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A Quantitative Study of the Relationship between CEO Compensation and Firm Exploration in High-Tech Industries.

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Abstract

The relationship between CEO compensation and exploration is an under investigated area of literature. In particular, the implications of the share of stock-based compensation remains largely untested. As the CEO's wealth is more and more connected to firm value, risk-aversion should arise. We test for the relationship between the share of stock-based CEO compensation and exploration by using patents as proxy for the latter. We create a model based on several previous research methods. Patents are, per definition, exploration and as such each patent is assigned a value of 1. Thereafter, we discount the value of the patent based on its exploitative characteristics. In our study, this is represented by the technical class of the patent and whether the technical class is novel to the firm or a frequent repeater in the firm's patent portfolio. We calculate the value by utilizing a Herfindahl-Hirschman Index. When conducting the study, we find the relationship to be inconclusive and not statistically significant. However, our novel model, by its tangible and quantitative nature, open for future research on the topic.

Contents

Introduction

The relationship between CEO compensation and firm exploration and exploitation is of vital importance for the performance and survival of firms. However, there is a lack of research linking exploration and exploitation to the arguably most important source of CEOs' motivation, the compensation. CEO compensation packages have long been a subject of controversy with stakeholders scattered from firm employees to politicians and the public. However, there is a reason for the abnormal size of executive compensation packages. CEOs have reached the top of the corporate ladder, eliminating further promotion and acknowledgment from superior colleagues as effective incentives. Left is the compensation package, growing in line with owners' attempt to saturate the CEO's self-interest.

This introduces the agency problem, which is the potential divergence of interests between agents of the firm, in this case the CEO, and the principals of the firm, the shareholders (Jensen & Meckling, 1976). However, it is not only the size of the compensation package that matters, the structure does as well. For instance, a strong consensus among agency theorists has been that stock-based compensation can mitigate the agency problem, as the outside agent becomes a shareholder of the firm and the interests of manager and owners becomes aligned (Jensen & Meckling, 1976; Agrawal & Knoeber, 1996; Ang et al., 2000; Chow, 1982; Fleming et al., 2005; O'Sullivan, 2000). Empirical evidence from prior studies suggest that stock-based CEO compensation is positively related to firm performance (Mehran, 1995; Core & Larcker, 2002; Rajgopal & Shelvin, 2002; Hanlon et al., 2003), valuation (Jensen & Meckling, 1976; Kim, Lee & Francis, 1988; McConnell & Servaes, 1990; Oswald & Jahera, 1991; Hudson, Jahera & Lloyd, 1992) and innovation (Datta, Iskandar-Datta & Raman, 2001; Sharma, 2011; Currim, Lim & Kim, 2012). However, several unexpected effects of stock-based compensation have brought this line of thought into question, especially the long-term effects of these relationships such as short-termism, earnings management and, to some extent, risk aversion (Bushee & Noe 1999; Core et al. 1999; Sanders, 2001; Miller, Wiseman & Gomez-Mejia, 2002; Singh & Davidson, 2003; Kahl, Liu & Longstaff, 2003; Bauman & Shaw 2006).

Recent studies show that the average job tenure for CEOs has approximately halved from 10 to 5 years during the last decades (The Economist, 2012; The Economist, 2015). Several scholars therefore emphasize that the divergence in time-perspective between agent-CEOs' and long-term shareholders' rapidly increase. Compensating CEOs with restricted stocks and stock options has been argued to make managers undiversified and hence risk averse, due to the fact that most of their wealth depends on firm value and performance (Kahl, Liu & Longstaff, 2003; Miller, Wiseman & Gomez-Mejia, 2002; Sanders, 2001). Several scholars have thus found evidence of a positive relationship between stock-based compensation and earnings management (The Economist, 2002; Cheng & Warfield, 2005; Cheng, Lou & Yue, 2013), or even to the extent of fraudulent reporting (Desai et al., 2006; O'Connor et al., 2006; Harris & Bromiley, 2007; Zhang et al. 2008), bringing previous evidence of increased firm performance and valuation relative to stock-based compensation into question. The same situation can be found in terms of firm innovation and risk-taking relative to stock-based compensation, where the details of the relationship and long-term effects remain unclear. Empirical evidence supports a positive relationship relative to innovation output and R&D spending (Datta, Iskandar-Datta & Raman, 2001; Lerner & Wulf, 2007; Sharma, 2011; Currim, Lim & Kim, 2012; Baranchuk, Kieschnick & Moussawi, 2014). However, the relationship of stock-based CEO compensation with firm exploration/exploitation remains largely unexplored. This study therefore investigates the use of stock-based CEO compensation to align the shareholders' and CEO's interests in relation to striking an optimal degree of exploration in innovation activities.

As presented in March's (1991) conceptual literature on exploration and exploitation, firms need to steadily exploit existing knowledge to achieve short-term productivity. On the other hand, to stay updated and not fall into success traps firms must simultaneously explore new knowledge. This brings forth the importance of striking an optimal strategic balance between the two activities. The success of these activities rests on differing criteria, whereas the rewards are of differing character. This brings forth the challenges, but also the necessity of striking an optimal strategic balance.

We aim at discovering the relationship between the share of stock-based CEO compensation and the firm-specific degree of exploration. By doing so, we hope to, first and foremost, discover whether there is any relationship at all and, ultimately, the concrete effects it may have on a firm's explorative and exploitative activities.

Research question: "*What is the relationship between the share of stock-based CEO compensation and the degree of firm exploration in innovation activities?*"

Opposed to most studies on exploration and exploitation, we do not take a behavioral stand along the knowledge dimension such as March (1991), but rather look at exploration and exploitation in relation to quantitative innovation output. The innovation literature is rich in research methods using patents, especially in studies distinguishing radical innovations from incremental innovations, which, to a large extent, is transmittable to the concepts of exploration and exploitation. By doing so, we are able to get a quantitative measure of the degree of firm exploration. When combining this with company and executive compensation data from Compustat, we can quantitatively investigate the relationship between the proportion of stock-based compensation and the degree of firm exploration in selected high-tech industries.

The choice of high-tech industries is based on the fact that the propensity to develop new ideas in high-tech industries are related to profitability, and the number of patents a company holds is positively associated with sales and stock performance (Chakrabarti & Halperin, 1990; Griliches, 1990). Exploitation is found to have a positive impact on the immediate innovation rate, i.e. incremental innovations that boost the number of patents produced, whereas exploration is found to enhance the innovation impact, i.e. radical innovations that have higher values (Kim et al., 2012). In general, for high-tech industries, about 5% of all raw ideas turn into patent applications. Out of those patent applications 0,6% turn into commercial successes (Stevens & Burley, 1997). This implies an idea-to-commercial success ratio of 0,033% and illustrates the high failure rate involved.

Moreover, short-tenured CEOs are argued to perform better than long-tenured CEOs in the highly dynamical technological situations describing the industries (Wu, Levitas & Priem, 2005), indicating a higher CEO turnover than average for the high-tech industries. The fundamental assumption in agency theory is that actors are solely motivated by self-interest. Agents will hence maximize their own well-being regardless of the interest of the principal. This implies that the CEO has an incentive to maximize firm value and performance within his or her tenure as CEO, while the shareholder wishes the CEO to undertake actions that maximize his or her return within their time as a shareholder. As the CEO is driven by self-interest and is the executor of the firm, this will lead to more short-termism, i.e. exploitation, in these industries. This follows from the simple fact that returns from exploitation are more predictable and proximate in time (March, 1991), whereas returns from exploration are more uncertain and distant in time (Levinthal & March, 1993). Given the indications of below average CEO tenure in high-tech industries, CEOs that allocate the firm's resources to exploration take the risk of investing in returns for the CEO successor. We argue that the increased frequency of patent applications and CEO changes relative to the normal state, makes high-tech industries the best candidate to investigate for distinct patterns.

Literature Review

Agency Theory

Agency theory relates to the contractual relationship between two or more persons, defined as a relationship in which one or more person(s) (principals) engage another person (agent) to perform some service on their behalf, which involves delegating some decision-making authority to the agent (Jensen & Meckling, 1976). Jensen and Meckling (1976) identify CEOs as agents, employed to maximize return on behalf of the shareholders (principals). Agency theory treats both principals and agents as rational economic actors who can form unbiased expectations regarding the impact of agency problems together with the associated future value of their wealth, and are assumed to be motivated solely by self-interest (Barnea et al., 1985). As a result, when the shareholders delegate some decision-making responsibility to the CEO, he or she may use that power to promote their own well-being, regardless of the best interests of the shareholders (Barnea, Haugen & Sanbet, 1985; Bromwich, 1992; Chowdhury, 2004). The agency problem in this paper hence relates to divergence in interest between the long-term shareholders and the agent CEO.

AGENCY COST

Hill and Jones (1992) define the cost incurred to align the principal and agent's incentives as agency cost. The divergence between the principal's and agent's interests may be limited by establishing appropriate incentives for the agent, and by incurring monitoring designed to limit opportunistic behavior (Hill & Jones, 1992). Attempts to monitor and thereby restrict the actions of the agent, and to ensure behavior that maximizes the shareholder's value, are referred to as monitoring cost. Bonding cost, on the other hand, is incurred by the agent, and related to contractual obligations that limit or restrict the agent's activity. There may, however, still be a loss caused by the divergence of the decisions taken by the agents and the decisions that would maximize the principals' welfare, despite the monitoring and bonding costs incurred. The cost associated with such decisions is defined as residual losses. We aim our focus at the sum of the principal's monitoring costs, the agent's bonding costs, and any remaining residual loss, which adds up to the total agency cost of separating ownership and control, i.e. we treat the concept comprehensively throughout the paper.

MANAGERIAL SHAREHOLDINGS AND THE AGENCY PROBLEM

The use of control mechanisms and their effect on the agency costs is a well-discussed area of corporate governance and agency literature, presenting evidence of various ways to overcome the agency problem and reduce the costs involved (Shleifer & Vishny, 1997). Providing managers with ownership in the firm is such a control mechanism, and is argued to motivate management monitoring and mitigate agency cost (Jensen & Meckling, 1976; Agrawal & Knoeber, 1996; Ang et al., 2000; Chow, 1982; Fleming et al., 2005; O'Sullivan, 2000). However, more recent empirical contributions argue that fundamental agency theorists simplify the agency problem and question the governance mechanism employed to mitigate the problem (Sanders, 2001; Miller, Wiseman & Gomez-Mejia, 2002; Singh & Davidson, 2003; Kahl, Liu & Longstaff, 2003; Bauman & Shaw 2006).

Jensen and Meckling's (1976) introduced the normative aspect of the agency relationship, how to structure the contractual relationship between the principal and agent, including the compensation incentives. Arguing that agents who own firm resources are less likely to commit moral hazard and thereby, in theory, avoid consumption of excessive perquisites, shirking, sub-optimal investments and entrenching activities. Activities that might include unnecessarily growing the firm through joint ventures (Reuer & Ragozzino, 2006), expanding internationally (Sanders & Carpenter, 1998), or expanding into new lines of business (Boyd, Gove, & Hitt, 2005; Denis, Denis, & Sarin, 1999). Growth actions that may increase the CEO's power and salary, but simultaneously reduce returns to shareholders. A subsequent trend in the US during the 1980s and 1990s was a relative decrease in CEO salary, in favor of an increase in stock-based CEO compensation (Bushman & Smith, 2001). Managers were provided with restricted stocks and stock options in the company, in addition to salary and bonus. This entails stocks that the managers cannot sell until certain conditions are met, and the stock price is equal to or higher than the value of the grant, and/or the option to buy stocks for a fixed price at a later point in time. The option is however worthless unless the future value of the stock is higher than the strike price of the option. Fundamental agency theorists hence argue that stock-based compensation is a valid response to the agency problem, as the shareholders and the CEO will share both rules and returns.

Jensen and Meckling (1976) emphasize that the higher the portion of stock ownership, the more responsible the manager is to maximize the shareholders' value. Asserting that the equity agency cost is zero when the manager owns 100 percent of the firm, and that there is a positive relationship between equity agency costs and the separation of ownership and control. As the manager's equity ownership falls below 100 percent, the equity ownership becomes relatively dispersed. Consequently, the manager gets a greater incentive to commit moral hazard (Jensen & Meckling, 1976; Fleming et al., 2005). Farrer and Ramsay (1998) emphasize that the manager only bears a portion of the expenses when the value of the firm decreases, arguing that a lower managerial equity holding is associated with lower incentives and efforts to maximize the shareholders' utility.

Similarly, Friend and Lang (1986) emphasize that insiders have a greater incentive to protect the shareholders' interests, and thus decrease the need for monitoring, as managers are less likely to deliberately mislead themselves (Vafeas, 1999; O'Sullivan, 2000). While Berger et al. (1997) argue that managers with high equity ownership have a greater incentive to make value maximizing decisions about capital structure, and their voting rights increase their influence on the firm's general policy (De Angelo & De Angelo, 1985), Florackis (2008) found that managerial ownership encourages better use of assets in the company's revenue generation. Moreover, McKnight and Weir (2009) and Yang et al. (2008) both found evidence of reduced agency cost in UK and Taiwanese companies as a result of high managerial ownership. However, some studies on agency cost and managerial stock ownership also provide contradictory or mixed findings, arguing that managerial shareholdings do not serve as an impediment for agency cost (e.g. Sanders, 2001; Miller, Wiseman & Gomez-Mejia, 2002; Singh & Davidson, 2003; Kahl, Liu & Longstaff,_2003; Bauman & Shaw 2006). These studies present evidence of managerial risk aversion, misconduct and opportunistic behavior in relations to stock-based CEO compensation incentives, which we will discuss in further detail during the following sections.

STOCK-BASED CEO COMPENSATION AND FIRM PERFORMANCE

Empirical evidence on the association between stock-based compensation and firm performance conflict. Several researchers find a positive association between stock-based compensation and firm performance (Mehran, 1995; Core & Larcker, 2002; Rajgopal & Shelvin, 2002), and between stock-based compensation and future earnings (Hanlon et al., 2003). Core et al. (1999), on the other hand, have found that subsequent operating and market performance is negatively related to the abnormal total compensation, although they attribute their findings to less effective governance. Moreover, Ittner et al. (2003) presented evidence that lower than expected option grants and/or holding of existing options leads to poorer performance in subsequent years. While Core and Guay (1999) have found that annual option grants are consistent with efficient contracting, and that there is no association between annual incremental option grants and firm performance. Collectively, the literature on the relationship between stock-based compensation and subsequent firm performance remains unclear (Dalton, Daily, Certo, & Roengpitya, 2003; Sundaramurthy, Rhoades, & Rechner, 2005). The difference in results may however be explained by the fact the studies use different ownership variables and datasets with different geographical origin.

MANAGERIAL SHAREHOLDINGS AND FIRM VALUE

Many researchers argue that a larger portion of equity owned by insiders leads to higher firm valuation (Jensen & Meckling, 1976; Kim, Lee & Francis, 1988; McConnell & Servaes, 1990; Oswald & Jahera, 1991; Hudson, Jahera & Lloyd, 1992). However, some scholars also find that managerial ownership is nonlinearly related to agency cost and firm value (Morck et al., 1988; Bhabra, 2007; Benson & Davidson, 2009; Jeelinek & Stuerke, 2009). Bhabra (2007) and Benson and Davidson (2009) both found an inverted U-shaped relationship between managerial ownership and firm value, while Morck et. al. (1988) found a significantly positive relationship between firm value and ownership when ownership was in the intervals between 0% and <5% and >25% and 100%, with equal levels at 5% and 65%. Thus, a significantly negative relationship between firm value and ownership when ownership was in the interval between 5% and <25%.

STOCK-BASED CEO COMPENSATION AND RISK TAKING

Agency theorists emphasize that shareholders can easily diversify their shareholdings and can therefore be expected to be risk neutral, willing to undertake any project that might result in a positive net present value regardless of its risk level. CEOs, on the other hand, are viewed as risk averse and opportunistic (Smith and Stulz 1985). CEO's risk aversion stems from the fact that they are faced with the risk of losing their jobs when undertaking risky projects. They are unable to diversify their income streams and may face personal liability in the case of corporate insolvency or financial distress (Beatty & Zajac, 1994; Coffee, 1988; Eisenhardt, 1989; Hoskisson, Hitt & Hill, 1993). CEOs are therefore expected to be biased against projects that entail high levels of risk, even when these projects would have a positive net present value. Which in turn also implies that CEOs are less likely to pursue explorative innovation strategies, as it introduces more risk.

Compensating the CEO with stock is argued to mitigate the CEO’s risk aversion, as the CEO becomes one of the shareholders. However, since CEOs already have a non-diversifiable employment stake in the firm, receiving stock may lead to an even larger non-diversifiable position and potentially even more risk-averse behavior (Kahl, Liu & Longstaff, 2003; Miller, Wiseman & Gomez-Mejia, 2002; Sanders, 2001). Findings on the subject indicate that top executives hold more than a third of their net worth in their own firm's stock (Bryant, 1997). In line with this argument, in situations where management has been able to trade the company's stock, it has been found that it tends to reduce managerial ownership in the company, contrary to what the incentive was originally intended to do (Ofek and Yermack, 2000). Devers et al. (2008) also found that restricted stocks reduced the propensity of CEOs to take strategic risks, i.e. reluctance to explore. However, stock option-based compensation schemes partially overcome this problem because the downside of stock options is limited (Coles, Daniel & Naveen, 2006; Dee, Lulseged & Nowlin, 2005; Ross, 2004; Williams & Rao, 2006). Stock options provide CEOs with the right to buy shares at pre-specified times and prices, yet they are not required to do so.

Empirical evidence suggests that stock-based compensation does indeed increase risk taking (e.g., Coles et al., 2006; Devers et al., 2007; Sanders & Hambrick, 2007; Williams & Rao, 2006; Wright et al., 2007). Several quantitative studies have demonstrated that stock ownership in the management team and risk-taking correlate positively (Amihud & Lev, 1981; Agrawal & Mandelker, 1987; Hill & Snell, 1988; Zahra, 1996; Esty, 1997). On the other hand, Wright et al. (1996) found an inverted U-shaped relationship, with risk-taking behavior first rising and then declining as stock ownership in the management team increased.

STOCK-BASED CEO COMPENSATION AND EARNINGS MANAGEMENT

Scholars examining the association between managerial ownership and stock-based compensation with future firm performance have found strong evidence of incentive-alignment effects (Lambert & Larcker 1987; Morck et al. 1988; Hanlon et al. 2003). However, these incentive-alignment effects may have a dark side. Consequently, encouraging CEOs to focus on short-term stock prices, which in turn may harm the firm's long-term potential at the expense of short-term profits.

Several scholars therefore argue that stock-based CEO compensation can lead to earnings management, or to the extent of fraudulent financial reporting (Burns & Kedia, 2006; Donoher, Reed, & Storrud-Barnes, 2007; Goldman & Slezak, 2006; Harris & Bromiley, 2007). The incentives for earnings management arise from managers diversifying the increased risk associated with ownership or stock-based compensation. Ofek and Yermack (2000) examined the dynamics of ownership and stock-based compensation, and found that when managers are awarded stock-based compensation, they tend to sell shares they own for risk diversification reasons. Managers with equity-based compensation are likely to continue selling shares in the future if the risk exposure is, or is expected to be, above the level that managers are willing to bear. The manager's wealth is hence sensitive to the short-term stock price, which may motivate CEOs with high stock incentives to pursue exploitative strategies in order to increase the short-term stock price and subsequently benefit from selling shares of their own firm's stock (The Economist 2002). Given that the capital markets use current earnings to predict future earnings when pricing firm equity, these managers are expected to use their accounting discretion to manage earnings in order to keep the short-term stock price high (Stein, 1989). Excesses in stock-based incentive compensation may even have the unintended effect of motivating CEOs to use overly aggressive accounting practices (Desai et al., 2006), or to misreport firm financial results to the SEC in order to artificially increase earnings and thereby ensure incentive compensation is received (O'Connor et al., 2006). Such financial misconduct by executives violates shareholder trust and ultimately reduces value to shareholders, i.e. stock-based compensation may worsen the agency problem instead of solving it. Empirical evidence shows that managers with high stock incentives are indeed more likely to report earnings that meet or just beat analysts' forecasts (Cheng & Warfield, 2005). Evidence also indicates that a high degree of stock-based CEO compensation motivates forecast precision (Cheng, Lou & Yue, 2013). This finding is consistent with the wealth of these managers being more sensitive to future stock performance, which leads to increased reserving of current earnings to avoid future earnings disappointments (Cheng & Warfield, 2005). Stock-based compensation incentives have also been found to increase the probability of fraudulent reporting (O'Connor et al., 2006), and that option-based compensation incentives increase the probability of fraudulent reporting even beyond stock ownership incentives (Zhang et al., 2008). Thus, suggesting a causal relationship between stock-based compensation, earnings management and financial reporting fraud. Although the nature of these relationships is unclear, there is a strong consensus that managerial ownership and stock-based compensation incentives may motivate managerial moral hazard behavior. Which supports the argument that stock-based compensation does not serve as an impediment for agency cost. The growing suspicion of stock option incentives has therefore caused many firms to abandon their stock option incentive programs, due to the potential downsides.

STOCK-BASED CEO COMPENSATION AND INNOVATION

Smith and Stulz (1985) emphasize in their study that increasing the convexity of managers' wealth with respect to firm value will increase the managers' willingness to make risky and explorative investments and decreases hedging. Hirshleifer and Suh (1992) hence argue that stock option compensation should be higher when there are more explorative growth opportunities, due to the convexity that they induce. Moreover, Manso (2011) explored the question of how to structure incentives to motivate innovation, and argue that the optimal incentive structure should be tolerant of short-term failure and reward long-term success, in other words, facilitate for exploration and dampen the desire to play safe and exploit. He argues that this can be implemented in part using executive compensation, and specifically long-term compensation plans such as stock options with long vesting periods. The evidence in Cadman, Rusticus and Sunder's (2013) study showed that stock option grants to CEOs have mean and median vesting periods of 36 months. Gopalan, Milbourn, Song and Thakor (2014) presented similar evidence, with vesting periods clustering around three to four years. Thus, due to both the convexity of payoffs with respect to firm value and the long-term nature of stock option compensation in practice, stock option compensation designed for long-term optimization should increase managers' incentives to pursue explorative innovation strategies. However, industries with shorter CEO tenure may incur undesirable consequences, as the evidence suggests that CEOs will pursue innovation strategies that yield return within their tenure as CEO. Thus, presenting an exploration/exploitation dilemma, where CEO's average tenure causes a problem for explorative strategies as the CEOs are not fully able to capitalize on it. However, with vesting periods of 36 months, the incentive to achieve short-term productivity, i.e. exploit, is also reduced in an attempt to seemingly encourage long-term thinking. As such, we see that the challenge of striking the right exploration/exploitation balance can, to a certain degree, be related to the challenge of designing option schemes with long-term optimal vesting periods for short-tenure CEOs.

Nevertheless, empirical evidence relative to an increased innovation incentive has been largely supported in literature. For instance, Francis, Hasan and Sharma (2011) found that patent innovation is increasing in stock option compensation. Datta, Iskandar-Datta and Raman (2001) found that managers with higher proportions of their compensation in the form of stock options make riskier acquisitions by choosing targets with more growth options and by conducting acquisitions which increase the acquiring firm's standard deviation of stock returns. Currim, Lim and Kim (2012) findings showed that increases in stock and stock option compensation, relative to cash bonuses, increase R&D and advertising spending. While Baranchuk, Kieschnick and Moussawi (2014) provided evidence that the proportion of stock-based CEO compensation, is positively associated with post-IPO patent production at newly public firms. Thus, implying that stock-based compensation does indeed enable innovation. However, the common trend in these studies is that they primarily measure innovation spending or innovation output relative to firm value. Lerner and Wulf (2007) on the other hand explored the degree of innovation relative to compensation for the head of R&D, and presented evidence that long-term incentives, in the form of stock option compensation or restricted stock, increases the number, originality, and citations of patents. However, the knowledge of intra-firm exploration and exploitation relative to stock-based compensation incentives for CEOs remain a largely unexplored area in the literature.

FROM COMPENSATION TO INNOVATION

Patents are innovations and contain rich information about the invention in question (Trajtenberg, 1990). However, an innovation can stem from both exploratory and exploitative activities, clouding the connection between innovation and exploration and exploitation. In general, exploration is related to radical innovations and exploitation to incremental innovations (March, 1991; Garcia & Nair, 2005) and this simplified connection lies at the heart of our thesis. When looking at exploration and exploitation in innovation activities we take the perspective of the firm, deeming it an explorative innovation depending on its newness to the firm.

Both research on innovation and on exploration and exploitation have incurred the same problem, that is lack of reliable, quantitative measures (Ahuja & Katila, 2001). Patents have been the solution for researchers in both fields. In the following sections, we provide the reader with a comprehensive overview of literature on exploration and exploitation and innovation, followed by an overview of different patent-related research methods in the subsequent section. We do this because patents bring the same to both fields. A larger understanding of the origins of the innovation on a component level, revealing what technology has been applied and whether this is something a firm has wholly or partially done before.

Exploration and Exploitation

In the seminal paper "Exploration and Exploitation in Organizational Learning", March (1991) conducted a groundbreaking study focused on adaptive processes with the balance between exploration and exploitation as its primary concern. Exploration refers to the exploration of new possibilities and is required to produce new technologies of high quality and impact (Henderson, 1993). Explorative terms include i.a. experimentation, risk-taking, distant search and variation (March, 1991; Stuart & Podolny, 1996). Exploitation, on the other hand, is the utilization of old certainties and increases the efficiency of existing technologies (Henderson, 1993). Exploitative terms include i.a. refinement, efficiency, local search and execution (March, 1991; Stuart & Podolny, 1996).

In studies of organizational learning, the problem of balancing exploration and exploitation is highlighted in the distinctions made between refinement of an existing technology and inventing a new one (Winter, 1971; Levinthal & March, 1981). A proportional increase in the exploration effort comes at the expense of a proportional decrease of the exploitation efficiency. On the other hand, a proportional increase of the exploitation efficiency implies an improvement of the relevant competence, making exploration efforts, such as experimentation of other competence areas, less attractive (Levitt & March, 1988).

In our study, we take the unidimensional view of exploration and exploitation as being two extremes on a continuum competing for a finite set of resources. This is in line with March's (1991) treatment of exploration and exploitation and makes it a far simpler task to quantify the balance between the two, as their proportions will add up to 1. Simultaneously, we reject the multi-dimensional orthogonal view, which opens for the two opposing activities to positively interact, creating synergies and thus exceeding 1 on the scale (Katila & Ahuja, 2002; Lavie & Rosenkopf, 2006; Gupta, Smith & Shalley, 2006; Katila & Chen, 2008). The balance between exploration and exploitation is crucial because excessive exploitation may lead to negative effects such as rigidity and organizational inertia (Volberda, 1996; Van Den Bosch et al., 1999) whereas excessive exploration may have adverse effects on e.g. efficiency and reliability (Levinthal & March, 1993; Gupta, Smith & Shalley, 2006). Derived from this, we embrace the concept of ambidexterity as a mechanism to strike this balance and ambidextrous strategies as a mean to get there (Levinthal, 1997; Lavie & Rosenkopf, 2006). Ambidexterity refers to the acknowledgment that firms need to do both activities simultaneously at the expense of total utilization of the potential within either exploitative or explorative activities in a firm. This is to ensure optimal long-term performance rather than maximize short-term potential (March, 1991). As we disregard positive interaction and synergy creation between the two types of activities, their respective proportions will fit with a unidimensional view and add up to 1 i.e a tradeoff between exploration and exploitation given a limited pool of firm resources.

The art of balancing exploration and exploitation is further complicated by its differing rewards. Compared to returns from exploitation, exploration's returns are less certain, more distant in time, and organizationally more distant from action and adaptation. These systematic facts make it easier to extract the consequences of exploitation as opposed to exploration, which again makes it more attractive for firms to quickly adapt to exploitation (March, 1991). An increase of competence at an activity increases the probability of return from that activity, leading to further improvement of competence related to that activity to reach the greatest probability of return (Argyris & Schön, 1978; David, 1985). This process produces strong path-dependence (David, 1990) and may lead to suboptimal equilibria whereby inferior activities the firm has great competence to deal with trumps superior activities the firm has limited competence to deal with (March et al., 1985).

As firms experience success, their routines and competences become more rooted and efficient, which again creates obstacles for the adaptive capability of the firm. As superior technologies and practices arise outside of the firm, it becomes more costly and difficult for the firm to integrate these (Christensen, 1997), potentially making them obsolete. Innovation efforts are characterized by uncertainty and because of this, it is natural for the exploiting firm to use the results of past searches as the starting point for new searches. This leads to the above mentioned incremental and path-dependent improvements on established technology and knowledge (Dosi, 1982). This inertia is especially troublesome in ever-changing market conditions where core capabilities often evolve to core rigidities, such as in high-tech industries (Leonard-Barton, 1992). These situations are labeled “competency traps” (Levitt & March, 1988) or “success traps” (Levinthal & March, 1993). On the other hand, exploration nurtures the adaptive capability of the firm, and might help the firm to come up with or foresee the rise of new superior technologies. Where excessive exploitation might lead to “competency traps”, excessive exploration might lead to a cycle in which “failure leads to search and change which leads to failure which leads to more search, and so on”, also called “failure traps” (Levinthal & March, 1993). This highlights the need to strike a strategic balance between the two types of activities.

The synchronous pursuit of explorative and exploitative activities is far from simple. It is, however, crucial for firms engaging in innovation activities (Colombo et al., 2014). Innovation is one of the most important organizational processes and outcomes for value creation (Deeds, DeCarolis & Coombs, 2000). It is a central mechanism for strategic change and growth through exploitation, exploration and repositioning in the ever-changing market conditions (Dittrich & Duysters, 2007). This implies that both explorative and exploitative activities foster innovation (March, 1991), but to a different extent. Existing literature suggests that exploitative localized learning improves immediate innovation rates, whereas explorative learning-by-experimentation enhance the innovation impact (Kim et al., 2012). However, an emphasis on the one reduces the other (Ahuja & Lampert, 2001), causing an inverse relationship between the innovation rate (exploitation) and the innovation impact (exploration) (Kim et al., 2012). The trade-off is inevitable because the two types of activities require very unalike orientations, strategies, capabilities, and structures (Argyres, 1996; Auh & Menguc, 2005).

Innovation

Many studies aim to distinguish between incremental and radical innovations. (Anderson & Tushman, 1990; Christensen & Rosenbloom, 1995; Cooper and Schendel, 1976; Tripsas, 1997). However, few studies have a clear definition of what distinguishes a radical innovation from an incremental innovation. Christensen and Rosebloom (1995) defined radical as "launching a new direction in technology" and incremental as "making progress along established path". This was further built upon by Christensen and Bower (1996), defining radical as "disrupts or redefines a performance trajectory" and incremental as "sustains the industry's rate of improvement in product performance". Aligned with our perspective, connecting innovation with exploration and exploitation, Rosenkopf and Nerkar (2001) defined radical exploration as building upon distant technology that resides outside of the firm.

As we take the perspective of the firm in our study, we do not proceed with the definitions that separate radical from incremental based on an industry-lens. However, by using patents we can follow Christensen and Rosebloom's definitions and distinguish between whether an invention is a launch in a new direction technology-wise or whether it is a continuation of an established path. This is because each patent is assigned a technical class and stored in publicly available databases, allowing for comparisons of utilized technology over time. We elaborate on this definition by incorporating Rosenkop and Nerkar's firm perspective, i.e. radical innovations are a launch in new directions technology-wise *for the firm* and incremental innovations are continuations of *firm-specific* established technology. This perspective is further validated by studies looking at the degree of newness to the firm's competences and activities as a vital component when determining whether an invention is radical or not (Chandy & Tellis, 1998; Garcia & Calantone, 2002), and studies determining it radical or not based on if the knowledge leading to the invention stems from outside of the firm's present knowledge base (Dewar & Dutton, 1986; Hill & Rothaermel, 2003). However, we differ somewhat from these perspectives as we will only look at the technological newness to the firm when deeming an invention radical or incremental. i.e. explorative or exploitative.

This is opposed to many prior studies, which have mainly used retrospective measures to identify radical innovations by their ex-post impact on future technological development (Ahuja & Lampert, 2001; Schoenmakers & Duysters, 2010), product performance (Leifer et al., 2001) or market structure (Mascitelli, 2000), resulting in a selection bias. The selection bias stems from the condition that the radical innovation must have had commercial success to be measured, thus leaving out radical technological innovations without any impact in the marketplace. This is a flaw since non-technological factors such as market power might play a significant part in whether the innovation is commercialized or not (Dahlin & Behrens, 2005). Many innovations with the potential to have a radical impact, may not realize this potential and are therefore missed in the analysis of successful innovations only (Verhoeven et al., 2016). By focusing on patents that are noncontingent on commercial success, we overcome these limitations and reveal a truer firm-specific innovation pattern without social biases such as market power.

Thus, we focus on the prospective characteristics of the innovations, i.e. the underlying technological characteristics. Radical characteristics are technologies that simply differs from existing (Ettlie et al., 1984; Mascitelli, 2000; Shane, 2001; Dahlin & Behrens, 2005), embeds new knowledge (Dewar & Dutton, 1986; Lettl et al.,2006; Carlo et al., 2012) and has a differing base of scientific and engineering principles compared to existing technology (Henderson & Clark, 1990). We embrace all the above mentioned characteristics when deeming an invention radical or not, conditioned on a firm context. Because of our firm perspective, we disregard the condition that requires radical innovations to derive from technology completely new to the world (e.g. Ahuja & Lampert, 2001; Banerjee & Cole, 2011).

Hypothesis

In this research, we aim to investigate the relationship between CEO compensation and exploration (see e.g. Currim, Lim and Kim, 2012). Salary and bonus are short-term compensation incentives, adjusted annually depending on current performance. Stock awards and option awards on the other hand, are generally perceived as long-term compensation incentive, directly linked to the value of the firm. However, a relatively high share of stock-based compensation concentrates the wealth of the CEO. Thus motivating some CEO's to maximize short-term stock prices to subsequently sell in order to diversify their wealth (Kahl, Liu & Longstaff, 2003; Miller, Wiseman & Gomez-Mejia, 2002; Sanders, 2001). While option awards itself is argued to partially solve the problem of risk-aversion, i.e. lead to more exploration than what is the case with stock awards, the implications of its proportional share of total compensation remain largely untested. If stock options are granted at the expense of salary and bonus, consequently acting as a substitute, it will lead to a higher portion of the CEO's wealth being contingent on the firm's stock price, which we argue should stimulate risk-aversion and exploitation.

We investigate its relation to the pure form of innovation, that is exploration. However, as it is the balance between exploration and exploitation we are interested in, we create a variable for the degree of exploration by adjusting for exploitative innovations. Our view is in line with one of the few studies that connects the degree of exploration with compensation. Lee and Meyer-Doyle (2017) found that a performance-based wage structure led to risk aversion and exploitation, whereas a flat wage structure led to more risk-taking and more exploration. Although this study looked at the employees, we argue that it is transferable to CEOs. However, there are indications of otherwise, with studies describing a positive relationship between e.g. the proportion of stock option-based compensation and risky innovation strategies (Datta, Iskandar-Datta & Raman, 2001). It is exactly because of this variety of findings, surrounding the identified gap in the literature, that we wish to conduct our own study on the topic.

We therefore hypothesize that stock-based compensation suffers from the same short-term perspective as the stock markets itself, stimulating exploitation at the expense of exploration and leaving firms vulnerable for alterations in the external environment in a long-term perspective.

H1: "The share of *stock-based CEO compensation is negatively related to exploration in high-tech firms".*

Research Methodology

We conduct a quantitative study concerning the proportion of stock-based CEO compensation relative to firms' degree of exploration. Our aim is to provide empirical evidence on this relationship through utilizing positivist and objectivist ontology by taking a structured and quantifiable approach to the research, without subjective interpretations of the data (Bryman & Bell, 2015). We utilize a set of predetermined measures and variables for analysis aimed to detect a relationship between stock-based CEO compensation and exploration. However, this specific relationship has, to our knowledge, never been measured quantifiably. We therefore choose a combination of respected methods we believe will create an optimal fit for our study.

Data

To answer our research question, we create a quantitative measure for the degree of exploration by using patent data. Every patent contains rich and computerized information about the origins of an invention, both with regards to the inventor and to technological antecedents. All patents have been assigned to a three-digit technical class, allowing us to examine in which technical areas a firm operates. In this research, we utilize the technical class, application date (given that the patent in the end is granted) and assignee, that is the firm that holds the patent. We combine this with company data from Compustat, extracting both data related to company financials and CEO compensation. The basic unit of analysis is each individual patent, using a firm's aggregated patent score to determine the degree of exploration. Thus, the level of analysis is the firm. We retrieve all patent data from Harvard Dataverse, which offer ready-made lists based on data from U.S. Patent Office. This is of great help as the U.S. Patent Office do not offer systematic industry or firm patent data. Further, these ready-made lists only contain data up to 2011, creating a natural upper-bound for our research period.

The data collection starts by deeming which industries to include as high-tech. The Greater Cincinnati Chamber of Commerce (GCCC) offer an adequate overview of high-tech industries in their High-Tech Database. Their selection of SIC codes are based on research of a variety of approaches and compared to other similar lists in the U.S. Industries in this database all share a few common features that make them high-tech. First, the proportion of engineers or scientists within each SIC code exceeds the national average. Second, they all have an R&D intensity above 2%. The most significant drawback with the database is that firms themselves choose their own SIC codes, making wrongful self-assigning a problem. Although the list certainly contains some firms that are not high-tech, this is the best way to get a large and quantitative database for our research. It is probably also better to include one too many than to risk excluding companies of interest.

Using the same list of SIC codes, we extract CEO compensation data from Execucomp within Compustat. We break down CEO compensation into four variables; salary, bonus, stock awards and option awards. The database provides us with all these components separately. The data on stock and option awards starts from 2006 as they are calculated on basis of FAS123R, creating a natural lower-bound on our research period. Thus, our research period is limited to 2006-2011. FAS123R is the financial accounting standard that requires firms to deduct the amount of stock-based compensation to executives and employees on an annual basis, which came into effect as of 2006. Other company data is retrieved only for control variables.

Scripting

We merge the two distinct data sources, Harvard Dataverse and Compustat, and script the data by using Microsoft SQL. However, the aggregate data lack a unique common identifier. In other words, the only way to match the data is by linking company names due to the lack of a primary key in the dataset. Although company names are not unique and might be written differently in the two databases. For instance, the company Avon is called "AVON PRODUCTS" in Compustat, whereas "AVON PRODUCTS, INC" in Harvard Dataverse. We therefore create an algorithm to measures the distance between two strings (Levenshtein, 1966). However, the issue with the Levenshtein distance is that "ALC INCORPORATED" gets a better match with e.g. "DNV INCORPORATED" than with "ALC INC". We therefore improve the algorithm to find the largest common substring for all companies (Navarro, 2001). However, it does not entirely solve the issue. We continue by adding further modifications to the algorithm, measuring the largest common substring from the first sign to the string with the lowest number of signs and return the score minus the number of signs in the smallest string. If the sign does not match the sign and spot in the other string, we return all the matches (Navarro, 2001).

This way we are able to match the company names, because the algorithm checks each letter in a chronological order and break the string once the sign and spot does not match the other string. This gives us a perfect match on 942 companies out of 5371 companies. However, due to missing values in the datasets we end up with a final sample of 122 companies.

Measurement Review

INNOVATION

Measurements of innovation have been conducted with a vast variety of lenses. Besides studies using patents and R&D spending as proxies, most of the studies have taken an industry perspective. Technologic trajectories (e.g. Dosi, 1982), s-curves (Foster, 1985) and technologic cycles (Tushman and Anderson, 1990) track products' technical performance over time, emphasizing that industries evolve in cycles, each representing a technologic advancement. Hedonic price models on the other hand distinguish radical from incremental innovation by measuring the change in the market's willingness to pay for the product (Henderson, 1993; Tirole, 1988). However, the simplicity of the model also raises some major drawbacks. First, incremental innovations might generate a more immediate economic payoff (Shane, 2001; Tellis & Golder, 1996). Second, the model requires commercial success, i.e. contains selection bias. Expert panels have also been utilized when evaluating innovations, attempting to capture the dimensional complexity (Ettlie et al., 1984; Dewar & Dutton, 1986). The most foremost advantage of this method is the high face validity, but it suffers from the same selection bias as many of the other models (Fischhoff, 1982).

EXPLORATION & EXPLOITATION

The concept of exploration and exploitation stems from organizational learning. Consequently, previous measures have to a large extent been of a behavioral art, investigating along the dimension of knowledge (e.g. March, 1991; Miller et al., 2006). Moreover, empirical studies have to a large extent, taken an orthogonal view, treating exploration and exploitation activities as something that positively interacts (He & Wong, 2004; Jansen et al., 2006; Katila & Ahuja, 2002; Lubatkin et al., 2006; Nerkar & Shane, 2003). Thus, they do not incorporate the fact that exploration and exploitation activities fight for resources within a firm with constrained resources, giving no attention to and leaving the balance between exploration and exploitation largely untested. Those who have focused on the balance have mostly utilized patent data (Katila & Ahuja, 2002) or content analysis of firm news (Uotila et al., 2009).

Studies focusing on the balance between exploration and exploitation in relation to monetary incentives are few. However, one exception is the newly published study by Lee and Meyer-Doyle (2017) who investigated the relationship between performance-based incentives and individual exploration behavior. They measured the *propensity of exploration* as the ratio of a sales employee's exploratory deals to the sales employee's total deals on that day. They found that a flat wage structure led to more exploration relative to a performance-based wage structure. This is in line with our hypothesis, i.e. that stock-based compensation stimulates a short-term perspective and exploitation

PATENTS

The patent system is the most prolific and up-to-date source of information on applied technology. Patents contain detailed technical information, which often cannot be detected anywhere else. In fact, up to 80% of current technological knowledge today is only available in patent documents. Since most applications are published within 18 months of their filing, the information is also rapidly available in a computerized format (European Patent Office, 2007). This allows for large scale assessment of technological developments.

Each patent is assigned to a three-digit technical class determined by the patent office and reclassified with varying frequency, where activity within a technical class triggers alterations. The breadth of a technical class differs between technologies, making cross-technology comparisons skewed (Dahlin & Behrens, 2005).

The most glaring limitation with the use of patent data is that not all inventions are patented. The reasons for why an invention is not patented varies. First, it may be because the invention did not meet the patentability criteria set by the USPTO, that is the invention must be novel, non-trivial and have a commercial application. Second, the inventor must make a strategic decision to patent, i.e. not rely on secrecy or other means of appropriability. The big unknown factor here is the proportion of non-patented inventions that exist. There is no systematic data on this, so the volume and proportion is completely unknown (Hall, Jaffe & Trajtenberg, 2002).

Patents have a transparent life history with an open paper trail of forward and backward citations to previous patents and scientific literature, as such revealing a detailed and consistent chronology of search activities (Almeida, Song & Grant, 2002). Backward citations enable researchers to gain a grander understanding of the origins of ideas, whereas forward citations reveal the amount and type of subsequent inventions that the focal patent has influenced. Thus, forward citations are also an adequate measure for the impact and value of the patents (Hall, Jaffe & Trajtenberg, 2002). This is a rather reliable indicator as there are strict procedures for citations to be issued (Griliches, 1990; Hall, Jaffe & Trajtenberg, 2002).

Researchers' treatment of focal patents, forward citations and backward citations varies from the very simple approaches to the highly complex approaches. Simple patent or citation counts as a representation for some sort of innovation output perhaps represents the simplest of the approaches. Key issues related to simple counts are the significant changes in the patenting and citation rate over time, as well as truncation of data, making the measure vulnerable to statistical biases. For instance, in the beginning of the 1980s there were about 65.000 successful U.S. patent applications annually, whereas in the mid-1990s the figure reached almost 140.000. Citation rate had a similar increase much due to the computerization of patent data. In addition, the art of innovations varies drastically on dimensions such as *value*, *significance* and *novelty* and so on, making simple count measures at best indicative (Hall, Jaffe & Trajtenberg, 2000). To deal with these issues, Hall, Jaffe and Trajtenberg (2000) came up with patent measures for the dimensions *originality* and *generality*. The generality dimension measures the technical diversity of forward citations to the focal patent. While the originality dimension measures the technical diversity in backward citation made by the focal patent. The measures are related to Argyres (1996) distance measure of technical classes, when testing the technical diversity of firms. However, it is less subjective as Argyres' method is based on subjective distance weight scores to patents dependent on their technical classes relative to the core activities of the connected firm.

When determining the radicalness of the innovations, backward citations are more frequently used. The theory is that backward citations to scientific articles represent novelty (Carpenter et al., 1981), since this implies a closer proximity to science rather than to established technology. Rosenkopf and Nerkar (2001) argued that radical innovations were more likely to cite patents from other technical classes than the technical class of the focal patent in question. The technical classes are defined on a component level, implying that a focal patent with a differing technical class is made by combining different components in new combinations, rather than building on existing innovations (Fleming, 2001). Shane (2001) built upon Rosenkopf and Nerkar's work and defined the radicalness of a patent by measuring the amount of three-digit technical classes it cited. The advantage of backward citations is that it captures the technical foundation more comprehensively than forward citations.

In research directly relating patent measures to exploration and exploitation, the search concept is expanded by an extra dimension. The already well-established dimension of *scope*, have been accompanied by the dimension of *depth* (Katila & Ahuja, 2002). The search depth dimension was measured by the degree of exploitation of existing knowledge within a given time period. The period was determined by research pointing to the fact that organizational memory in high-tech firms is imperfect with rapid depreciation of knowledge, losing significant value within 5 years (Argote, 1999). Thus measuring how often the same patent(s) were cited in the given period as a proportion of total citations. While the search scope dimension measured how often new patent(s) were cited in the given period as a proportion of total citations. However, the sum of scope and depth do not have to add up to a total of 100 percent because the unidimensional view of exploration and exploitation have been updated to a multidimensional view, as such treating exploration and exploitation as orthogonal variables (Katila & Ahuja, 2002). Although this view grants a deeper meaning to the concept of exploitation, compared to the unidimensional view of exploration and exploitation, it raises some issues related to the quantification of the balance between exploration and exploitation.

Variables

EXPLORATION

The dependent variable in our study is the degree of exploration, which we treat in a unidimensional context. Patents are per definition exploration, where every patent count as 1. We use the same method as previous scholars have used for backward citations to determine the degree of exploration, however we use intra-firm patent history regarding technical class rather than backward citations.

$$Exploration = 1 - (Exploitation) = 1 - \sum_{j}^{n} S^2 ij$$

Sij indicates the percentage of previous patents *i* that belong to technical class *j*, out of *n* classes in total. The sum is the Herfindahl-Hirschman Index of exploitation. The degree of exploitation is determined by looking retrospectively at the technical classes 10 years prior to the patent in question, which is in line with the timeframes of prior studies (e.g. Stuart & Podolny, 1996; Rosenkopf & Nerkar, 2001). The reason we use post intra-firm patent history is because we are only interested in what is “new to the firm”, rather than what is “new to the industry”. Our method for measuring exploration is hence a patent count discounted by the Herfindahl-Hirschman adjusted percentage of exploitation, enabling us to find the intra-firm degree of exploration. Moreover, the patent data contains extensive amounts of information. We therefore use LinqPad to run the more advanced algorithms and calculate the Herfindahl-Hirschman adjusted percentage of exploitation, counting the number of times each firm uses a distinct technical class, given the 10-year interval of interest. The count is hence squared, and the count of the specific technical class for each patent is divided by the sum of the count for all technical classes used by the firm the last 10 years. In other words, we aim to find out how often a firm has used the technical class before. Moreover, we calculate the exploration degree, which is 1 minus the exploitation value. Finally, we create a mean average exploration degree for each company.

CEO COMPENSATION

The independent variable in our study is the CEO compensation. The total CEO compensation is made up of four components retrieved from Execucomp in Compustat; salary, bonus, stock awards and option awards. Our focus will be to test the relationship between the share of stock-based CEO compensation and the exploration/exploitation balance. The compensation values utilized in the analysis will be the mean values controlled for standard deviations. This prohibits us from testing the direct effect of e.g. a base salary increase or decrease, but unfortunately this will not be possible because of the limitations in the dataset. The proportion of stock-based compensation is determined as follows:

$$\frac{stock\ awards + option\ awards}{salary + bonus + stock\ awards + option\ awards}$$

Whereof salary is the US dollar value of the base salary earned by the CEO during the fiscal year, and bonus is the US dollar value of the bonus earned by the CEO during the fiscal year. Stock awards FAS123R is the value of stock-related awards that do not have option-like features. Such awards include restricted stock, restricted stock units, phantom stock, phantom stock units, common stock equivalent units and so on. The valuation is based upon the value of shares that vested during the fiscal year following FAS123R. This is the sum that the firm must record as compensation cost on their income statement and as capitalized on their balance sheet during that fiscal year.

Thus, the variable discloses the cost that was charged to the company, distinguishing it from the grant date fair value method. Lastly, option awards FAS123R is the value of option-related awards, such as options, stock appreciation rights, and other instruments with option-like features. The valuation is based upon the value of options that vested during the fiscal year following FAS123R. Like stock awards FAS123R, this is the sum that the firm must record as compensation cost on their income statement and as capitalized on their balance sheet during that fiscal year.

CONTROL VARIABLES

The variables related to CEO characteristics will be utilized as control variables. They are all retrieved from Execucomp.

Age

Studies show that R&D spending is negatively correlated with the age of the CEO, i.e. young CEOs spend relatively more on R&D (Thomas et al., 1991; Barker & Mueller, 2002). This follows from the simple fact that R&D spending, and especially explorative R&D spending, is associated with high risk. It is well documented that risk-taking behavior among CEOs decreases with age, making younger CEOs relatively more risk-seeking (Serfling, 2014). Prendergast and Stole (1996) predicted in their model that younger CEOs have a more risk-seeking behavior with more aggressive investment strategies to signal superior ability and talent. Moreover, Kim and Lu (2011) stated that firms with fewer tangible assets typically conduct more research, have less operating profits and younger CEOs. However, researchers are not unanimous. Models incorporating career concerns predict that younger CEOs are more risk-averse due to their lack of reputation (Hirshleifer & Thakor, 1992; Holmstrom, 1999; Scharfstein & Stein, 1990; Zwiebel, 1995). These contradicting schools of thought make CEO age an intriguing aspect to investigate.

Gender

4.8% of Fortune 500 firms had a female CEO in mid-2014 (Faccio et al., 2016). This was a historic high. Furthermore, only 3% of Scandinavia’s 145 largest firms have a female CEO (Wall Street Journal, 2016). This drastic gender gap among CEOs has naturally attracted a diversity of researchers. Female CEOs have been found to be more conservative and risk-averse than their male counterpart (Palvia et al., 2014). Moreover, they have been found to be managing relatively smaller firms, of younger average age and of lower seniority (Mohan & Ruggiero, 2003**)**. These variables have been argued to explain the wage gap between female and male executive officers, rather than the gender itself. In a study by Bertrand and Hallock (2001) they concluded that there is no wage gap between top executive officers. In fact, they found that once a female reached top-level she earned marginally more than its male counterpart, ceteris paribus. This finding requires ceteris paribus as firm size, tenure and age all are variables that are positively correlated with compensation, and characteristics that favor men. Mohan and Ruggiero (2003) found that there was no wage gap when the potential value of options was excluded, but a significant wage gap once included. Our study has the potential to enrich this area of study, as we are able to look at structural contexts between compensation components and CEO characteristics.

Tenure

CEO tenure has implications for both compensation and for the firm's innovativity. Aligned with agency theory, the main determinator for CEO compensation should be company performance, i.e. stock returns. However, it is argued that as the CEO's influence on the board of directors increases with tenure, this relationship weakens at the expense of the CEO's compensation preferences (Hill & Phan, 1991; Barkema et al., 1998).

Tenure is positively correlated with age, and thus there are indications of less risk-seeking behavior, i.e. relatively less explorative innovation and relatively more exploitative innovation. However, tenure is simply argued to magnify other characteristics effect on innovation as they have a more secure position in the firm (Musteen et al., 2010; Barker & Mueller, 2002). As such, in the rare scenario of a young CEO with high tenure, we should expect to see very high levels of explorative innovation.

Leverage

The variable for leverage in our study is “debt ratio”, which we calculate by extracting data from Compustat on “Assets - total” and “Liabilities - total”. This is in line with Kim and Lu (2011) which proposed to check for financial leverage when looking at firm characteristics that could affect a firm’s innovativity. Financial leverage may affect the firm’s willingness to conduct more expensive searches, i.e. distant searches and explorative innovation.

Firm size

When testing for firm size, we use the variable “market value” from CompuStat. Thus, we measure the size of the firm based on revenue and not the number of employees. High-tech firms are characterized by highly educated employees and cutting-edge technology, which are both aspects that a simple employee count measure does not reveal. The desire to test for size stems from the fact that learning tends to crowd out exploration (Levinthal & March, 1993; Sorensen & Stuart, 2000, Ahuja & Katila, 2004). As firms grow in size and conduct more searches, they will conduct relatively more local searches. This is a contentious decision where reliability and efficiency is deemed more important than variation (Katila & Chen, 2008).

Industry

The sample consists of a variety of high-tech industries, labelled with their four digit SIC codes. We will cluster the industries based on their first two digits when controlling for industry.

Analysis

Examining Data

The dataset contains 122 observations and 8 variables. The dependent variable, *exploration*, has a mean of 0.89, which can be interpreted as the selected high-tech firms on average has an 89% degree of exploration. This is a somewhat higher value than what we expected, but nevertheless a high value was expected as our sample consists of firms from the most innovative industries. Other explanations for the high value might be that our concentration model is too extreme when discounting the value of exploitation. Perhaps a patent index exceeding beyond 10-years would be more proper to illustrate the explorative state of high-tech firms. However, the largest contributor to the high value is the chosen perspective, newness to the firm. A joint industry patent index would likely lead to far more moderate explorative values. However, this causes no problem to our study as we are mainly interested in finding the relationship between the degree of exploration and the share of stock-based CEO compensation, rather than to reveal what exact quantitative exploration/exploitation balance high-tech firms choose on average. If our aim was to do so, we would need a far more comprehensive measure than patents, which only shows 5% of all idea-creation in high-tech firms.

Moreover, from figure 1, we see that the average share of stock-based CEO compensation is 57%, with stock options being the largest compensation component on average with 35% of total compensation. The average tenure is slightly higher than expected at 7,19 years. However, the median deals with the extreme outliers and reports a tenure of 5 years, precisely as anticipated. Unfortunately, from figure 2, we see that only 2,5% of the CEOs in the sample are females, making it a tough challenge to draw any statistically significant findings regarding this.

Figure 1 Data Description

	Observations	Mean	Median	Range		Std. Dev
Variables				Low	High	
Exploration	122	0,89	0,95	0,09	1	0,14
Value share of compensation	122	0,57	0,62	0	0,93	0,27
Stock share	122	0,31	0,31	0	0,88	0,25
Option share	122	0,35	0,32	0	0,93	0,25
Salary share	122	0,29	0,22	0,06	1	0,22
Bonsus share	122	0,06	0	0	0,82	0,13
Market value	119	11247,03	2626,21	47	151113,2	21972,72
Debt ratio	120	0,46	0,44	0,08	1,22	0,23
Age	122	55,37	56	38	91,33	7,43
Tenure	122	7,19	5	0	56	7,76

Figure 2 Gender Distribution

	Male	Female
Gender	119	3

From figure 3, we see that after starting with a sample of 29 unique two-digit SIC codes, we end up with 12 unique SIC codes, with an uneven distribution.

Figure 3 Industry Distribution

Industry (SIC codes)	Frequency	Percent	Cumulative
13	1	0.82	0.82
26	1	0.82	1.64
28	28	22.95	24.59
29	1	0.82	25.41
30	2	1.64	27.05
33	2	1.64	28.69
34	1	0.82	29.51
35	14	11.48	40.98
36	29	23.77	64.75
37	6	4.92	69.67
38	21	17.21	86.89
73	16	13.11	100
Total	122	100	

Furthermore, we perform a pairwise correlation test to identify the interactive dynamics between the variables. By doing it pairwise, we can retrieve the p-value of each individual correlation. The p-values are listed in cursive below each variable, where bolded are significant at the 0,05-level, indicating statistically significant correlations.

Variables	Exploration	Value share of comp.	Market value	Debt ratio	Age	Tenure	Gender	Industry
Exploration	1,000							
Value share of comp.	0,149	1,000						
	0,101							
Market value	0,153	0,370	1,000					
	0,095	***0,000***						
Debt ratio	0,119	0,075	-0,002	1,000				
	0,197	*0,415*	*0,980*					
Age	-0,165	-0,079	0,017	0,051	1,000			
	0,068	*0,390*	*0,855*	*0,582*				
Tenure	0,005	-0,149	-0,086	-0,154	0,509	1,000		
	0,955	*0,101*	*0,352*	*0,092*	***0,000***			
Gender	-0,028	0,083	0,036	-0,053	0,151	0,076	1,000	
	0,763	*0,362*	*0,699*	*0,562*	*0,098*	*0,407*		
Industry	-0,101	-0,272	-0,377	-0,229	-0,029	0,086	0,241	1,000
	0,266	***0,000***	***0,000***	***0,012***	*0,747*	*0,347*	*0,075*	

Figure 4 Correlation table

To familiarize ourselves with the variables beyond simple numeric statistics, we plot the histograms for all the variables enabling us to see the shape of the variables, as well. When performing this test, we discover large spreads for the variables *market value, age* and *tenure*.

Figure 5 Histogram - market value

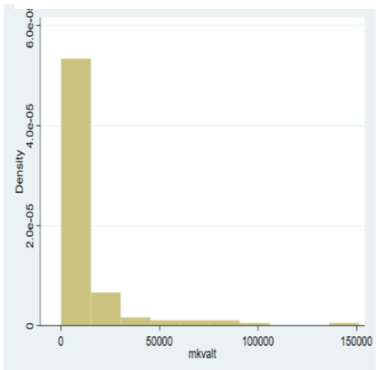


Figure 6 Histogram - age

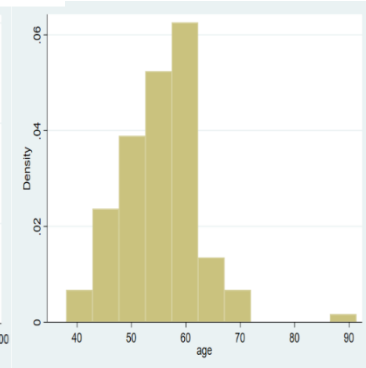
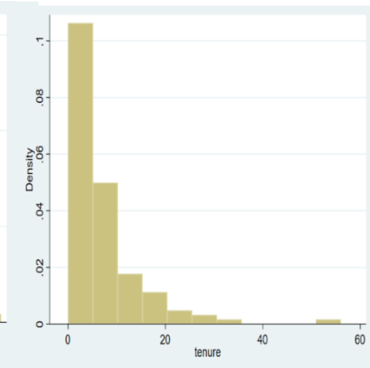


Figure 7 Histogram - tenure



These results indicate that the variables of *market value*, *age* and *tenure* are valid candidates for variable transformations later in the analysis. For full-size histograms for all the predictor variables, we refer the reader to the appendix.

Initial Regression Analysis

We begin the analysis by conducting a first regression analysis. As stated in the hypothesis, we are expecting a negative relationship between *exploration* and *value share of compensation.*

First and foremost, we see that the coefficient for *value share of compensation* is 0.060. This indicates that it is positively related to the degree of *exploration*, although just so. However, with a p-value of 0,248 it is far from statistically significant at the 0,05-level, i.e. we cannot exclude that the coefficient is zero or negative. Moreover, we see that this is the case for all our predictor variables, except *age.* The initial regression analysis indicates that age is negatively related to the degree of exploration, in line with what

Figure 5 Multiple regression

Model	
P-value	0,146
R-squared	0,091
Observations	119
Independent variables	
Value share of comp.	0,060
	0,248
Market value	0,712
	0,277
Debt ratio	0,081
	0,158
Age	-0,004
	0,034
Tenure	0,003
	0,144
Gender	0,003
	0,968
Industry	-0,002
	0,707

is expected. Younger CEOs are more risk-seeking, leading to higher degrees of exploration. However, the model is not statistically significant with a p-value of 0,146, indicating that, as it is now, the control variables do not help with granting us a statistically significant relationship between *exploration* and *value share of compensation*. In fact, the R-squared value of 0,091 indicates that only 9,1% of the variation in exploration is explained by the predictor variables. We will thus proceed with several checks to create a model with a better fit.

Multiple Regression

To reduce concerns of heteroscedasticity, we apply robust standard errors to the variables in the regression. Ceteris paribus, this gives us the output illustrated in figure 6. The p-value changes from 0,146 to 0,063, closer to a statistical significant relationship at the 0,05-level. Regarding the predictor variables, *age* is no longer statistically significant with a p-value of 0,065, although close. However, *debt ratio's* p-value changes from 0,158 to 0,039, i.e. significant at the 0,05-level.

Figure 6 Multiple regression w/ robust standard errors

Model	
P-value	0,063
R-squared	0,091
Observations	119
Independent variables	
Value share of comp.	0,060
	0,296
Market value	0,712
	0,118
Debt ratio	0,081
	0,039
Age	-0,004
	0,065
Tenure	0,003
	0,184
Gender	0,003
	0,915
Industry	-0,002
	0,644

Revisiting the correlation matrix, we create interaction variables for the statistically significant correlations and test for these. We find that only the inclusion of the interaction variable *age*tenure* gives us a significant model, with a p-value of 0,045.

Continuing, we test the remaining interaction variables step-wise, in addition to *age*tenure.* All these tests led to the model being rejected at the 0,05-level (see appendix).

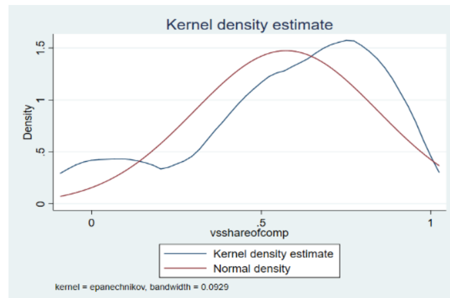
Transforming variables

To verify that our data fits the assumptions of linear regression we will focus on certain regression diagnostics. The residuals of the variables need to be normally distributed for the t-tests to be valid. However, this is not the case for the estimation of regression coefficients. Since we are interested in having valid t-tests, we will investigate the issue of normality closer.

Non-normally distributed residuals often stem from non-normally distributed variables. We will thus look closer at the distribution of our variables and see how we can apply a more normal shape.

We begin by testing the predictor variable, *value share of compensation.* The Kernel density test reveals that the variable is indeed non-normally distributed. By using the ladder-command in Stata, we opt to not transform the variable as the variable as is has the lowest chi-square value.

Figure 7 Kdensity test of value share of compensation



Applying this two-step approach to the rest of the predictor variables, we end up with log transforming *market value* and *age*, and square rooting *debt ratio* and *tenure*. For Kernel density tests and ladder-command output, we refer to the appendix.

Multiple Regression with Transformed Variables

Revisiting the approach from the previous multiple regression section, we first test the full regression. This model is neither significant at the 0,05-level. However, the adjusted regression gives us a p-value of 0,061, whereas the previous regression provided a p-value of 0,063.

None of the predictor variables are significant, although logged *age* comes very close with a p-value of 0,051. Furthermore, we see that *value share of compensation* clearly has the highest p-value, indicating that it should be the first predictor variable to be removed. Yet, this is the main predictor variable and removing it would disable us from answering our hypothesis. In other words, we first remove *gender*.

Figure 8 Multiple Regression w/ transformed variables

Model	
P-value	0,061
R-squared	0,101
Observations	119
Independent variables	
Value share of comp.	0,016
	0,032
Debt ratio (squareroot)	0,078
	0,118
Tenure (squareroot)	0,011
	0,348
Market value (log)	0,016
	0,071
Age (log)	-0,229
	0,051
Gender	0,019
	0,518
Industry	-0,002
	0,000

This gives us a significant model with a p-value of 0,0362. This is slightly more significant than figure 9. We could continue removing one and one variable, which would provide us with a more significant model at the expense of explained variance in exploration. Instead we conclude that the attempt of transforming the variables gave us little to no improvement. Thus, maintaining that the full regression including the interaction variable *age*tenure* is the model that is both significant, simplest to interpret and explains most of the variation in exploration.

*Figure 9 Multiple Regression w/ age*tenure*

Model	
P-value	0,045
R-squared	0,113
Observations	119
Independent variables	
Value share of comp.	0,072
	0,221
Market value	0,690
	0,135
Debt ratio	0,080
	0,041
Age	-0,005
	0,023
Tenure	-0,006
	0,156
Gender	0,008
	0,757
Industry	-0,001
	0,684
Age*Tenure	0,001
	0,014

Discussion and Conclusion

Few studies have focused on the relation between CEO compensation and exploration. In fact, there is a scarcity of studies linking individual incentivizing to exploration, with Lee and Meyer-Doyle's (2017) recent study as a rare exception. With this thesis, we aimed to cover this identified gap in literature. However, the findings did not match the ambition. The optimal model was statistically significant, but not for the dependent variable of interest, *value share of compensation*. The weak and statistically insignificant relationship between exploration and the share of stock-based CEO compensation were surprising and disappointing. Ultimately, it has left our hypothesis unanswered.

The possible reasons for these significant deviations from expectations are many. First and foremost, exploration is an intangible construct by nature. This makes it a hard task for firms to offer performance-based compensation related to exploration. This itself is a highly valid explanation, simultaneously questioning our research question. However, we were interested in finding indirect effects between the share of stock-based compensation and degree of explorative innovation. A CEO with a large share of compensation contingent on the firm's performance in the capital markets should be affected in either way.

Prior research has provided evidence of a positive relationship between stock-based compensation and innovation (Hirshleifer and Suh, 1992; Smith and Stulz, 1985), arguing that it should increase CEOs' risk-taking. We, however, proposed a negative relationship as risk-aversion should increase in line with the share of contingent compensation. All the same, our model proved insignificant disabling us from challenging previous findings.

Limitations & Future Research

Although we argue that our most positive contribution is the novel and well-founded estimation model for exploration, it may also have been our Achilles' heel. It is, before now, unproven and sincere limitations in the data set led to a perhaps too simplified version. The sincere limitations include limited sample size due to missing values in either patent or compensation data and limited research period due to the non-adjustable limitations in both the patent and compensation data. The latter had further ripple effects which led to the exclusion of lagging patent data to related compensation year. This, consequently, led us to use average values for all variables for the entire research period. Additionally, it disabled us from testing contractual change during the period on an individual level for relevant CEOs.

This comes on top of the inherent limitations of using patents. First and foremost, patents only show 5% of idea-creation (Stevens & Burley, 1997). This implies that we were only able to measure the extremity of explorative innovation. Not all explorative and exploitative innovation activities are natural to patent and not all patentable ideas meet criteria set by the USPTO (Hall, Jaffe & Trajtenberg, 2002). Although, patents are a step in the right direction to reveal a truer innovation pattern it is neither a completely comprehensive proxy.

The most significant upside with patents is that it enables large scale quantitative assessment. However, all large scale studies come with its trade-offs. In our case, it led to a simplified and superficial variable for the share of stock-based CEO compensation. Although Compustat provided us with four valuable compensation components there are still a vast amount of compensation data left unknown. Particularly, criteria around stock awards and option awards, such as e.g. vesting periods, would make the variable more precise. However, such an approach would significantly reduce the sample and require a more qualitative touch. Thus, we suggest that future research tries out a more qualitative and behavioral approach with a detailed investigation of CEO compensation contracts and its effect on explorative patent production.

Furthermore, we leave for future research to identify control variables that can aid to explain the remaining ~90% of variation in the degree of exploration, ceteris paribus. Certain adjustments to the dependent variable and the main predictor variable, the share of stock-based CEO compensation, might also help the explanatory power. We sincerely hope that future research finds our novel model useful and we welcome any incremental improvements to the model. It is a rare art to get it spot on the first attempt.

A major control we hoped to execute ourselves was to test the model on a control industry, preferably characterized as low-tech. This would function as a quality control to the model, where strong deviations in the findings between the industries would indicate a well-fitted model. Worst case, such a study could provide strong indications of whether the model is obsolete and nothing more than a complex construct without measurement capability.

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Appendix

Figure 10 Histogram – debt ratio

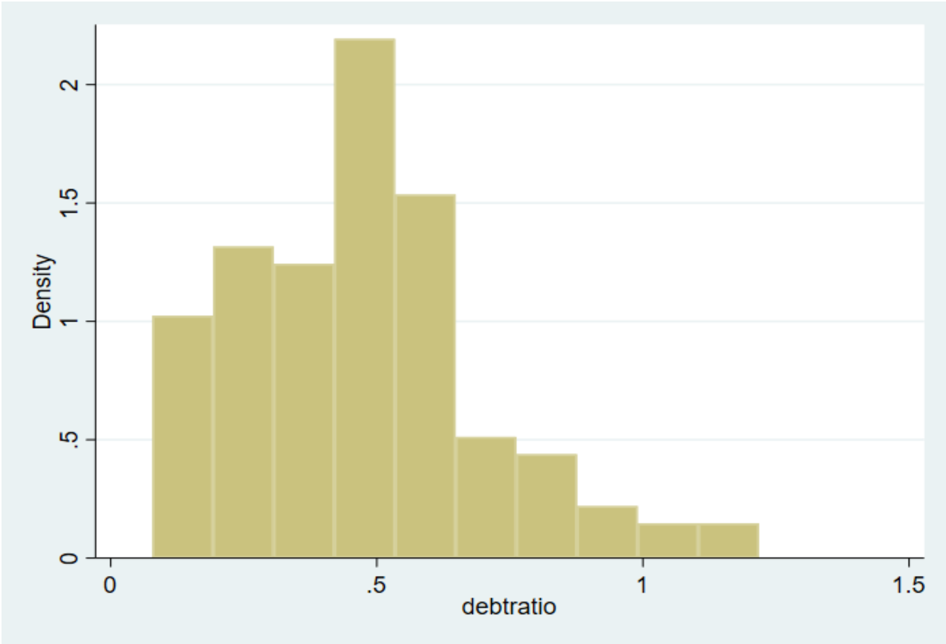

Figure 11 Histogram – value share of compensation

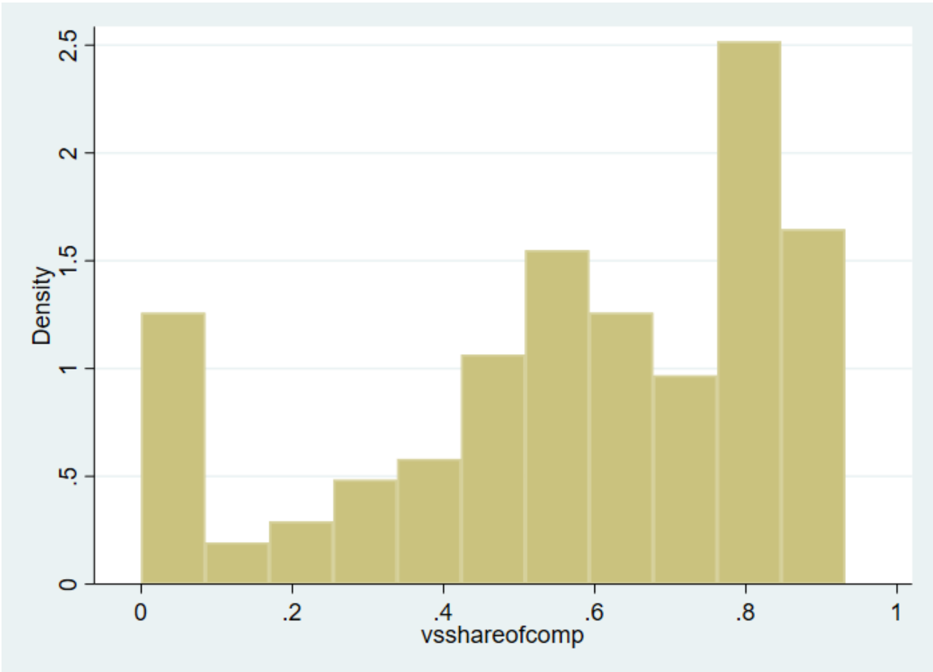

Figure 12 Scatter plot exploration & industry

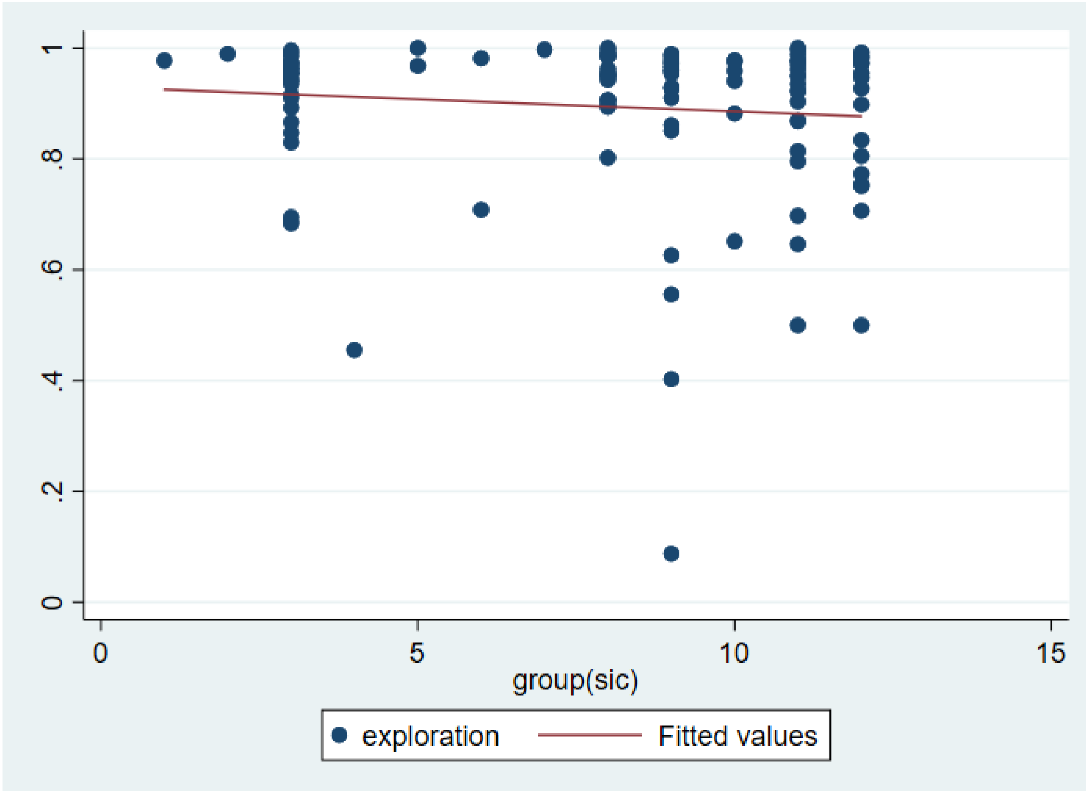

Figure 13 Scatter plot exploration & gender

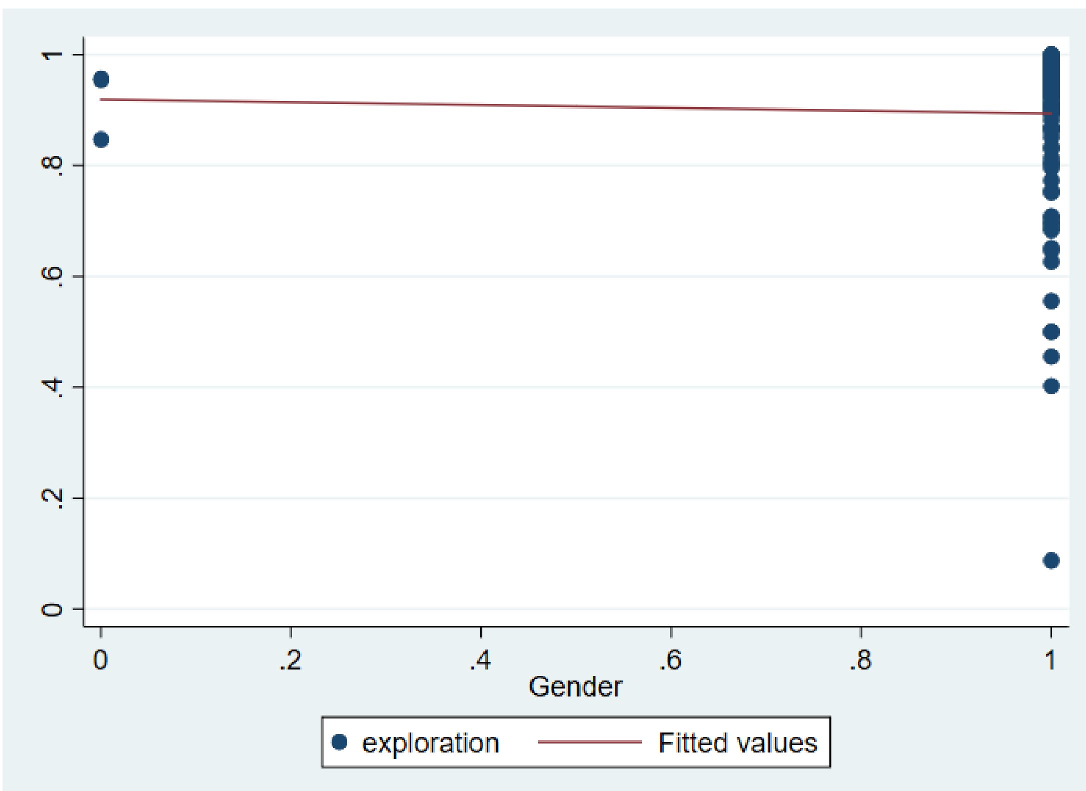

Figure 14 Scatter plot exploration & age

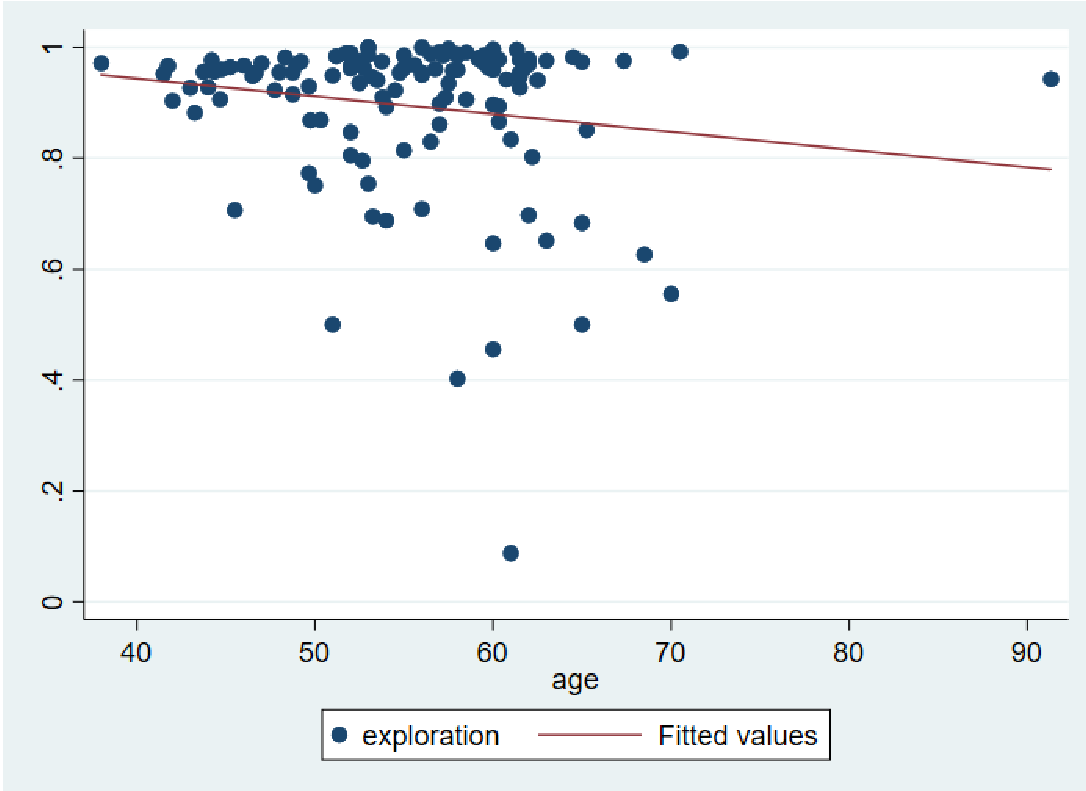

Figure 15 Scatter plot exploration & tenure

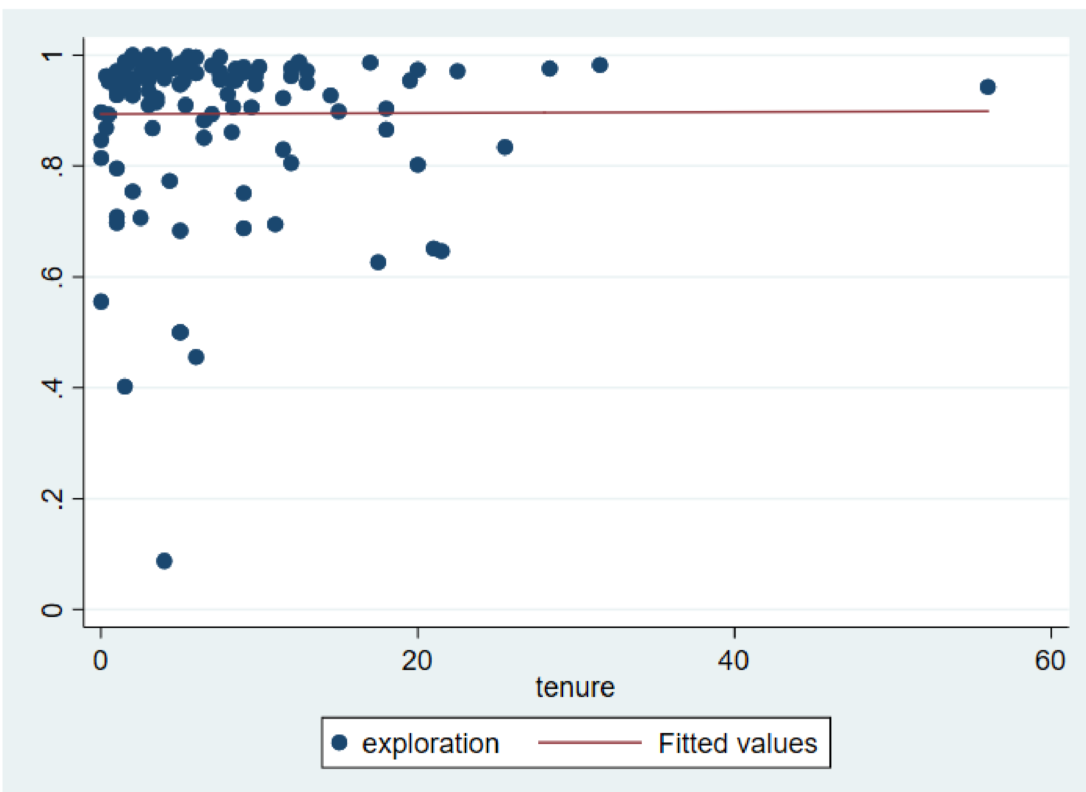

Figure 16 Scatter plot exploration & debt ratio

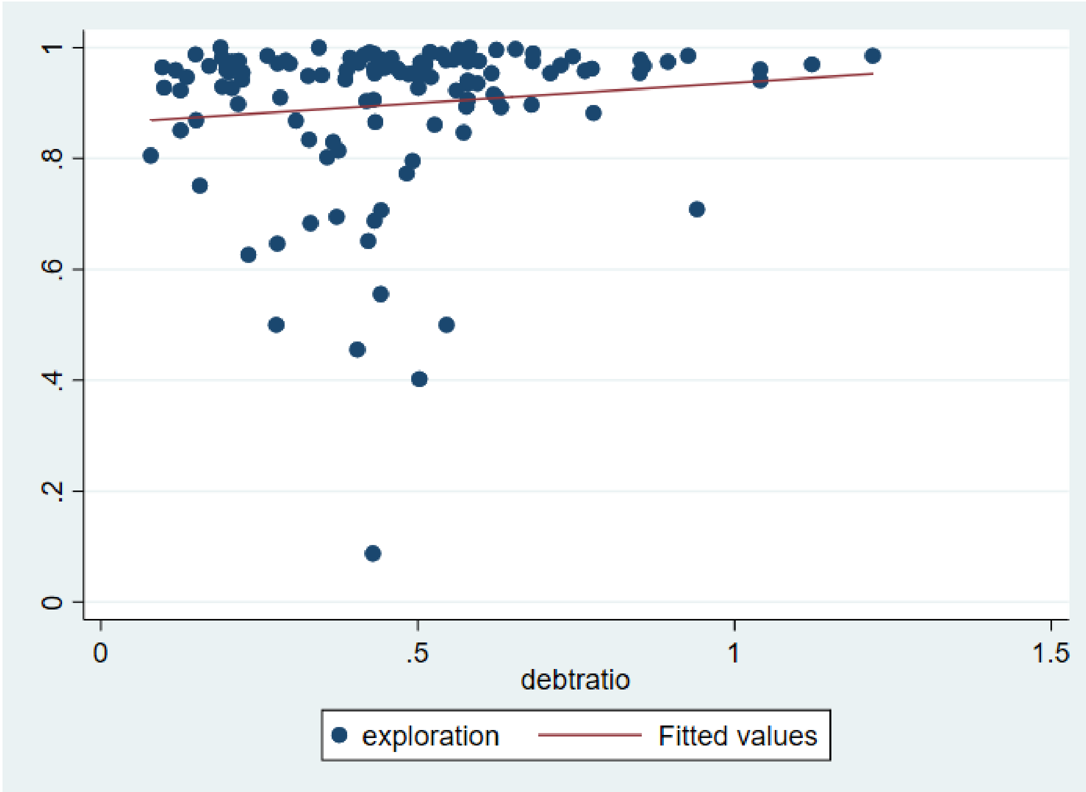

Figure 17 Scatter plot exploration & market value

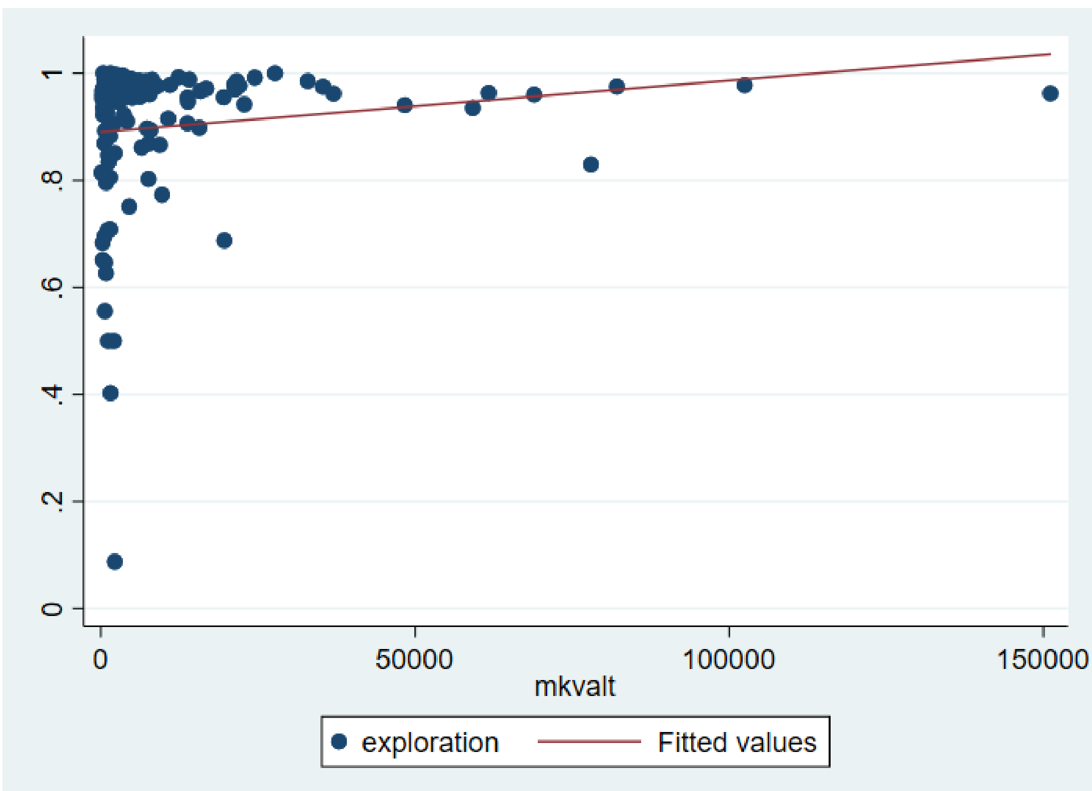

Figure 18 Multiple regression w/ all interaction variables

Model	
P-value	0,177
R-squared	0,123
Observations	119
Independent variables	
Value share of comp.	0,096
	0,432
Market value	0,160
	0,962
Debt ratio	0,043
	0,622
Age	-0,005
	0,032
Tenure	-0,006
	0,220
Gender	0,014
	0,651
Industry	-0,005
	0,671
Age*Tenure	0,000
	0,023
Industry*Value share...	-0,004
	0,788
Value share*Market val	-0,936
	0,807
Industry*Market value	0,337
	0,180
Industry*Debt ratio	0,005
	0,622

*Figure 19 Multiple regression w/ age*tenure & industry*debt ratio*

Model	
P-value	0,072
R-squared	0,106
Observations	119
Independent variables	
Value share of comp.	0,070
	0,244
Market value	0,687
	0,139
Debt ratio	0,042
	0,638
Age	-0,006
	0,024
Tenure	-0,006
	0,166
Gender	0,010
	0,719
Industry	-0,004
	0,621
Age*Tenure	0,000
	0,015
Industry*Debt ratio	0,005
	0,667

*Figure 20 Multiple regression w/ age*tenure & industry*market value*

Model	
P-value	0,069
R-squared	0,122
Observations	119
Independent variables	
Value share of comp.	0,058
	0,345
Market value	-0,518
	0,452
Debt ratio	0,085
	0,034
Age	-0,005
	0,028
Tenure	-0,005
	0,239
Gender	0,016
	0,607
Industry	-0,005
	0,302
Age*Tenure	0,000
	0,027
Industry*Market value	0,336
	0,086

*Figure 21 Multiple regression w/ age*tenure & industry*value share*

Model	
P-value	0,077
R-squared	0,106
Observations	119
Independent variables	
Value share of comp.	0,042
	0,708
Market value	0,744
	0,091
Debt ratio	0,079
	0,050
Age	-0,006
	0,027
Tenure	-0,006
	0,172
Gender	0,012
	0,704
Industry	-0,003
	0,707
Age*Tenure	0,000
	0,016
Industry*Value share...	0,003
	0,807

*Figure 22 Multiple regression w/ age*tenure & value share of comp.*market value*

Model	
P-value	0,070
R-squared	0,111
Observations	119
Independent variables	
Value share of comp.	0,086
	0,162
Market value	0,462
	0,063
Debt ratio	0,081
	0,040
Age	-0,005
	0,027
Tenure	-0,006
	0,170
Gender	0,011
	0,697
Industry	-0,002
	0,541
Age*Tenure	0,000
	0,014
Value share..*Market va	-0,488
	0,107

*Figure 23 Multiple regression w/ industry*debt ratio*

Model	
P-value	0,098
R-squared	0,092
Observations	119
Independent variables	
Value share of comp.	0,058
	0,323
Market value	0,710
	0,122
Debt ratio	0,041
	0,649
Age	-0,004
	0,067
Tenure	0,003
	0,182
Gender	0,005
	0,878
Industry	-0,004
	0,596
Industry*Debt ratio	0,005
	0,653

*Figure 24 Multiple regression w/ industry*market value*

Model	
P-value	0,078
R-squared	0,110
Observations	119
Independent variables	
Value share of comp.	0,046
	0,438
Market value	-0,581
	0,396
Debt ratio	0,086
	0,033
Age	-0,004
	0,071
Tenure	0,003
	0,160
Gender	0,011
	0,737
Industry	-0,005
	0,260
Industry*Market value	0,359
	0,060

*Figure 25 Multiple regression w/ industry*value share of compensation*

Model	
P-value	0,107
R-squared	0,092
Observations	119
Independent variables	
Value share of comp.	0,001
	0,993
Market value	0,818
	0,061
Debt ratio	0,079
	0,052
Age	-0,004
	0,071
Tenure	0,003
	0,179
Gender	0,009
	0,786
Industry	-0,006
	0,552
Industry*Value share...	0,007
	0,632

*Figure 26 Multiple regression w/ value share of comp.*market value*

Model	
P-value	0,084
R-squared	0,097
Observations	119
Independent variables	
Value share of comp.	0,074
	0,216
Market value	0,482
	0,050
Debt ratio	0,082
	0,039
Age	-0,004
	0,075
Tenure	0,003
	0,171
Gender	0,006
	0,853
Industry	-0,002
	0,502
Value share...*Market v	-0,510
	0,091

Figure 27 Multiple regression excl. gender

Model	
P-value	0,028
R-squared	0,105
Observations	119
Independent variables	
Value share of comp.	0,073
	0,210
Market value	0,696
	0,129
Debt ratio	0,080
	0,040
Age	-0,006
	0,021
Tenure	-0,006
	0,157
Industry	-0,001
	0,688
Age*Tenure	0,000
	0,014

Figure 28 Multiple regression excl gender & industry

Model	
P-value	0,016
R-squared	0,105
Observations	119
Independent variables	
Value share of comp.	0,075
	0,195
Market value	0,763
	0,105
Debt ratio	0,084
	0,028
Age	-0,006
	0,020
Tenure	-0,006
	0,141
Age*Tenure	0,000
	0,012

*Figure 29 Multiple regression excl gender, industry, tenure & age*tenure*

Model	
P-value	0,005
R-squared	0,051
Observations	119
Independent variables	
Value share of comp.	0,065
	0,284
Market value	0,675
	0,108
Debt ratio	0,064
	0,074

*Figure 30 Multiple regression excl gender, industry, tenure, age, age*tenure*

Model	
P-value	0,012
R-squared	0,073
Observations	119
Independent variables	
Value share of comp.	0,056
	0,345
Market value	0,731
	0,094
Debt ratio	0,069
	0,052
Age	-0,003
	0,126

Figure 31 Kdensity test tenure

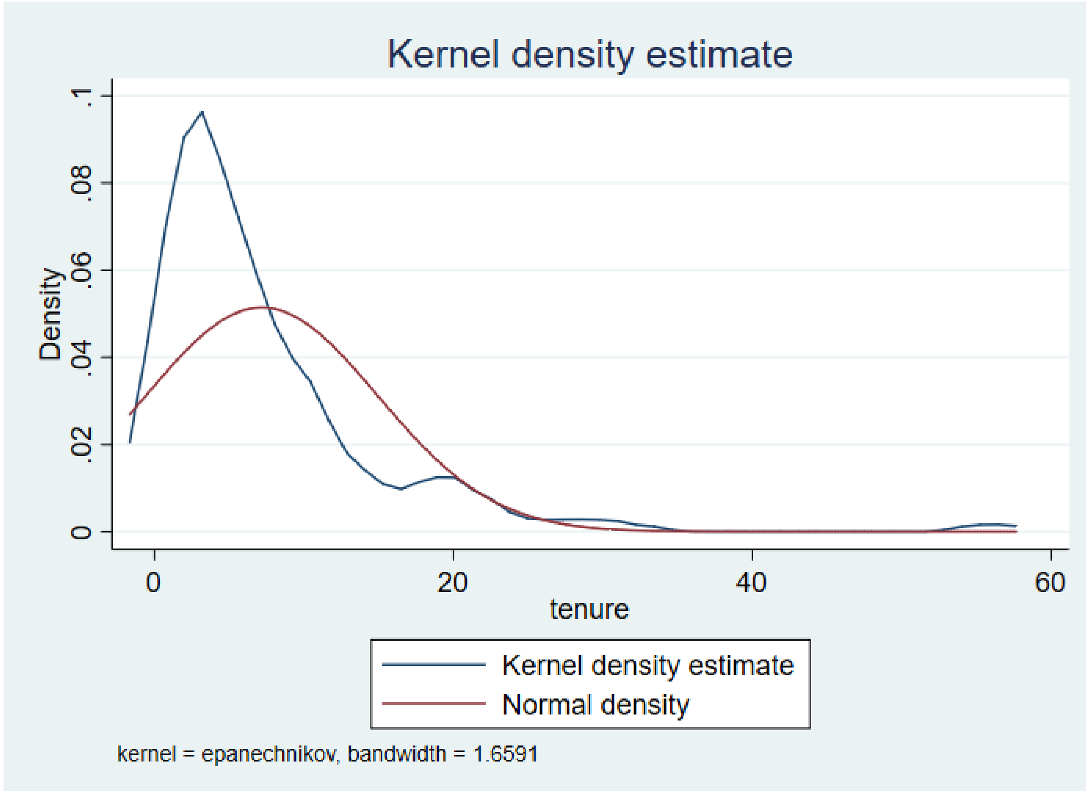

Figure 32 Kdensity test age

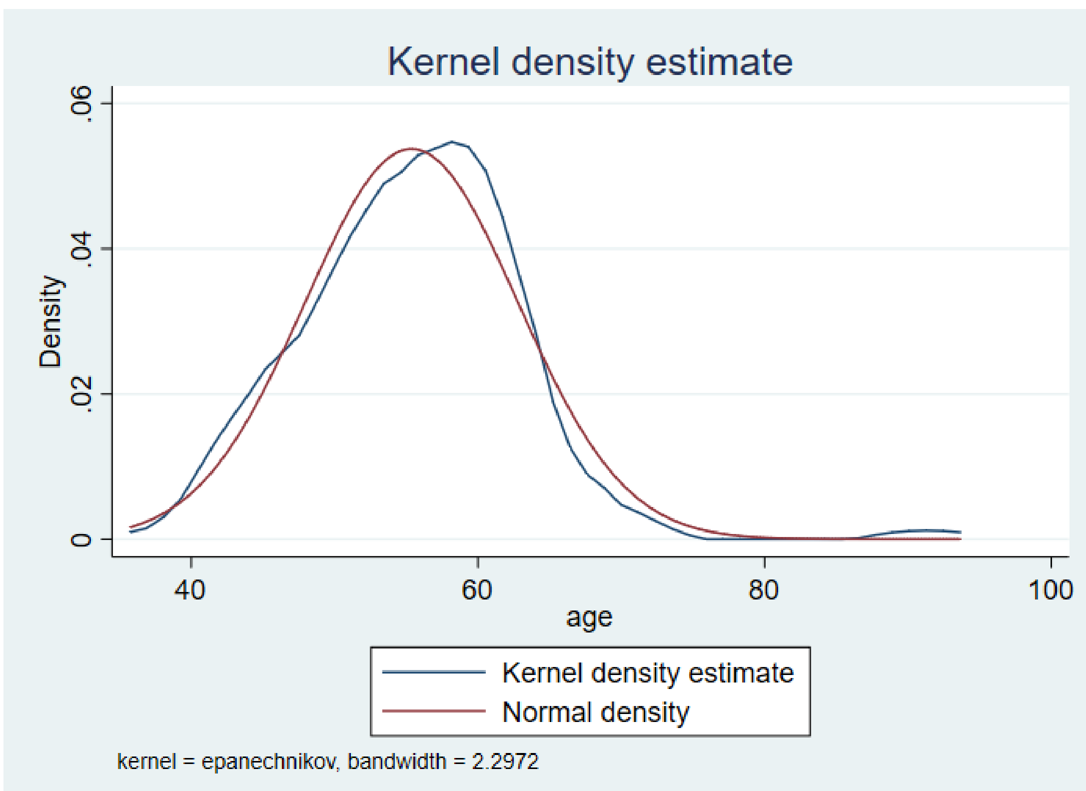

Figure 33 Kdensity test debt ratio

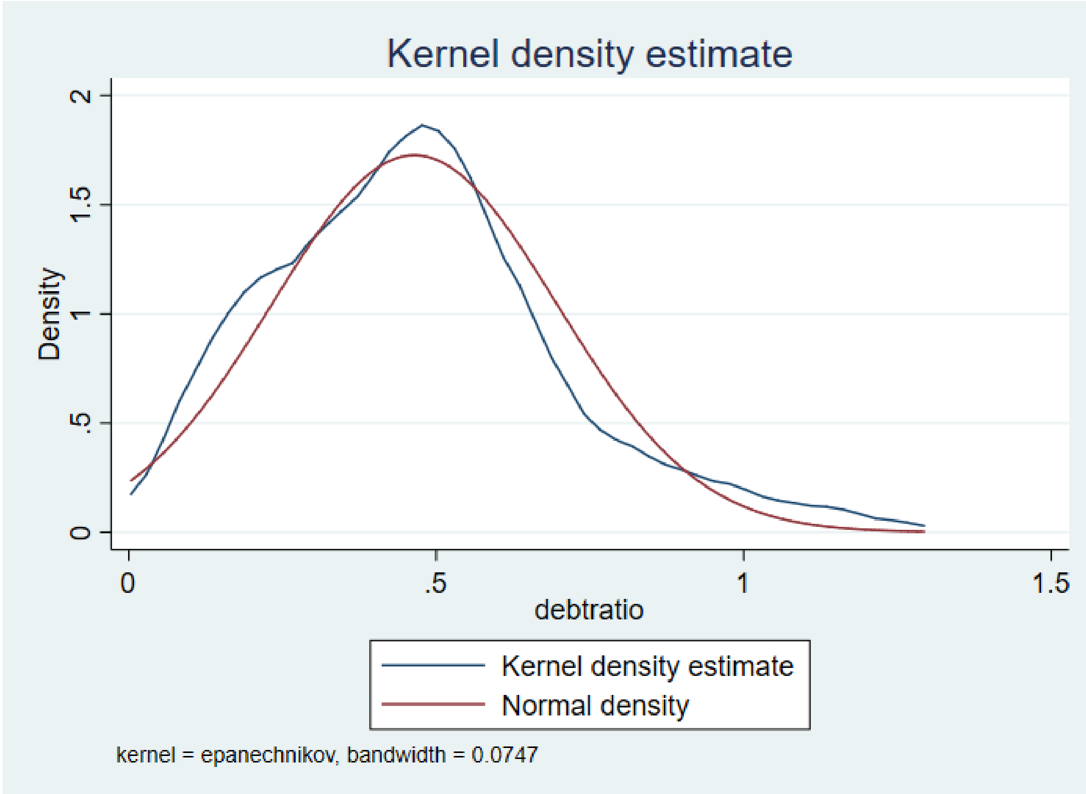

Figure 34 Kdensity test market value

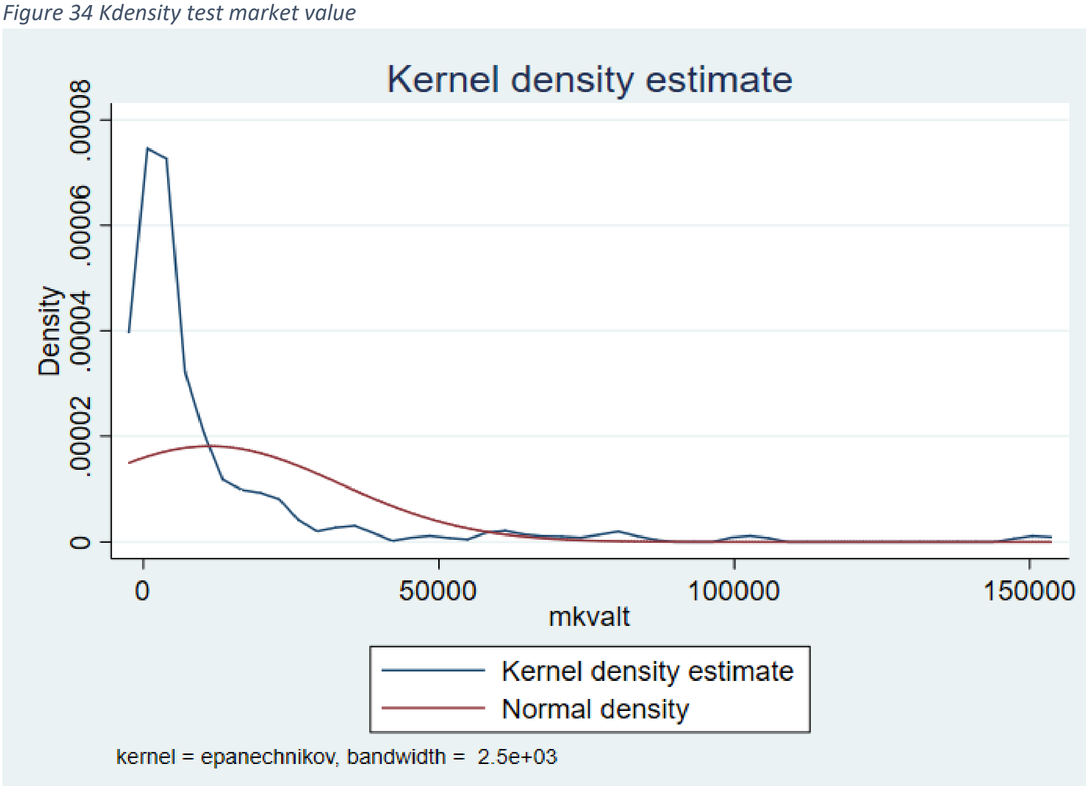

Figure 35 Ladder tenure

Transformation	formula	chi2(2)	P(chi2)
cubic	tenure^3	.	0.000
square	tenure^2	.	0.000
identity	tenure	71.28	0.000
square root	sqrt(tenure)	15.77	0.000
log	log(tenure)	.	.
1/(square root)	1/sqrt(tenure)	.	.
inverse	1/tenure	.	.
1/square	1/(tenure^2)	.	.
1/cubic	1/(tenure^3)	.	.

Figure 36 Ladder age

Transformation	formula	chi2(2)	P(chi2)
cubic	age^3	.	0.000
square	age^2	49.57	0.000
identity	age	19.07	0.000
square root	sqrt(age)	9.07	0.011
log	log(age)	4.22	0.121
1/(square root)	1/sqrt(age)	4.28	0.118
inverse	1/age	7.19	0.027
1/square	1/(age^2)	16.06	0.000
1/cubic	1/(age^3)	27.10	0.000

Figure 37 Ladder debt ratio

Transformation	formula	chi2(2)	P(chi2)
cubic	debtra~o^3	.	0.000
square	debtra~o^2	47.35	0.000
identity	debtra~o	9.96	0.007
square root	sqrt(debtra~o)	0.14	0.931
log	log(debtra~o)	7.93	0.019
1/(square root)	1/sqrt(debtra~o)	26.02	0.000
inverse	1/debtra~o	48.79	0.000
1/square	1/(debtra~o^2)	.	0.000
1/cubic	1/(debtra~o^3)	.	0.000

Figure 38 Ladder market value

Transformation	formula	chi2(2)	P(chi2)
cubic	mkvalt^3	.	0.000
square	mkvalt^2	.	0.000
identity	mkvalt	.	0.000
square root	sqrt(mkvalt)	41.16	0.000
log	log(mkvalt)	2.68	0.261
1/(square root)	1/sqrt(mkvalt)	61.12	0.000
inverse	1/mkvalt	.	0.000
1/square	1/(mkvalt^2)	.	0.000
1/cubic	1/(mkvalt^3)	.	0.000

Figure 39 Ladder value share of compensation

Transformation	formula	chi2(2)	P(chi2)
cubic	vsshar~p^3	36.92	0.000
square	vsshar~p^2	42.75	0.000
identity	vsshar~p	10.52	0.005
square root	sqrt(vsshar~p)	32.16	0.000
log	log(vsshar~p)	.	.
1/(square root)	1/sqrt(vsshar~p)	.	.
inverse	1/vsshar~p	.	.
1/square	1/(vsshar~p^2)	.	.
1/cubic	1/(vsshar~p^3)	.	.