tech firms, I observe similar results as in section 4.3 when SIC codes are used to identify high tech firms.

5.4 Skewed innovation (R&D intensity) proxy as dependent variable

As previous discussed in section 4.2 I use the logarithm of R&D intensity as a proxy for innovation because R&D expenditures are highly skewed. Since only 50% of the population has positive R&D, I subsequently lose approximately 2,700 observations. Table 14 in the appendix reports the results when the skewed proxy for innovation (R&D intensity) is used. The findings are similar as in section 4.4 however I find a positive relation between board ownership and innovation consistent with hypothesis 4.

5.5 CEO ownership as alternative to board ownership

Since verification costs are high for R&D intensive firms, monitoring by the board is ineffective. Ownership tends to be a better tool to incentivize managerial directors (Kor Y. Y., 2006). However I do not observe a positive relation between board ownership and innovation for high tech firms in section 4.4. Deriving from summary statistics (table 3), CEO ownership is significantly higher than the average ownership by the board in this sample. Therefore incentive alignment tends to be stronger for CEOs than for outside directors. These managers are more likely to invest in innovation when their compensation is tied to long-term performance. Table 17 provides the specification of the regression model. CEO ownership is simply measured as shares held by the CEO divided by total shares outstanding. Regression results are reported in table 18. Consistent with the incentive alignment theory (agency theory), I observe a positive statistically significant effect of CEO ownership on innovation for high tech firms ($\beta 2$=2.082; $p<0.01$) after controlling for board ownership.

5.6 Analysis and interpretation

This section provides the interpretation of the variables of interest of the models given in sections 4.3-4.4. I run log-level regressions for all models with 'Q' and 'innovation' as dependent variables, which makes it relatively simple to interpreter the coefficient estimate results. The regression coefficients of the explanatory variables represent the change of the dependent variable expressed in terms of percentages if the explanatory variable increases by one unit. The variable of interests in table 5-8 are $\beta 2$, $\beta 2'$, and $\beta 2^*$. For example when regressing board size on Q with regression coefficient $\beta 2$=-0.061, every additional board member results in a decrease in Q of 6.1%. Striking is the effect of the fraction of insiders on Q. The regression coefficient estimate $\beta 2$ has a value of 1.153, suggesting that a one-unit increase of inside directors (here percentage point) results in a 115.3% increase in Q for high tech firms. The same interpretation holds for the models measuring the effect of board characteristics on innovation. For example the regression coefficient ($\beta 2'$) estimating the effect of the average age of the board on innovation has a value of -0.026, suggesting that a one unit increase (here years) in director's age results in a 2.6% decrease in innovation investment for high tech firms.

5.7 Summary

To summarize, I find statistically significant results consistent with hypotheses 1-3 and 5 relating to financial performance. While inside directors and a combined CEO and chairman significantly enhance Tobin's Q for high tech firms in accordance with the stewardship theory, board size and director's age significantly negatively affect financial performance for high tech firms. Even after using an alternative proxy for board independence (Linck, Netter, & Yang, 2008) I obtain strong supporting similar results. No significant relation is found for board ownership and Q and therefore hypotheses 4 is rejected.

The empirical results related to innovation are consistent with hypotheses 1, 3 and 5. Strong supporting evidence is found for the prediction that inside directors increase innovation. Board size and the average age of the board both negatively affect innovation, which is in line with the predictions. Board leadership does not significantly affect innovation and therefore I reject hypothesis 2. Surprisingly, I observe results in contrast to the predictions regarding board ownership and innovation and therefore hypothesis 4 is also rejected. However after focusing solely on CEO ownership, I observe a strong positive significant relation between ownership and investment in innovation for high tech firms.

6. Conclusion

This thesis challenges the existing literature that a more independent board is necessarily beneficial to a firm. By examining several board characteristics on both firm financial and non-financial performance measures, I argue that optimal board structure varies between industries. Where prior literature shows evidence that is consistent with the agency theory, this thesis also provides argumentation in favor of the stewardship theory. High tech firms are likely to benefit from having more executive directors on the board because firm-specific knowledge is relatively important for R&D intensive firms. Furthermore, monitoring costs increase with a firm's growth opportunities and therefore ownership by the board tends to be a better tool to align interests for high tech firms. Under the assumption that financial performance depends on innovation investments for high tech firms, similar relationships are predicted.

The empirical results show mixed findings when board structure is regressed on financial performance Tobin's Q for high tech firms. Strong supporting evidence is found for hypotheses 1a and 1b that insiders (outsiders) positively (negatively) affect Q. Even after including a new proxy for board independence I find a similar significant association between insiders and financial performance for R&D intensive firms. Hence, these firms for which firm-specific knowledge is important and monitoring (verification) costs are high, benefit from having more inside directors on the board. The results are also in compliance with the stewardship theory where the role of a combined CEO and chairman is expected to positively affect financial performance (Q) for high tech firms. Due the existence of information asymmetry particularly in this industry, duality increases chief executive discretion that enhances financial performance significantly. Hypothesis 3 stating that financial performance decreases with board size because of high monitoring costs is also accepted. This thesis also finds evidence for the negative relation between director's age and Q. High tech firms appear to benefit from having younger directors with current technological knowledge. While the findings support hypotheses 1-3 and 5, I do not find statistically significant effects of hypotheses 4 where ownership by the board is included in the model. However when director's ownership is regressed on ROA I find a strong significant positive effect in line with hypothesis 4.

The results in section 4.4 are consistent with some of the hypotheses related to innovation. I find strong supporting evidence for hypotheses 1 and 3 that smaller boards and boards consisting of insiders of high tech companies invest more in innovation. Further as the average age of the board increases, investment in innovation appears to decrease as been hypothesized (H5). No significant relation regarding board leadership and innovation is found. Remarkably, the relation between board ownership and innovation shows reversed signs. Where board ownership enhances innovation for low tech firms, board ownership negatively affects innovation for high tech firms. Yet these relations are only significant at the 10 percent level. However CEO ownership strongly positively affects innovation for high tech firms suggesting that ownership is a better tool to align interests than monitoring but only for chief executive directors. Managers are more likely to invest in R&D when their compensation is tied to long-term performance.

As is stated in chapter 1 by the research question, this research aims to describe the relation between board structure and a firm's (non) financial performance for high tech firms. The results that are briefly discussed above emphasize the existence of significant relations between board characteristics and (non) financial performance, which differ between industries.

This thesis contributes to the existing literature by showing the effect of five board characteristics on financial and non-financial performance and by distinguishing firms by industry. These findings have several implications for both organizations and policy makers. While the implementation of SOX suggests that an independent board is necessarily value enhancing, this thesis finds evidence that an insider-dominated board is optimal for firms operating in the high tech industry. Moreover, I find that certain board characteristics are related to investment in innovation. The results strengthen the argumentation of earlier studies that regulatory actions applying one-size-fits-all criteria can damage certain firms (Gillian et al., 2003; Coles et al., 2008). Interesting is recent scandal of high tech company Facebook (2018) with Mark Zuckerberg as combined CEO and chairman at the age of 33. While some typical board characteristics (CEO duality, relatively few members (9) considering market capitalization, high ownership, and relatively young directors (age 52)) present in the boardroom contribute to the rise of the organization, the lack of governance control by (outside) directors is considered to be the main cause of the scandal. Where the success of Facebook generally confirms my findings consistent with the stewardship theory, a weak board of directors could also be detrimental in the technology sector.

6.1 Limitations

As in many similar studies, establishing a causal relation between board structure and firm performance has been the main limitation. In addition as discussed in chapter 3, the inevitable omitted variables contribute to the low internal validity of this research and possible causality issues. The use of solely R&D intensity as a proxy for innovation can also be considered as a limitation. This proxy only focuses on the investment in innovation and neglects the output of innovation (e.g. patents).

6.2 Suggestions for future research

Since this thesis emphasizes that optimal board structure varies by industry, it would be interesting for future research to perform a similar study based on a different industry. Moreover, this sample consists of relatively large US publicly listed corporations. Future research could use a dataset consisting of high tech start-ups, which are commonly resource-poor and rely on external stakeholders such as venture capitalists. Furthermore since the US regulation mandates firms to have a one-tier board, replacing this sample with firms consisting of a two-tier board should strengthen the predictions due the relatively high monitoring costs. It would also be interesting to test whether the implementation of SOX influenced board structure and consequently firm (non) financial performance and which industry gained or suffered the most from this regulation. Recent Facebook scandal has shown the downside of CEO power over the board for innovative companies despite the exceptional success in the past. The empirical results of this thesis and this recent event have led to interesting questions regarding the optimal trade-off between CEO power and control by the board in the high tech industry. The stewardship theory assumes rational behavior of executive directors while powerful CEOs might be prone to managerial overconfidence, future research could extend the literature by including this irrational behavior in the regression models.

References

Adams, R., & Ferreira, D. (2007). A theory of friendly boards. *Journal of finance, 62*(1), 217-250.

Adams, R., Almeida, H., & Ferreira, D. (2005). Powerful CEOs and their impact on corporate performance. *The Review of Financial Studies, 18*(4), 1403–1432.

Alexander, C., Bauguess, S., Bernile, G., Lee, Y.-H., & Marietta-Westberg, J. (2013). Economic effects of SOX Section 404 compliance: A corporate insider perspective. *Journal of Accounting and Economics, 56*(2-3), 267-290.

Balkin, D., Markman, G., & Gomez-Meija, L. (2000). Is CEO pay in high technology firms related to innovation? *Academy of management journal, 43*(6), 1118-1129.

Barron, O., Byard, D., Kile, C., & Riedl, E. (2002). High-Technology Intangibles and Analysts' Forecasts. *Journal of accounting research, 40*(2), 289-312.

Baysinger, & Hoskisson. (1990). The composition of boards of directors and strategic control: effects of corporate strategy. *Academy of management Review, 15*(1), 72-87.

Bhagat, S., & Black, B. (2002). The Non-Correlation between Board Independence and Long-Term Firm Performance. *The journal of corporation law, Working paper*(185), 231-273.

Block, D., & Gerstner, A.-M. (2016). One-Tier vs. Two-Tier Board Structure: A Comparison Between the United States and Germany. *Comparative Corporate Governance and Financial Regulation*(1), 3-68.

Boone, A., Field, L., Karpoff, J., & Raheja, C. (2007). The determinants of corporate board size and composition: An empirical analysis. *Journal of financial economics, 85*(1), 66-101.

Borokhovich, K., Parrino, R., & Trapani, T. (1996). Outside Directors and CEO Selection. *Journal of financial and quantitative analysis, 31*(3), 337-355.

Bowen, R., Davis, A., & Matsumoto, D. (2005). Emphasis on Pro Forma versus GAAP Earnings in Quarterly Press Releases: Determinants, SEC Intervention, and Market Reactions. *The Accounting Review, 80*(4), 1011-1038.

Boyd, B. K. (1995). CEO duality and firm performance: A contingency model. *Strategic Management Journal, 16*(4), 301-312.

Braun, M., & Sharma, A. (2007). Should the CEO Also Be Chair of the Board? An Empirical Examination of Family-Controlled Public Firms. *Family Business Review, 20*(2), 111–126.

Brickley, J., Coles, J., & Jarrel, G. (1997). Leadership structure: Separating the CEO and Chairman of the Board. *Journal of corporate finance, 3*(3), 189-220.

Chen, H.-L. (2014). Board Capital, CEO Power and R&D Investment in Electronics Firms. *Corporate Governance: An International Review, 22*(5), 422-436.

Choi, S. B., Park, B., & Hong, P. (2012). Does Ownership Structure Matter for Firm Technological Innovation Performance? The Case of Korean Firms. *Corporate Governance: An international review, 20*(3), 267–288.

Chung, K., & Pruitt, S. (1994). A Simple Approximation of Tobin's q. *Financial Management, 23*(3), 70-74.

Clarysse, B., Knockaert, M., & Lockett, A. (2007). Outside Board Members in High Tech Start-ups. *Small Business Economics, 29*(3), 243–25.

Coles, J., Daniel, N., & Naveen, L. (2008). Boards: Does one size fit all? *Journal of Financial Economics, 87*(2), 329-356.

Corbetta, G., & Salvato, C. (2004). Self-Serving or Self-Actualizing? Models of Man and Agency Costsin Different Types of Family Firms: A Commentary on“Comparing the Agency Costs of Family and Non-family Firms: Conceptual Issues and Exploratory Evidence”. *Entrepreneurship theory and practice, 28*(4), 355-362.

Cotter, J., Shivdasani, A., & Zenner, M. (1998). Do Independent Directors Enhance Target Shareholder Wealth During Tender Offers? *Journal of financial economics, 43*(2), 195-218.

Cui, H., & Mak, Y. T. (2002). The relationship between managerial ownership and firm performance in high R&D firms. *The journal of corporate finance, 8*(4), 313-336.

de Villiers, C., Naiker, V., & van Staden, C. (2011). The Effect of Board Characteristics on Firm Environmental Performance. *Journal of Management, 37*(6), 1636-1663.

Dehlen, T., Zellweger, T., Kammerlaner, N., & Halter, F. (2014). The role of information asymmetry in the choice of entrepreneurial exit routes. *Journal of Business Venturing, 29*(2), 193-209.

Donaldson, L., & Davis, J. (1991). Stewardship Theory or Agency Theory: CEO Governance and Shareholder Returns. *Australian journal of management, 16*(1), 49-64.

Duchin, R., Matsusaka, J., & Ozbas, O. (2010). When are outside directors effective? *Journal of Financial Economics, 96*(2), 195-214.

Elsayed, K. (2007). Does CEO Duality Really Affect Corporate Performance? *Corporate Governance an international review, 15*(6), 1203-1214.

Fama, E., & Jensen, M. (1983). Separation of Ownership and Control. *Journal of Law and Economics, 26*(2), 301-325.

Finkelstein, S., & D'Aveni, R. (1994). CEO Duality as a Double-Edged Sword: How Boards of Directors Balance Entrenchment Avoidance and Unity of Command. *Academy of Management Journal*, 1079-1108.

Forbes, D., & Milliken, F. (1999). Cognition and corporate governance: Understanding boards of directors as strategic decision-making groups. . *Academy of Management. The Academy of Management Review, 24*(3), 489-505.

Francis, B., Hasan, I., & Wu, Q. (2015). Professors in the Boardroom and Their Impact on Corporate Governance and Firm Performance. *Financial Management, 44*(3), 547-581.

Gillian, S., Hartzell, J., & Starks, L. (2003). Industries, Investment Opportunities, and Corporate Governance Structures*. *Unpublished working paper*.

Guo, R.-J., Lev, B., & Zhou, N. (2005). The Valuation of Biotech Ipos. *Journal of Accounting, Auditing & Finance, 20*(4), 423-459.

Hall, B., Jaffe, A., & Trajtenberg, M. (2005). Market value and patent citations. *Journal of economics, 36*(1), 16-38.

Hambrick, D., & Abrahamson, E. (1995). Assessing managerial discretion across industries: A multimethod approach. *Academy of Management Journal, 38*(5), 1427-1441.

Harris, M., & Raviv, A. (2008). A Theory of Board Control and Size. *The Review of Financial Studies, 21*(4), 1797-1832.

Hay, D. A., & Morris, D. (1979). *Industrial Economics: Theory and Evidence.* Oxford University Press.

Heppner, P., Kivlighan, D., & Wampold, B. (1992). *Research Design in Counseling.* Brooks/Cole Publishing Company.

Hermalin, B., & Weisbach, M. (2001). Boards of directors as an endogenously determined institution: A survey pf the economic literature. *NBER Working Paper Series*(8160), 1-39.

Holthausen, R., Larcker, D., & Sloan, R. (1995). Business unit innovation and the structure of executive compensation. *Journal of Accounting & Economics, 19*(2-3), 279-313.

Huse, M. (2008). *The Value Creating Board: Corporate Governance and Organizational Behaviour.* Oslo: Norwegian School of Management.

Jackling, B., & Johl, S. (2009). Board Structure and Firm Performance: Evidence from India's Top Companies. *Corporate governance: An International Review, 17*(4), 492-509.

Jensen, M. (1986). Agency Costs of Free Cash Flow, Corporate Finance, and Takeovers. *The American Economic Review, 76*(2), 323-329.

Jungmann, C. (2006). The Effectiveness of Corporate Governance in One-Tier and Two-Tier Board Systems – Evidence from the UK and Germany –. *European Company and Financial Law Review, 3*(4), 426-474.

Klein, A. (1998). Firm Performance and Board Committee Structure. *The Journal of Law & Economics, 41*(1), 275-304.

Klein, A. (2003). Likely Effects of Stock Exchange Governance Proposals and Sarbanes-Oxley on Corporate Boards and Financial Reporting. *Accounting horizons, 17*(4), 343-355.

Kor, Y. Y. (2006). Direct and interaction effects of topmanagement and board composition. *Strategic management journal, 27*(11), 1081-1099.

Kor, Y., & Mahoney, J. (2005). How dynamics, management, and governance of resource deployments influence firm-level performance. *Strategic Management Journal, 26*(5), 489-496.

Kotz, R. (1998). Technology company boards: A new model. *Directors and Boards, 22*(3), 26-28.

Leblanc, R., & Schwartz, M. (2007). The Black Box of Board Process: gaining access to a difficult subject. *Corporate Governance: An international review, 15*(5), 843-851.

Lehn, K., Patro, S., & Zhao, M. (2009). Determinants of the Size and Composition of US Corporate Boards: 1935-2000. *Financial management, 38*(4), 747-780.

Libby. (1981). Accounting and Human Information Processing: Theory and Applications.

Linck, J., Netter, J., & Yang, T. (2008). The determinants of board structure. *Journal of financial economics, 87*(2), 308-328.

Lipton, M., & Lorsch, J. (1992). A Modest Proposal for Improved Corporate. *The Business Lawyer, 48*(1), 59-77.

Masulis, R., & Mobbs, S. (2011). Are All Inside Directors the Same? Evidence from the External Directorship Market. *The journal of finance, 66*(3), 823-872.

Michaely, R., & Michael, R. (2006). Dividend Smoothing, Agency Costs, and Information Asymmetry: Lessons from the Dividend Policies of Private Firms.

Millet-Reyes, B., & Zhao, R. (2010). A Comparison Between One-Tier and Two-TierBoard Structures in France. *Journal of International Financial Management and Accounting, 21*(3), 279-310.

Nyberg, A., Gerhart, B., Fulmer, I., & Carpenter, M. (2010). Agency theory revisited: CEO return and shareholder interest alignment. *Academy of Management Journal, 53*(5), 1029-1049.

Pearl, J. (2001). Intangible Investments, Tangible Results. *MIT Sloan Management Review, 43*(1), 13-14.

Pombo, C., & Gutiérrez, L. (2011). Outside directors, board interlocks and firm performance: Empirical evidence from Colombian business groups. *Journal of Economics and Business, 63*(4), 251-277.

Raheja, C. G. (2005). Determinants of Board Size and Composition: A theory of corporate boards. *journal of financial and quantittative analysis, 40*(2), 283-306.

Rajan, R., & Zingales, L. (2001). The Firm as a Dedicated Hierarchy: A Theory of the Origin and Growth of Firms. *The Quarterly Journal of Economics, 116*(3), 805-851.

Rosenstein, J. (1988). The board and strategy: Venture capital and high technology. *Journal of Business Venturing, 3*(2), 159-170.

Stiles, P. (2001). The Impact of the Board on Strategy: An Empirical Examination. *Journal of management studies, 38*(5), 627-650.

Williamson, O. (1975). Markets and Hierarchies: analysis and Antitrust Implications: A Study in the Economics of Internal Organization. *Business & Public Policy Group, 22*(3), 540-544.

Wintoki, B. (2007). Corporate boards and regulation: The effect of the Sarbanes–Oxley Act and the exchange listing requirements on firm value. *Journal of corporate finance, 13*(2-3), 229-250.

Yermack, D. (1995). Higher market valuation of companies with a small board of directors. *Journal of financial economics, 40*(2), 185-211.

Zona, F., Zattoni, A., & Minichilli, A. (2013). A Contingency Model of Boards of Directors and Firm Innovation: The Moderating Role of Firm Size. *British Journal of Management, 24*(3), 299-315.

Appendix

Figure 1: Libby boxes

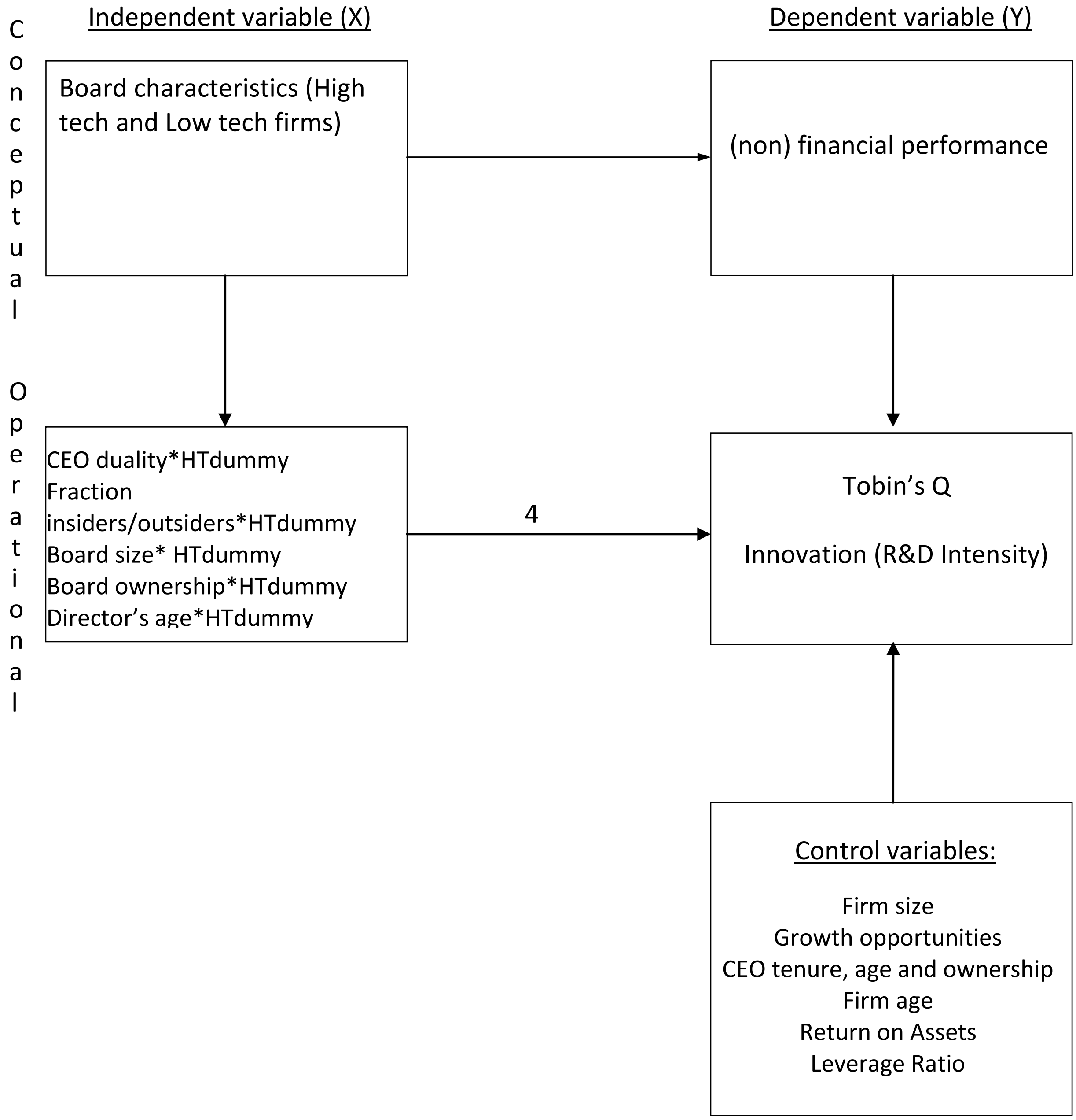
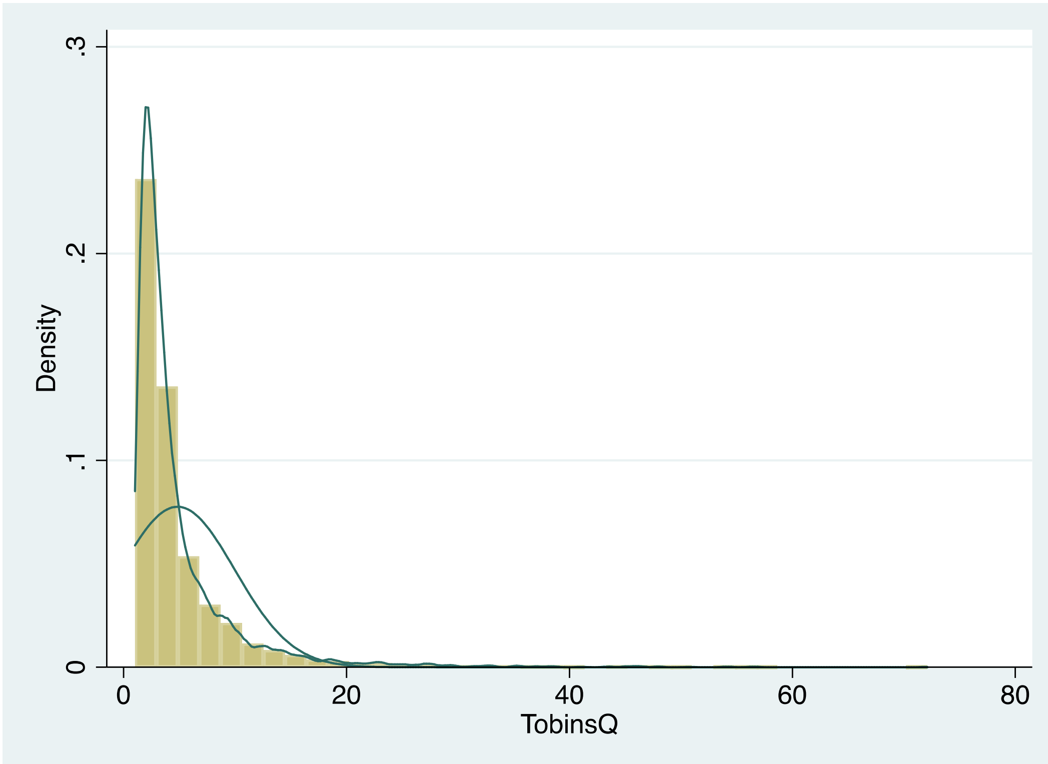


Figure 2: Test of normality Tobin's Q

a: Tobin's Q



b: log (Tobin's Q)

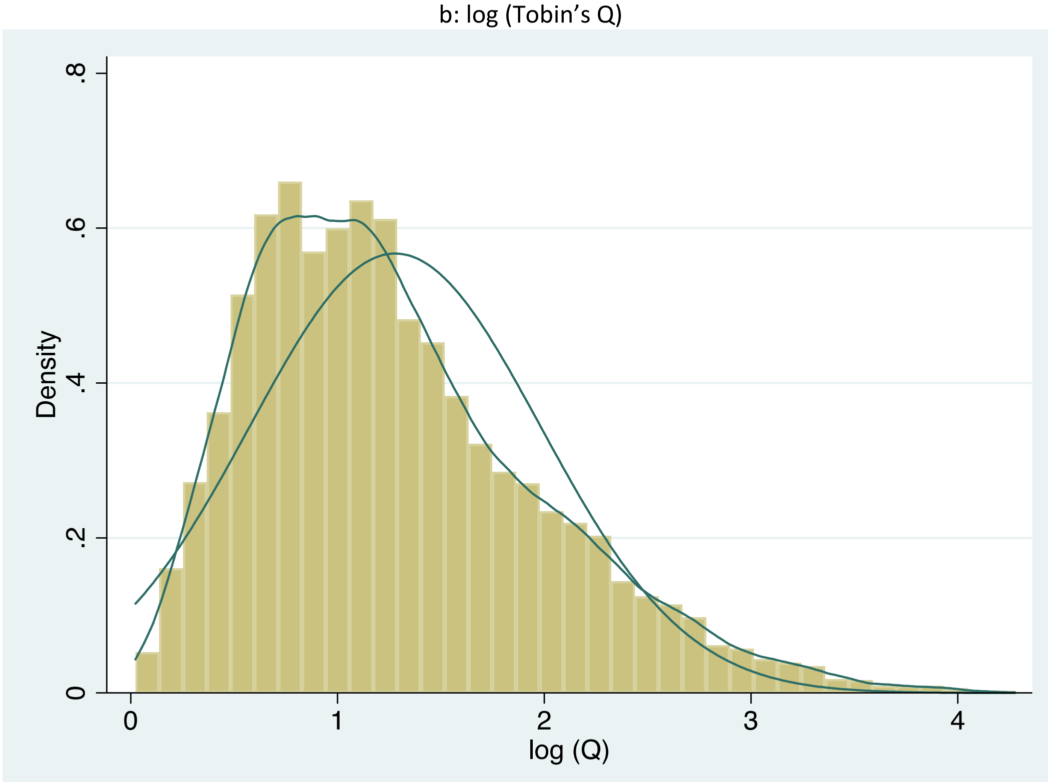
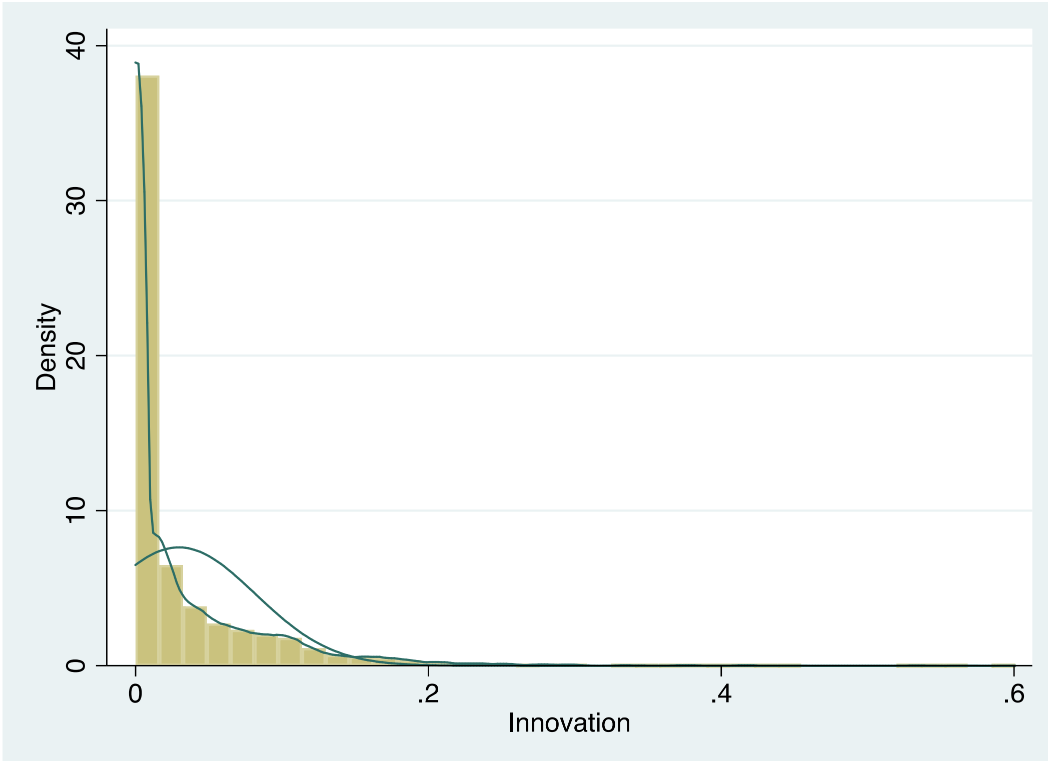


Figure 3: Test of normality Innovation

a: Innovation



b: log(Innovation)

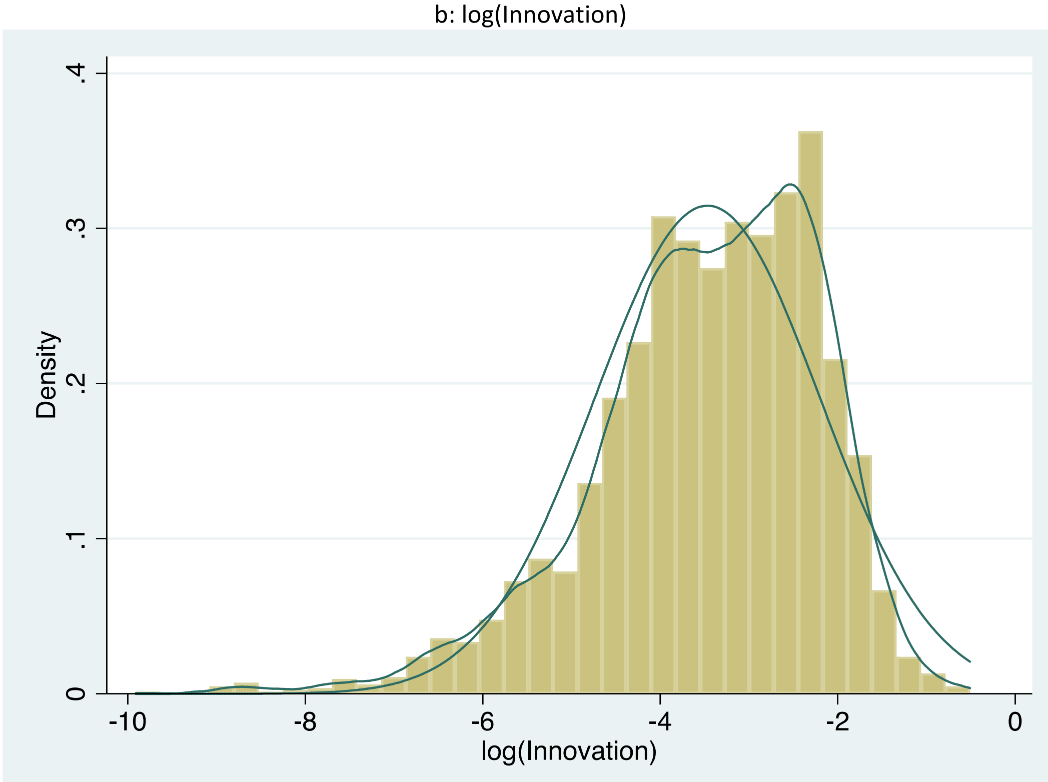


Table 9: ROA as alternative to Tobin's Q as dependent variable

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	Dependent Variable: ROA		
	(1)	(2)	(3)
Independent Variables	Model 1	Model 2	Model 3
Fraction Insiders	-0.001		
	(0.022)		
Fraction Insiders x HTdummy	0.142***		
	(0.042)		
R&D Expenditures	-0.001	-0.001	-0.001**
	(0.001)	(0.001)	(0.001)
MTB	0.001	0.001	-0.001***
	(0.001)	(0.001)	(0.001)
Firm Age	0.004**	0.004**	0.001
	(0.002)	(0.002)	(0.002)
Firm Size	0.018***	0.018***	0.020***
	(0.001)	(0.001)	(0.001)
CEO Age	0.001	0.001	0.001
	(0.001)	(0.001)	(0.001)
CEO Tenure	0.001	0.001	0.001
	(0.001)	(0.001)	(0.001)
CEO Ownership	0.007	0.007	0.012
	(0.029)	(0.029)	(0.026)
Leverage Ratio	-0.115***	-0.115***	0.075***
	(0.008)	(0.008)	(0.010)
HTdummy	-0.021	0.121***	-0.004
	(0.025)	(0.043)	(0.023)
Fraction Outsiders		0.001	
		(0.022)	
Fraction Outsiders x		-0.142***	
HTdummy		(0.042)	
CEO Duality			0.001
			(0.006)
CEO Duality x Htdummy			-0.002
			(0.012)
Constant	-0.0287	-0.0295	-0.260***
	(0.029)	(0.033)	(0.027)
Observations	5,733	5,733	5,768
R-squared	0.188	0.188	0.318
Industry FE	YES	YES	YES
Year FE	YES	YES	YES

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 9, continued

	Dependent Variable: ROA		
	(1)	(2)	(3)
Independent Variables	Model 4	Model 5	Model 3
Board Size	-0.002**		
	(0.001)		
Board Size x HTdummy	-0.003		
	(0.002)		
R&D Expenditures	0.001	-0.001*	-0.001*
	(0.001)	(0.001)	(0.001)
MTB	0.001	0.001	-0.001***
	(0.001)	(0.001)	(0.001)
Firm Age	0.004**	0.004**	0.001
	(0.001)	(0.001)	(0.001)
Firm Size	0.021***	0.019***	0.020***
	(0.001)	(0.001)	(0.001)
CEO Age	-0.001	-0.001	0.001
	(0.001)	(0.001)	(0.001)
CEO Tenure	0.001	0.001	0.001
	(0.001)	(0.001)	(0.001)
CEO Ownership	0.013	0.020	0.011
	(0.028)	(0.028)	(0.026)
Leverage Ratio	-0.118***	-0.120***	0.076***
	(0.008)	(0.008)	(0.010)
HTdummy	0.028	0.003	0.001
	(0.029)	(0.024)	(0.022)
Board Ownership		-0.051	
		(0.096)	
Board Ownership x HTdummy		0.589**	
		(0.280)	
Director's Age			0.001
			(0.001)
Director's Age			0.003***
			(0.001)
Constant	-0.036	-0.039	-0.256***
	(0.029)	(0.028)	(0.027)
Observations	5,768	5,768	5,768
R-squared	0.188	0.187	0.322
Industry FE	YES	YES	YES
Year FE	YES	YES	YES

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 10: R&D expenditures to sales as alternative to R&D expenditures to total assets as dependent variable

	Dependent Variable: Log(Innovation)				
	(1)	(2)	(3)	(4)	(5)
Independent Variables	Model 1	Model 2	Model 3	Model 4	Model 5
Fraction Insiders	-0.703**				
	(0.332)				
Fraction Insiders x HTdummy	1.020**				
	(0.443)				
ROA	-0.939***	-1.074***	-1.061***	-1.057***	-1.041***
	(0.138)	(0.136)	(0.136)	(0.136)	(0.136)
MTB	0.001	0.001	0.001	0.001	0.001
	(0.001)	(0.001)	(0.001))	(0.001)	(0.001)
Firm Age	-0.017	-0.023	-0.025	-0.020	-0.022
	(0.018)	(0.019)	(0.018)	(0.019)	(0.018)
Firm Size	-0.035***	-0.039***	-0.056***	-0.046***	-0.039***
	(0.013)	(0.012)	(0.015)	(0.013)	(0.012)
CEO Age	0.002*	0.002**	0.002***	0.002**	0.002**
	(0.00111)	(0.00104)	(0.000918)	(0.000936)	(0.000920)
CEO Tenure	-0.007***	-0.008***	-0.007***	-0.008***	-0.007**
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
CEO Ownership	0.167	0.099	0.083	0.110	-0.035
	(0.468)	(0.466)	(0.464)	(0.467)	(0.467)
Leverage Ratio	-0.591***	-0.553***	-0.608***	-0.557***	-0.531***
	(0.094)	(0.094)	(0.094)	(0.093)	(0.093)
HTdummy	-0.350	-0.247	0.448	-0.263	-0.297
	(0.313)	(0.309)	(0.346)	(0.308)	(0.308)
CEO Duality		0.085			
		(0.098)			
CEO Duality x HTdummy		-0.084			
		(0.136)			
Board Size			0.059***		
			(0.012)		
Board Size x HTdummy			-0.076***		
			(0.017)		
Board Ownership				-0.893	
				(2.221)	
Board Ownership x HTdummy				-6.572**	
				(3.177)	
Director’s Age					0.004
					(0.006)
Director’s Age x HTdummy					-0.027***
					(0.008)
Constant	-1.372***	-1.402***	-1.803***	-1.337***	-1.431***
	(0.358)	(0.350)	(0.357)	(0.350)	(0.349)
Observations	2,986	3,002	3,002	3,002	3,002
R-squared	0.709	0.708	0.710	0.708	0.709
Industry FE	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES

Standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1

Table 11: Regression models with new proxies for insiders and outsiders

$Tobin's\ Q = \alpha + \beta 1 INSIDEDOM + \beta 2 INSIDEDOM*HTdummy + \beta 3 Fraction\ Outsiders + HTdummy + Controls + \varepsilon$	(1)
$Tobin's\ Q = \alpha + \beta 1 OUTSIDEDOM + \beta 2 OUTSIDEDOM*HTdummy + \beta 3 Fraction\ Insiders + HTdummy + Controls + \varepsilon$	(2)

Table 12: Regression results with new proxies for board independence

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Dependent Variable: Log(Tobin's Q)			
		(1)	(2)
Independent variables		Model 1	Model 2
INSIDEDOM	$\beta1$	-0.032*	
		(0.017)	
INSIDEDOM x HTdummy	$\beta2$	0.166***	
		(0.027)	
Fraction Outsiders	$\beta3$	-0.126	
		(0.100)	
R&D Expenditures		0.001***	0.001***
		(0.001)	(0.001)
ROA		1.715***	1.715***
		(0.053)	(0.053)
MTB		0.001**	0.001**
		(0.001)	(0.001)
Firm Age		0.027***	0.027***
		(0.007)	(0.007)
CEO Age		-0.001**	-0.001**
		(0.001)	(0.001)
CEO Tenure		-0.001	-0.001
		(0.001)	(0.001)
Firm Size		-0.043***	-0.043***
		(0.005)	(0.005)
CEO Ownership		0.003	0.003
		(0.115)	(0.115)
Leverage Ratio		-1.994***	-1.994***
		(0.033)	(0.033)
HTdummy		0.044	0.211**
		(0.096)	(0.096)
OUTSIDEDOM	$\beta1'$		0.032*
			(0.017)
OUTSIDEDOM x HTdummy	$\beta2'$		-0.166***
			(0.027)
Fraction Insiders	$\beta3'$		0.126
			(0.100)
Constant		2.624***	2.466***
		(0.142)	(0.116)
Observations		5,733	5,733
R-squared		0.709	0.709
Industry FE		YES	YES
Year FE		YES	YES

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 13: Regression results with new proxies for board independence

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Dependent Variable: Log(Innovation)		
	(1)	(2)
VARIABLES	Model 1	Model 2
INSIDEDOM	0.026	
	(0.048)	
INSIDEDOM x HTdummy	0.143**	
	(0.061)	
Fraction Outsiders	0.455	
	(0.307)	
ROA	-0.273**	-0.273**
	(0.126)	(0.126)
MTB	0.001	0.001
	(0.001)	(0.001)
Firm Age	0.004	0.004
	(0.017)	(0.017)
CEO Age	0.002**	0.002**
	(0.001)	(0.001)
CEO Tenure	-0.010***	-0.010***
	(0.002)	(0.002)
Firm Size	-0.044***	-0.044***
	(0.012)	(0.012)
CEO Ownership	1.371***	1.371***
	(0.427)	(0.427)
Leverage Ratio	-0.321***	-0.321***
	(0.086)	(0.086)
HTdummy	-0.270	-0.127
	(0.281)	(0.283)
OUTSIDEDOM		-0.025
		(0.048)
OUTSIDEDOM x HTdummy		-0.143**
		(0.061)
Fraction Insiders		-0.455
		(0.307)
Constant	-2.553***	-2.073***
	(0.406)	(0.330)
Observations	2,986	2,986
R-squared	0.687	0.687
Industry FE	YES	YES
Year FE	YES	YES

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 14: Regression results with skewed Innovation proxy as dependent variable

Dependent Variable: Innovation (R&D intensity skewed)					
	(1)	(2)	(3)	(4)	(5)
Independent Variables	Model 1	Model 2	Model 3	Model 4	Model 5
Fraction Insiders	-0.019**				
	(0.008)				
Fraction Insiders x HTdummy	0.047***				
	(0.016)				
ROA	-0.057***	-0.063***	-0.064***	-0.063***	-0.061***
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
MTB	0.001	0.001	0.001	0.001	0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Firm Age	-0.001	-0.001	-0.001	-0.001	-0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Firm Size	-0.003***	-0.003***	-0.003***	-0.003***	-0.003***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
CEO Age	-0.001	-0.001	-0.001	-0.001	-0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
CEO Tenure	-0.001	-0.001	-0.001	-0.001	-0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
CEO Ownership	0.006	0.003	0.003	0.005	0.004
	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)
Leverage Ratio	-0.006**	-0.006**	-0.006**	-0.005*	-0.004
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
HTdummy	0.015	0.021**	0.056***	0.021**	0.017*
	(0.009)	(0.009)	(0.011)	(0.009)	(0.009)
CEO Duality		-0.0043*			
		(0.002)			
CEO Duality x HTdummy		0.004			
		(0.004)			
Board Size			0.001**		
			(0.001)		
Board Size x HTdummy			-0.004***		
			(0.001)		
Board Ownership				-0.102***	
				(0.036)	
Board Ownership x HTdummy				0.121	
				(0.106)	
Director's Age					0.001
					(0.001)
Director's Age x HTdummy					-0.003***
					(0.001)
Constant	0.073***	0.073***	0.062***	0.073***	0.068***
	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)
Observations	5,733	5,768	5,768	5,768	5,768
R-squared	0.510	0.512	0.514	0.512	0.524
Industry FE	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES

Standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1

Table 15: Correlation matrix

	Board Size	Insiders%	Director Age	CEO Duality	Board Ownership	Total Assets	R&D	ROA	Tobin's Q	MTB	Firm Age	Leverage Ratio	Sales	R&D Intensity
Board Size	1													
Insiders%	-0.277***	1												
Director's Age	0.058***	-0.053***	1											
CEO Duality	0.042**	0.370***	0.041**	1										
Board Ownership	-0.096***	0.360***	-0.026	0.203***	1									
Total Assets	0.333***	-0.136***	0.042**	0.006	-0.058***	1								
R&D	0.226***	-0.115***	-0.003	-0.031*	-0.072***	0.466***	1							
ROA	0.041**	0.003	0.006	0.004	-0.021	0.026*	0.060***	1						
Tobin's Q	-0.267***	0.172***	-0.051***	0.039**	0.042**	-0.119***	0.023	0.381***	1					
MTB	0.042**	-0.029*	0.006	-0.006	-0.013	0.080***	0.092***	0.043**	0.020	1				
Firm Age	0.012	0.048***	-0.092***	0.027*	0.010	-0.014	0.004	-0.023	0.008	-0.004	1			
Leverage Ratio	0.338***	-0.203***	-0.035**	-0.060***	-0.063***	0.142***	0.052***	-0.113***	-0.708***	0.034*	-0.015	1		
Sales	0.600***	-0.230***	0.055***	0.001	-0.134***	0.478***	0.352***	0.117***	-0.360***	0.084***	0.008	0.451***	1	
R&D Intensity	-0.159***	-0.012	-0.058***	-0.044***	-0.050***	-0.044***	0.230***	-0.126***	0.328***	0.010	-0.003	-0.227***	-0.256***	1

* $p < 0.1$, ** $p < 0.05$, **

Table 16: Alternative proxy for the HTdummy (R&D intensity)

	Dependent Variable: Log(Tobin's Q)				
	(1)	(2)	(3)	(4)	(5)
Independent Variables	Model 1	Model 2	Model 3	Model 4	Model 5
Fraction Insiders	-0.008				
	(0.086)				
Fraction Insiders x HTdummy	0.614***				
	(0.159)				
R&D Expenditures	0.001	0.001	0.001**	0.001	0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
ROA	1.905***	1.826***	1.838***	1.829***	1.828***
	(0.053)	(0.053)	(0.053)	(0.053)	(0.053)
MTB	0.001**	0.001**	0.001**	0.001**	0.001**
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Firm Age	0.034***	0.033***	0.034***	0.034***	0.035***
	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)
Firm Size	-0.038***	-0.041***	-0.042***	-0.043***	-0.040***
	(0.005)	(0.004)	(0.005)	(0.004)	(0.004)
CEO Age	-0.001***	-0.001***	-0.001***	-0.001***	-0.001***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
CEO Tenure	-0.001	-0.001	-0.001	-0.001	-0.001
	(0.0001)	(0.0001)	(0.001)	(0.001)	(0.0001)
CEO Ownership	0.135	0.175	0.156	0.187*	0.179
	(0.113)	(0.111)	(0.111)	(0.112)	(0.111)
Leverage Ratio	-1.915***	-1.919***	-1.915***	-1.915***	-1.929***
	(0.031)	(0.031)	(0.031)	(0.031)	(0.031)
HTdummy	0.207***	0.304***	0.607***	0.315***	0.229
	(0.030)	(0.016)	(0.058)	(0.017)	(0.194)
CEO Duality		-0.056**			
		(0.025)			
CEO Duality x HTdummy		0.087*			
		(0.052)			
Board Size			0.006*		
			(0.003)		
Board Size x HTdummy			-0.035***		
			(0.006)		
Board Ownership				-0.355	
				(0.377)	
Board Ownership x HTdummy				-1.123	
				(1.034)	
Director's Age					-0.008***
					(0.001)
Director's Age x HTdummy					0.001
					(0.003)
Constant	2.239***	2.293***	2.222***	2.290***	2.791***
	(0.106)	(0.104)	(0.105)	(0.104)	(0.147)
Observations	5,733	5,768	5,768	5,768	5,768
R-squared	0.677	0.671	0.673	0.671	0.673
Industry FE	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES

Standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1

Table 17: Regression models with CEO ownership included in the model

$$Innovation = \alpha + \beta 1 CEOOWNERSHIP + \beta 2 CEOOWNERSHIP*HTdummy +$$
$$\beta 3 BOARDOWNERSHIP + \delta HTdummy + Controls + \varepsilon$$

Table 18: Regression results with CEO ownership as alternative to board ownership

		Dependent Variable: Log(Innovation)
		(1)
Independent Variables		Model 1
CEO Ownership	$\beta 1$	0.375
		(0.537)
CEO Ownership x		2.082***
HTdummy	$\beta 2$	(0.710)
Board Ownership	$\beta 3$	1.511
		(1.506)
ROA		-0.343***
		(0.123)
MTB		0.001
		(0.001)
Firm Age		-0.000102
		(0.017)
Firm Size		-0.045***
		(0.012)
CEO Age		0.002***
		(0.001)
CEO Tenure		-0.009***
		(0.003)
Leverage Ratio		-0.312***
		(0.085)
HTdummy		-0.265
		(0.280)
Constant		-2.110***
		(0.318)
Observations		3,002
R-squared		0.686
Industry FE		YES
Year FE		YES

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1