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CEO Incentives and firm risk: in the context of cross-listing

- Evidence from the S&P 500

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Abstract

Title: CEO incentives and firm risk: in the context of cross-listings

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Keywords: CEO compensation, CEO incentives, Stock options, Firm risk, Black-Scholes, Delta, Vega, Agency Theory

Purpose: This research aims to investigate the relation of CEO compensation, especially how the sensitivity of CEO wealth to stock return volatility (vega), but also how the sensitivity of CEO wealth to stock price (delta) affects the risk of the firm. Moreover, these relations are investigated in the context of cross-listing to examine whether there are differences between US-only listed firms and those that are dual listed.

Theoretical framework: Agency theory, CEO compensation, Cross-listing, Investment myopia (short-termism), Moral-hazard and contract theory.

Methodology: Quantitative approach through regression analysis with firm risk as the dependent variable. With, delta, vega, option compensation, cash compensation and CEO stock ownership as main explanatory variables.

Conclusion: The paper concludes that CEO compensation incentives have an effect on firm risk. Vega expresses a positive and significant relation implying that the convexity of CEOs compensation structure increases firm risk. Delta demonstrates negative relation towards firm risk implying higher risk-aversion. Option compensation incentivizes CEOs to increase firm risk, as its value is dependent on the volatility of the firm. Cash compensation and CEO ownership displays a negative relationship with firm risk but non-significant. The findings also suggest that there are no to minimal differences depending on the listing situation.

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1. Introduction

This first chapter aims to introduce the subject and discuss why it is of importance to study. Furthermore, a purpose is presented, together with the disposition of the paper.

1.1 Background

Tim Sloan, CEO of Wells Fargo received a pay rise of 5%, increasing from $17.5 million to $18.4 million between 2017 and 2018. Meanwhile, several scandals had been present, and the stock had seen its price drop with 25 percent. Of the $18.4 million that Tim Sloan received, $2.4 million was salary, $14 consisted of stock awards and the last $2 million was incentive awards. Thus, roughly 87 percent of Tim Sloan's compensation was constituted by stock- and incentive awards. Moreover, option-based executive compensation has seen considerable growth and has thereby been researched thoroughly (Gormley, Matsa & Milbourn, 2013). The notion is that through the different components of executive compensation, risk-averse CEOs can be incentivized to undertake projects associated with higher risk, which corresponds to the preferences of shareholders.

To understand how executive compensation can be argued to adjust the risk preference of the executive, agency theory is often recalled. The agency theory argues that there is an agent (CEO)-principal (owner) problem. Which arise due to the belief that both agents and principals are utility maximizers – they try to maximize their individual benefits. Principals maximize their utility when share-value is maximized, meanwhile, agents can maximize their utility by transferring the value of the firm to themselves. The principal only risks the amount she has invested in the company and can effectively diversify her risk. While agents have their wealth tied up to the company and can't diversify as effectively. Hence, a disagreement of risk preference occurs which result in economic inefficiency and it is argued that the

disagreement can be resolved through effectively designed contracts. (Jensen & Meckling 1976). However, designing a contract that perfectly aligns the interests of agents and principal is near impossible. Thereby it is of utmost importance to provide incentives for top managers, to the extent that the risk preference of principals and agents are aligned.

Jensen and Murphy (1990) suggest that tying executive compensation to the performance of the firm encourages the agent to improve his effort, but it increases the risk of her compensation. With respect to this, the sensitivity of CEO wealth to stock price, hereafter referred to as delta, appears to align the interests of agents and principals. However, delta increases CEOs exposure to risk, which can induce them to ignore positive but risky NPV projects. Such risk-aversion can be reduced by enlarging the convexity of the manager's wealth and its relation to firm performance (Smith & Stulz, 1985). Option-based compensation enlarges the convexity of executive compensation (Guay, 1999), thus CEOs with such incentives are induced to invest in a manner that maximizes shareholder value. By studying the risk-aversion- and wealth effect and how this is a tradeoff, the relation of a CEO's appetite for risk and incentives can be better understood.

Whenever a CEO has stock and stock options, a relation between her wealth and the firm's stock-price performance is present, which is generally referred to as wealth-performance relation. Given that the stock price changes over time, a CEO's payoff from these incentives are uncertain and risk is put on the CEO (Jensen & Meckling, 1976; Jensen & Murphy, 1990). A CEO's preference for risk can be illustrated with the following:

$$\partial CE/\partial\sigma = \partial E(wealth)/\partial\sigma - \partial(risk\ premium)/\partial\sigma \qquad \text{(eq. 1)}$$

The equation suggests that the firm risk on managers preference can be divided into two components, the first being, $\partial E(wealth)/\partial\sigma$, which represent the change in expected wealth of a CEO when the firm risk changes. While the second component, $\partial(risk\ premium)/\partial\sigma$, represent how risk-aversion affect a CEOs utility.

When payoffs from the incentives have a linear relation to firm performance, the effect on CEOs wealth is zero. Because expected wealth has a positive relation to risk when a CEO holds stock or stock options, which in turn increases in value as the risk of the firm does (Guay, 1999). Since in a levered firm, the equity holders, basically, hold a European call option on the firm with an exercise price equal to the face value of the firm's debt, the value of stocks increases in relation to the volatility of a firm's cash flows (Jensen & Meckling, 1976).

The second component of the equation 1, which Guay (1999) refers to as the risk aversion effect, is argued to measure how risk-aversion affects managers utility. If a manager is risk-averse and have the majority of her wealth tied to the firm, as such she is poorly diversified. An increase in firm risk decreases the managers utility function. A CEO's preference for risk levels will be a tradeoff between the two parts of the equation. However, Smith and Stulz (1985) and Milgrom and Roberts (1992) suggest that adjusting the convexity, in the wealth-performance relation, mitigates the likelihood of a CEO taking decisions that are risk-averse.

1.2 Problem Discussion

There is no lack of prior research on the subject of the relationship between CEO compensation and firm performance or firm risk. Jensen and Meckling (1976) wrote a paper that focused on the agent-principal problem which functions as the foundation in the majority of studies. Agency-theory is essential to understand why and how principals design contracts

in order to overcome the divergence of interests. They also concluded that the convex payoff of options, create an incentive for the CEO to increase risk since they share the gains but not all of the losses. Conflicting, Lambert, Larcker and Verrecchia (1991) present findings that show how options are a leveraged position in the equity of the firm and therefore, potentially, enlarge a CEOs exposure to firm risk, thereby inducing the CEO to be more risk-averse.

Since then, several studies have been conducted, one where Guay (1999) shows that it is especially the convexity of stock options (vega) that set the sensitivity of CEO wealth to equity risk (delta). His findings include that stock return volatility has a positive relation to convexity, hence risk-taking and vega are linked. The overall compensation structure is important to influence a CEO's preference for risk, but especially vega. Prior studies find a positive relation of vega to both leverage and stock return volatility[1]. Implying that higher vega induces CEOs to adopt more aggressive debt policy and increase the overall firm risk. Further empirical evidence is provided by Conyon, Core and Guay (2011), which highlight that CEOs are not accepting a higher risk without suitable compensation to do so. Assuming that a CEO is incentivized to act in the interest of the shareholders, she would seek to make decisions that optimize the value of the firm. One article by Gormley, Matsa, Milbourn (2013), find that when left-tail (material) risk is increased, boards of the companies reduce a top managers delta and that lower convexity induces managers to reduce the risk of the firm.

Given the discussion above, one can conclude that both shareholders and CEOs would benefit from an increased share price. One possibility to do this would be to cross-list the company. Miller (1999) finds that foreign firms that cross-list on US capital markets and raise new capital through a public offering perceive a positive development in shareholder wealth. He

[1] See Guay (1999); Coles, Daniel and Naveen (2006)

finds evidence that cross-listings can decrease barriers to capital which leads to a higher share price and lower cost of capital. Another study by Errunza and Miller (2000) conclude that almost half of the firms in their sample, consisting of 126 firms from 32 countries, experienced a significant decline in the cost of capital. Meanwhile, Sarkissian and Schill (2009) find supporting evidence that cross-listings only boost short-term valuation and aren't persistent. They find small evidence of permanently effects on return for firms that cross-list themselves. Hence, the evidence of whether cross-listings create increased valuation and a lower cost of capital is contradictory.

Studying CEO incentives and firm risk are especially interesting since CEOs are often paid large sums to act in the interest of shareholders and even before shareholders actually know the outcome of employing a CEO, they have to pay a substantial amount. However, if they can pay this amount in different components, they might be able to increase the effort of the CEO and align her interests with those of the shareholders. As mentioned, this relation has been subject to prior research but the characteristics of firms, markets and CEOs changes (Core & Guay, 1999), thereof we study a time period where the S&P 500 has reached numerous all-time high levels, which could indicate a change in the dynamics of firms, market and CEOs. Moreover, CEO compensation incentives and risk-taking have not been studied in the context of cross-listings before, hence we fill a gap in the existing literature. We also stress that this is particularly interesting since globalization can induce firms to not only be present in more countries but also be accessible on an increased number of capital markets (Karolyi, 2006).

1.3 Purpose and Research Question

The purpose of this research is to investigate the relation between CEO compensation incentives and firm risk. Specifically how the sensitivity of CEO wealth to stock return volatility (vega) and stock price (delta) affects the risk of the firm. Prior studies have reported mixed result whether CEO compensation can incentivize risk-taking which can be a result of different samples and time periods, as the characteristics of both firm and CEO changes with time (Core & Guay, 1999).[2]

Furthermore, the scope of this study is the companies constituting the S&P 500 index over the years of 2013-2017, which is of particular interest given the numerous all-time high levels that the S&P 500 index have experienced during the studied years. Moreover, the S&P 500 cover 83 percent of the US equity market, hence it provides a good estimation of how CEO compensation and firm risk is related in the general firm of US (*S&P 500 The Gauge of the Market Economy*, 2019). The S&P 500 index noted a price of 1466 at the beginning of 2013, which reached 2673 at the end of 2017, thus generating a return of 82% over five years. In relation, the S&P 500 has had an average return of approximately 10 percent per year since its beginning.

The relation between CEO compensation incentives and firm risk is, mainly, of importance for shareholders. Because they need to understand how the design of CEO compensation will affect the CEOs behavior and decisions and how such can be alternated to fit the preference of the shareholder.

[2] (Guay, 1999; Coles, Daniel & Naveen, 2006; Devers, Wiseman & Arrfelt, 2008; Lambert, Larcker & Verecchia, 1991; Ross, 2004)

1. Is there a relation between compensation incentives of CEOs and firm risk?
2. Are there differences of compensation incentives and firm risk between cross-listed and not cross-listed firms?

1.4 Disposition

In section two, the literature review, important empirical findings are presented in order to give an understanding of what prior research has concluded. The aim is to give a review of what has been established within prior literature. Section three, the theoretical framework, present important theories that provide important knowledge needed to draw conclusions regarding the topic of this thesis. Furthermore, the hypotheses of this paper are presented. Section four, the methodology, is of great importance and is where the procedures of this study are presented. Moreover, the empirical model is presented and the choices that have been made throughout this paper, enabling critically examining the procedure and the choices that were made. Section five, presents the data that was collected, the procedure of the data collection, the variables that are used and a summary of statistic outputs. In chapter six, the analysis and discussion take place regarding the findings. Lastly, chapter seven, is where we present our brief summary of the findings of this paper.

2. Literature Review

In this following section, important research on the subject is presented. Research that directly is related but also research that studies the subject but in another context are considered.

2.1 Previous Research

The agency theory has been the central point in understanding CEO compensation and it is suggested that tying the manager's wealth to the firm, reduces agency costs. Jensen and Meckling (1976) evolve around the theories of property rights, agency and finance to develop a theory regarding ownership structure. They also address how cost and rewards are allocated within the firm depending on individual rights. Since the rights are normally realized through contracts, the behavior of individuals within the firm will be dependent on the nature of the contracts. They also point out that in the case of a levered firm, the equity holders basically holds a European call option to buy the firm, where the exercise price is the face value of the firm's' debt. Jensen and Murphy (1990) start with the agency theory and how the divergence of incentives between agents and principals can be counteracted through compensation incentives. They find that the relation between top management compensation and firm performance is statistically significant and positive. However, they find that the effect of incentives is small, especially considering its expected importance in aligning interests of agents and principals. Guay (1999) also has his starting point in the study of Jensen and Meckling (1976) and stresses that the relation between manager's wealth and stock price isn't enough to control arising agency conflicts. But that the convexity of the relationship also needs to be managed. Guay hypothesizes that firm apply convexity to managers' compensation in order to overcome the risk-aversion of managers. As such, he suggests that

stock options have a significant effect of the convexity while common stockholdings don't. The findings suggest that there is a positive relation between the convexity of CEO compensation and firm's assets but also between equity risk and convexity (Guay, 1999). A related article by Core and Guay (1999) examine the annual grants of option and restricted stock of CEOs and how firms, by the usage of such, manage optimal levels of equity incentives in order to align the risk preferences. They hypothesize that firms adjust the grants of common stocks and stock options to maximize the incentives since firm- and CEO characteristics change over time. Another paper investigating if executive stock options incentivize CEOs to invest in high-risk projects is the one by Rajgopal and Shevlin (2002). However, they investigate the issue from oil and gas producer's standpoint and whether exploration risk has a relation with the CEO equity-based compensation sensitivity to stock return volatility (vega). They posit that the riskiness of exploration is positively related to equity-based incentives, which is supported by their findings.

Miller, Gomez-Mejia and Wiseman (2002) approach the issue from a slightly different angle and investigate how systematic and unsystematic firm risk affect CEO compensation. They hypothesize that performance-based compensation will be greater when the firm has moderate levels of firm risk. But also, that the relation of CEO compensation and firm risk is curvilinear, meaning that CEO compensation is higher with the presence of moderate risk to either low or high firm risk. They concluded that depending on the degree of risk, the conceptualization of the CEO compensation package varies. Additionally, their findings suggested that CEO pay and firm risk indicated a stronger relation for unsystematic risk relative systematic risk. Kizildag, Ozdemir and Upneja (2013) conducted similar research but they investigated the relation between CEO compensation and systematic risk in the context of the American restaurant industry. Their paper recognized a positive relationship between

incentive-based compensation and firm risk, suggesting that firm risk encourages CEOs to take on a higher proportion of incentive-based compensation. However, firm risk does not appear to mitigate the association between performance and pay.

Another measure of risk is used in the paper by Devers, Wiseman and Arrfelt (2008), where they investigate how the CEO equity-based compensation affects strategic risk taking. Their research was based on three established principles; behavior agency model, agency theory and prospect theory. They measure strategic risk with; R&D expenses, capital investments and usage of long-term debt. They hypothesize that the highest level of strategic risk occurs when the CEO has moderate values of accumulated stock options. Furthermore, they state that the current value of accumulated stock options has a positive relation with strategic risk-taking. They concluded that strategic risk-taking is significantly impacted by CEO compensation packages. However, depending on the type of equity-based compensation, the strategic risk-taking exhibited dissimilarities. They acknowledged that cash-based compensation mitigates the inducement characteristics of equity-based pay, implying that cash-based compensation may affect CEOs perception of equity compensation. Coles, Daniel and Naveen (2006) have a similar approach as Devers, Wiseman and Arrfelt (2008). They advance the issue through measuring the relation of CEO compensation, investment policies, debt policies and firm risk and their causal relationship. They find support for that vega induces riskier policies in terms of more R&D investments, decreased investments in PP&E and higher leverage, thus being consistent with theory. Furthermore, they establish that vega and delta are positively affected by stock return volatility. They use a larger sample and a longer time frame than comparable studies.

One study with contradictory findings to the ones above is the paper by Lambert, Larcker and Verrecchia (1991). They investigate the valuation of compensation from the perspective of the manager. They argue that due to a manager's inability to diversify themselves from their firm-specific wealth, will affect the manager's valuation and that the correct valuation method for their stock options doesn't have to be the Black and Scholes (1973). More specifically they examine how the view on risk and structure of the manager's wealth affect the valuation method of a contract. Their result indicates that the individual value of a compensation contract can be of substantially less value for the CEO than the perceived cost as by shareholders. Moreover, they find support for that the value of the individual component depends on the rest of the compensation package. Suggesting that the components value is interlinked with each other and thereby can't be valued in isolation (Lambert, Larcker & Verecchia, 1991). Ross (2004), similar to Lambert, Larcker, Verecchia (1991), suggest that incentivizing CEOs with options will not make them more likely to adopt riskier projects. He argues that compensation packages including options raise the base compensation, hence the CEO asses risk from a wealthier point than before. This is of importance due to the conception that the attitude toward risk can be substantially different from varying wealth levels. He finds support for that an agent's risk appetite doesn't solely depend on the convexity of compensation schedules but also on how these schedules insinuate changes in the agent's utility function, thus changing the appetite towards risk.

Hagendorff and Vallascas (2011), investigated how the CEO compensation package affects risk-taking by examining acquisitions within the banking industry. The sample consisted of 172 bank mergers in the US. Their results imply that CEOs tend to account for the contractual risk-taking incentives entrenched in their compensation package when participating in acquisitions. This indicates that CEOs are inclined to engage in risk-increasing deals as a

byproduct to higher pay-risk sensitivity. Demonstrating that there is a causal relationship between the riskiness of executives' investment choices and CEO compensation. Gande and Kalpathy (2017) further examined this causal relationship by investigating the largest financial firms in the U.S. before the financial crisis in 2008. Their research affirmed prior findings in the field (Hagendorff & Vallascas, 2011), by concluding that risk-taking is positively affected by equity incentives entrenched in executive compensation, thus, could lead to eventual solvency issues. However, their research proved that the solvency problems could be mitigated by attaining stronger incentive alignment.

Chakraborty, Gao and Sheikh (2018) examined how CEO option compensation affects firm risk and included an investigation of an eventual size effect. Their sample consisted of Canadian organizations listed on the S&P/TSX composite index. The results indicated that a robust size effect was present, implying that depending on the firm size, the relationship between CEO option compensation and firm risk shifts. For example, small firms exhibited a positive and significant relationship between option compensation and firm risk meanwhile larger firms did not present any significant effect. Furthermore, they establish that cross-listing changes some of the studied governance mechanisms such as board size, CEO duality and institutional ownership. They find that cross-listings enlarges the effects of governance mechanisms on firm risk. Which links to the findings of Abdallah and Ioannidis (2010), that report a decrease of local beta (risk) when firms cross-list themselves.

3. Theoretical Background and Hypothesis Development

This chapter consists of the theoretical frameworks which are relevant to the purpose of this study. Furthermore, those theories which help generate greater understanding of the studied topic and which help create greater insights are presented. Lastly, this chapter is concluded with the development of the hypotheses, founded on prior literature and the theoretical background.

3.1 Agency Theory

Wilson (1968) argues that a syndicate is a collection of individuals who must make aligned decisions under uncertainty. Finally, they will obtain a return on the decision, which should be distributed between the decision makers, known as risk-sharing. However, the issue is that the different individuals have diverse appetite towards risk. Agency theory expands the risk-sharing literature by including the so-called agency problem. Which appears when interests differ among cooperating parties, such as syndicates (Jensen & Meckling, 1976; Ross, 1973). More precisely, agency theory focuses on the relationship between two parties, where the principal assigns the agent with work and the agent to execute the given work. The ambition of agency theory is to describe the relationship between the principal and agent. Assuming that both the agent and the principal are utility maximizers, it can be reasoned that agents will not always act in the interests of principals. Thereby, the principals and agents' goals and objectives diverge from one another. Moreover, agency problems appear if there is inefficiency or difficulties connected to verifying what agents achieve (Jensen & Meckling, 1976). In summary; when the interests of agents and principals diverge from one another and when asymmetric information is involved, the agency problem arises (Bebchuk & Fried, 2004).

The essence of the agency problem is the difficulty of validating the agent's actions and that those are in line with given expectations (Eisenhardt, 1989). Since principals and agents are trying to maximize their respective utility, they encourage decisions that may nurture their individual interests. To mitigate the discussed dissent between principals and agents, the agency theory suggests instituting suitable compensation programs, thereby aligning the incentives between the individuals of the syndicate (Jensen & Meckling, 1976).

When the manager wholly owns the firm she will take actions which maximize her utility. However, if the owner (manager) proceeds with selling equity claims which are given the identical, proportion right to the profits and have limited liability, agency costs will arise. Since the new shareholders will bear a part of the cost of the benefits that the manager takes out in order to maximize her individual utility. This is referred to as the agency cost of outside equity. (Jensen & Meckling, 1976)

Assuming that the CEO act in the interest of shareholders, she would introduce debt to the capital structure of the firm. Since debt, due to tax subsidies on interest payments, will increase the value of the firm, this refers to the trade-off theory of capital structure (Modigliani, Miller, 1963). Such a belief would imply that the firm should be solely financed with debt. However, as the debt increases, so does bankruptcy costs (Jensen & Meckling, 1976). Thus, the benefits of tax savings and the costs of bankruptcy have to be weighed against each other, in order to find an optimal level of debt and equity in the aspect of firm value (Kraus & Litzenberger, 1973). Meanwhile, agency theory extends the trade-off theory and explains how firms act in regard to a managerial approach (Frank & Goyal, 2009). The agency theory-perspective suggests that CEOs have incentives to operate the firm in a way

that maximizes their personal wealth i.e. maximizing the firm's equity value. Simultaneously, shareholders wish to increase the firm's equity value, whereas debtholders wish to keep the firm solvent such that it can pay back its obligations, hence a conflict of interest arises. This conflict concerns what level of risk the firm should accept. For example, if a firm is highly levered (high likelihood of bankruptcy), shareholders may be tempted to accept projects which carry excessive risk. Because these projects, if successful, bring high payoffs and if the projects are unsuccessful debtholders take the largest hit (Jensen & Meckling, 1976). On the other hand, high levels of debt can make managers reject projects which carry positive NPV, which in the end have a negative impact on firm value. Rejection of such projects relies on the fact that most of the positive NPV would benefit the debtholders to a larger extent, than shareholders, this is known as the underinvestment problem (Myers, 1977).

In order to solve the two problems – conflict of objectives and verification of the agent's actions – of the agency-principal relationships, one can establish contracts which are tied to performance and thereby direct the relationship between the parties. These contracts are supposed to align the preferences of agents and principals due to the fact that they are dependent on the same actions and rewarded accordingly, hence the disagreement of the two are reduced (Eisenhardt, 1989). This is an important factor in order to align the risk preference between agents and principals. Because of the issue that CEOs have difficulties in diversifying their firm-specific wealth and are thereby assumed to favor less risky projects. Conversely, shareholders can diversify their wealth across numerous firms and thereby favor risky projects in order to maximize returns (Eisenhardt, 1989; Jensen & Meckling, 1976).

3.1.1 Moral Hazard and Contract Theory

Contract theory is based on the risk-sharing problem and the notion that the principal and agent have different risk preferences. If the principals had complete information regarding the activities of the CEO and all the investment opportunities of the firm, they could design a perfect contract that would govern and enforce all managerial action for every plausible scenario. However, the agent can decide on how much effort she is willing to put into each individual task and principals can only observe the outcome of the efforts and not the efforts themselves. Both the effort agents put in and principal's inability to observe the agent give rise to moral hazard. The moral hazard problem is the result of asymmetric information since the actions of agents can't be observed and consequently contracted (Holmstrom, 1979). It is argued that the moral hazard problem can be eased by incorporating shares or stock options to the agent, by such making her a shareholder. Giving shares or stock options to the CEO, induce her to act as an agent and a principal at the same time. Where, the higher the compensation, the less will the CEO heed the interest of principals. (Jensen & Murphy, 1990).

3.2 Investment Myopia

The output of the firm depends on the CEOs ability, decision-making and the state of nature. Given that the ability is unknown, shareholders design CEOs compensation on past and present productivity. However, the CEO can adopt projects that have short-term profits and can thereby improve the perception of her abilities in an early stage, which could increase her compensation (Narayanan, 1985).

Stock options play an important role in aligning risk incentives between agents and principals because CEOs sensitivity of wealth is dependent on the volatility of the equity value. Consequently, an increase in volatility results in a higher price of the option and simultaneously the sensitivity of the relation between CEO wealth and equity value increases

with a higher share price. Thereby, it is suggested that stock options incentivize risk-averse managers to accept more risky projects and opt to increase the stock price (Guay, 1999; Jensen & Meckling, 1976).

However, this could tempt CEOs to engage in activities which enhances short-term results and consequently their individual wealth, even at the expense of long-term profits. The idea behind this is that the stock market focuses on earnings to forecast a firm's value and makes the assumption that higher earnings today is associated with higher earnings in the future (Stein, 1989). It is further argued that capital markets pressure CEOs to focus on short-term earnings and forgo the pursuit of reaching their long-term objectives (Stein, 1989). Jensen (1986) argues that myopic behavior can occur when managers hold few stocks in which company they are employed in, or when they are compensated in ways that incentives them to focus on accounting earnings over the value of the firm. While Stein (1989) implies that if CEOs have compensation tied up to the stock price, they may adopt a myopic behavior in order to maximize their wealth. From another point of view, the managerial career theory, emphasizes that managers may engage in short-term projects which consequently have short-term returns because they want to establish their reputation which is based on earnings (Narayanan, 1985).

3.3 CEO Compensation Structure

Traditionally, compensation is considered to be related and a consequence of performance, which implies that CEOs who have superior performance are expected to have a greater pay-off (Jensen & Murphy, 1990; Mehran, 1995). A common practice of firms is to employ compensation packages with different components of pay, that can be divided into cash and noncash pay, including; salary, bonus, long-term incentive pay (LTIP), stocks option

incentives and other payments such as pensions and perks (Miller, Wiseman & Gomez-Mejia, 2002).

Salary represents the fixed component as it is contracted beforehand and due to its limited correlation with firm performance (Murphy, 1999). Bhagat and Bolton (2013) argue that salary doesn't depend on performance and the CEO is given the same amount of pay in a given period, regardless of the performance, thereby the CEO has no incentive to adopt risky projects. The CEO would rather prefer projects with no or minimal risk. However, the fixed salary component is normally used as a benchmark or a starting point for bonuses. For example, cash bonuses are usually expressed as a percentage relative to the base salary. Consequently, a change in the fixed or base salary will impact the variable compensation (Murphy, 1999)

Stock options provide the CEO with the option but not the obligation to purchase stocks of their employing firm at the given exercise (strike) price at a certain time, all predetermined by the option contract. Therefore, it creates an incentive for the CEO to increase the value of the underlying shares so that they simultaneously increase their individual as well as shareholders. Furthermore, stock options help to align the interests of shareholders and executives but also incentivizes executives to achieve superior results, as they will be sharing the gains and losses with shareholders (Jensen & Murphy, 1990; Jensen & Meckling, 1976).

A CEOs wealth's sensitivity to stock price (delta) is seen as aligning the incentives of a CEO and shareholders of the corresponding firm. Moreover, higher delta implies that managers will work more effectively since they will take part in the costs and benefits together with shareholders. Due to the notion that CEOs can't diversify their firm-specific wealth, they have to bear more risk than diversified shareholders. Thus, the risk of CEO neglecting positive

NPV projects is present. However, this can potentially be counterbalanced by an expansion in vega. Such option-based compensation incentives can reduce risk-aversion that is inherited from high deltas because they are a convex payoff of firm performance. (Coles, Daniel & Naveen, 2006; Smith & Stulz, 1985). Meaning that delta compensation incentives the CEO to adopt risky and positive NPV project. But simultaneously, higher levels of sensitivity to performance will enlarge the CEOs exposure to risk, relative to shareholders, meaning that higher delta could increase the CEOs risk-aversion (Smith & Stulz, 1985).

3.4 Cross-listing

The traditional reasoning behind cross-listings can be explained by market segmentation, which can arise from direct barriers such as, ownership restrictions and taxes. Indirect barriers such as information accessibility, accounting standards or liquidity risk also help explain why a firm would benefit from cross-listing themselves (Miller, 1999). Counteracting the market segmentation is suggested to decrease the cost of capital (Errunza & Losq, 1985). It is argued that the cost of capital can be decreased if the firm cross-list on a more liquid market and thereby decrease the bid-ask spread (Amihud & Mendelson, 1986). Simultaneously Stapleton and Subrahmanyam, (1977) claim that decreasing the cost of capital increases firm value.

Firms can also signal their quality through cross-listing because some exchanges have more rigorous requirements of what information the individual company has to submit. Which in turn, can result in greater media attention, analyst coverage and enable better forecast accuracy for the analysts (Roosenboom & van Dijk, 2009).

Doidge (2004) imply that minority investors around the world are unsatisfactorily protected by legislation. Furthermore, controlling of shareholders can decrease the value of the firm at

the expense of minority shareholders (Doidge 2004). This can also help explain why non-U.S. firms face difficulties in raising equity and why their equity is less valued (La Porta, Lopez-de-Silanes, Shleifer & Vishny, 2000). Additionally, Doidge (2004) express whether a firm should cross-list or not as a trade-off between private benefits of control and the usage of bonding in order to decrease the cost of capital.

3.5 Hypotheses Development

Prior literature provides evidence of a relation between CEO compensation incentives and firm risk[3]. Furthermore, the agency theory argues that to mitigate the divergence of interests between principals and agents, optimal contracts need to be designed, so that it incentivizes the CEO to adopt risky projects (Jensen & Meckling, 1976). Moreover, it is argued that convexity, which is given by option-based compensation, creates incentives for the CEO to take more risk (Coles, Daniel & Naveen, 2006). Thus, we formulate our first and second hypothesis.

H1: Sensitivity of CEO wealth to stock return volatility (vega) has a positive relation to firm risk.

H2: Option compensation has a positive relation to firm risk

The evidence of deltas effect on firm risk is contradictory. While John and John (1993) argue that if higher NPV projects are risky, increased delta could incentivize the CEO to adopt more risky projects. However, higher delta, expose the manager to more risk, given on the notion that they can't diversify their firm-specific wealth (Guay, 1999). Guay (1999) further argues that shareholders can incentivize managers to increase equity value by managing delta.

[3] Guay (1999); Rajgopal and Shevlin (2002); Coles, Daniel and Naveen (2006)

Moreover, theories of managerial short-termism argue that tying up a CEOs compensation to the equity value, she might embrace a myopic behavior and focus on maximizing equity value in order to maximize her own utility (Jensen & Murphy, 1990; Jensen & Meckling, 1976). Which is further supported by the agency theory, which implies that a CEO is aiming to maximize her own utility. Lastly, if a CEO increases the equity value, she increases her payoff from her stock options due to the fact that a bigger difference between the predetermined exercise price and the spot price of the underlying stock. As such, we formulate our third hypothesis

H3: Sensitivity of CEO wealth to stock price (delta) has a positive relation to firm risk.

It can be argued that a CEO who is incentivized, through vega, to heed the interest of shareholders should seek to cross-list the firm. As this generates a greater investor base, creating more liquidity (Amihud & Mendelson, 1986) and thereby decreasing the cost of capital. Which in the end increases the value of the firm (Stapleton & Subrahmanyam, 1977). As discussed earlier, an increase of the firm value simultaneously increases the wealth of the CEO given the convexity of stock options, thus, benefiting both parties. We expect to see differences between the risk measures and its relation to firm risk. Since cross-listings may decrease the volatility of equity due to the greater investor base and decreased bid-ask spread.

H4: There is a difference between CEO compensation incentives and firm risk between cross-listed and non-cross-listed firms.

4. Methodology

In this section, the research approach and design of the study is discussed. The empirical models that are used together with specifications are also presented.

4.1 Research Approach & Design

The thesis uses a quantitative research approach which according to Eliasson (2013) should be applied whenever a study aims to investigate a potentially widespread phenomenon or when the results serve the purpose to draw general conclusions. Furthermore, a quantitative approach allows the research to compile and investigate a large number of observations, which is argued to establish a more reliable study (Bryman & Bell, 2013). Additionally, Saunders, Lewis and Thornhill (2009), emphasizes the applicability of quantitative approaches when handling large data sets. This approach has also been the main method in prior research, acting as further evidence of its utility for this paper (Croci, Del Giudice & Jankengård, 2017; Gande & Kalpathy, 2017; Chakraborty, Gao & Sheikh, 2018).

Moreover, Bryman and Bell (2013) claim that a quantitative approach is best complemented with a deductive research approach, allowing us to develop the hypothesis on the basis of prior research and current theories. This is further reinforced by Jacobsen (2002), who argues that the deductive approach is the optimal method in order to investigate a theory's applicability in real environments. Therefore, quantitative research with a deductive approach enables us to explore theoretical predictions regarding interdependent relationships within a practical context, thus, investigate whether theoretical predictions is existent in reality.

In order to investigate the relationship between firm risk and CEO compensation, the hypotheses will be statistically tested through regression analyses. The paper uses panel-data as it exhibits both cross-sectional and time-series dimensions, which according to Greene (2012) is generally analyzed through pooled OLS, random effects and fixed effects models.

4.2 Fixed Effects vs Random Effects

In order to deal with the structural setting, there are two commonly used estimation models that account for both cross-sectional and time dimensions, which are fixed effects and random effects. The difference between the two is that random effects do not require any correlation between the variables and the error term in contrast to the fixed effects model. In order to assess the ideal estimation model, we conducted a Hausman test where the null hypothesis states that the preferred model is random effects. The results indicated that the null hypothesis was to be rejected (table 1) thus, signifying that our sample should employ the fixed effects model specification. The fixed effects model is an error constituent model that allows us to estimate unobservable observation of specific effects that are fixed (Roberts & Whited, 2012). Furthermore, Brooks (2014) define the fixed effects model as an estimation specification used for panel data that includes dichotomies variables. This allows us to account for the relationship between dependent and independent on both a cross-sectional and time-varying setting. We control for year effects by introducing dummy variables that represent each individual year and are included in our regressions. Furthermore, in order to account for heteroscedasticity, we employ a robustness check including robust standard errors clustered by firm.

4.3 Empirical Method

In order to investigate the relationship between firm risk and CEO compensation, we divide CEO compensation into three parts, option compensation, cash compensation and CEO ownership. These three corresponds to our main explanatory variables. Therefore, our generic regression will use the following empirical method specification:

$$\text{Firm risk}_{it} = \beta_0 + \beta_1 \text{ Option compensation} + \beta_2 \text{ Cash compensation} + \beta_3 \text{ CEO ownership} + \gamma_{it} \sum \text{Controls}_i + \varepsilon_{it} \quad \text{(eq. 2)}$$

However, we also intend to convey how CEOs sensitivity to stock price and stock return volatility relate to firm risk. By adding delta and vega to our generic model we can account for CEOs incentives, as it is a way to align the interests of shareholders and CEOs. This directs the focus towards value maximization hence, how firms can induce managers to make ideal financing and investment decisions. Therefore, we perform an additional regression with the following model specification:

$$\text{Firm risk}_{it} = \beta_0 + \beta_1 \text{ Delta} + \beta_2 \text{ Vega} + \beta_3 \text{ Option compensation} + \beta_4 \text{ Cash compensation} + \beta_5 \text{ CEO ownership} + \gamma_{it} \sum \text{Controls}_i + \varepsilon_{it} \quad \text{(eq. 3)}$$

This empirical model is the main regression specification and acts as the foundation of the analysis. We also aim to investigate cross-listing effects by dividing the main sample into two sub-samples reflecting each firm's listing categorization. These sub-samples also uses our main regression specification in order to convey differences between listing status.

4.4 Validity & Reliability

Bryman and Bell (2013) and Eliasson (2013) defines validity as the degree in which the research measures what it intends to measure. Thus, it is vital to apply suitable tools in order to address the research question (Eliasson, 2013). Accordingly, the regression model derives from prior studies and incorporates existent theories as a mean for an explanation.

Reliability refers to the extent to which the research is repeatable. A common synonym to reliability is, therefore, replicability (Bryman & Bell, 2013). The data sample for this paper is based on secondary data retrieved from primarily Compustat and Execucomp. Therefore, the

data compilation process is highly replicable as it is based on annual reports. Additionally, both the variables and theories used in order to answer the research question derives from previous papers (Gande & Kalpathy, 2017; Chakraborty, Gao & Sheikh, 2018), allowing this paper to compare results with similar studies.

5. Data and Data Descriptive

In this fifth section, the data gathering process is discussed along with what variables are of scope for this paper. A discussion about the data set and its characteristics are also presented.

5.1 Data Collection

We collect data on CEO compensation, company specifics and macroeconomics from Compustat – Capital IQ, Execucomp, CRSP and FactSet. The compilation procedure began by gathering all available information regarding CEO compensation from Execucomp. Thereafter, we assembled a year on year ticker list for each firm that had complete records of CEO compensation. Consequently, the sample experienced a loss of data due to incomplete information, which resulted in an unbalanced panel with a final sample of 2445 firm-year observations. The company tickers gathered from Execucomp was used as the unique identifier in order to download stock prices from Factset, company financials from Capital IQ, treasury data (long and short term) from CRSP and information of cross-listings from Datastream. Data regarding CEO compensation was matched with the CEO name and company ticker symbol.

The paper investigates the S&P 500 firms during the period 2013-2017. The reasoning behind the selected time-period derives from the coverage of the S&P 500 index. S&P 500 is based on the 500 largest publicly traded companies in the U.S. and weighted on the basis of market capitalization. During 2013 the index registered an all-time high since its introduction and has experienced approximately an 82 percent increase between 2013 and 2017. Furthermore, the result of this study can be compared to studies before the all-time-highs' of the S&P 500 and

shed light on whether delta and vega have changed, which could be the case due to changes in CEO and firm characteristics (Core & Guay, 1999).

5.2 Dependent Variables

Our dependent variable, firm risk, is measured by using the natural logarithm of the standard deviation of annualized daily stock returns, which are calculated year over year. This is in line with prior research. For example, Chakraborty, Gao & Sheikh, (2018) express firm risk as the natural logarithm of the annualized standard deviation of daily stock returns. Whereas, Coles, Daniel and Naveen (2006) study the influence vega has on risk by using an intermediary for firm risk, computed by using the logarithm of the variance of daily returns.

5.3 Independent Variables

Delta is defined as the dollar change in the value of the CEO's option portfolio to a 1% change in stock price. Meanwhile, vega is expressed as the dollar change in the value of the CEO's option portfolio to a 0.01 change in stock-return volatility. Both delta and vega are calculated through the Black and Scholes model with the adjustment of accounting for dividends as by Merton (1973) (See appendix 1). Option compensation derives from the fair value of all options granted during the year. The valuation is done on a grant-date fair value basis which is in line with FAS 123R. Previous research provides evidence of a positive relationship between option compensation and firm risk (Chakraborty, Gao & Sheikh, 2018). Cash compensation is the dollar value of the basic cash compensation and bonuses earned by each individual CEO during the year. CEO ownership is expressed as the shares owned by the CEO divided by total shares outstanding.

Firm size is defined as the natural logarithm of sales, which is in line with prior studies where the evidence points towards a negative relation to firm risk (Coles, Daniel & Naveen, 2006; Guay, 1999; Low, 2009). We also control for return on assets, which is defined as net income divided by total assets and functions as a measurement of profitability. Market to book is calculated as common shares outstanding multiplied by closing price divided by total equity. The market to book measurement is a proxy for future growth opportunities and discussed to impact firm risk (Coles, Daniel & Naveen., 2006). Leverage is expressed as the ratio of debt to assets, where debt corresponds to the total long-term debt and assets is measured as the total assets of the firm. Evidence from prior studies are proven to be ambiguous (Boubakri, Mansi & Saffar, 2013; Leland, 1998; Friend & Lang, 1988). Capital intensity is calculated as total assets divided by sales. Previous research has demonstrated indefinite results of its effect on firm risk (Miller & Bromiley, 1990). The inclusion of capital intensity is based on the argumentation that it can increase the risk in two ways as discussed in Miller and Bromiley (1990). The age variable is defined as the age of the respective executive for each examined year. It was incorporated as a control variable, which corresponds to prior research, where it also was established as a significant variable (Chakraborty, Gao & Sheikh, 2018). Gender is initially expressed as a string variable categorized by either male or female. Therefore, it has been redesigned as a dummy variable where male corresponds to one and female to zero. Gupta, Mortal & Guo (2018) argues that there is a compensation gap between the genders of the CEOs'.

5.4 Descriptive Statistics

Table 2 and table 3 presents the summary statistics of the variables incorporated in this paper. The average volatility is 23.4% with a maximum and minimum value of 5.5% and 82.9% respectively. There is an apparent difference between listing status for the firms, as cross-

listed firms on average experiences lower volatility, with a value of 22.7% compared to 26.3% for U.S. only firms, thus, suggesting that firm risk is lower for cross-listed companies.

Delta presents an average value of $533,000 for our full sample which is similar to cross-listed firms. However, firms only listed in the U.S. portrays higher average values reaching up to $540,000 regardless of the lower maximum value. This suggests that firms only listed in the U.S. on average experience a larger change in CEO wealth for a 1% change in stock price. Vega, on the other hand, is lower for domestically listed companies with an average value of $191,800 compared to $241,900 for cross-listed companies. Implying that cross-listed firms are more sensitive to changes in stock-return volatility. Option compensation follows the same relation as delta, insinuating that cross-listed firms demonstrate higher maximum values but lower average values. Option compensation displays an average value of $1,692,000 for cross-listed firms, simultaneously an average value of $2,374,000 for non-cross-listed firms. This indicates that firms only listed in the U.S. tend to have larger compensation through options relative firms that are cross-listed. However, cash compensation is higher for cross-listed firms with an average value of $1,465,000 compared to $1,195,000 for domestically listed firms further implying that cross-listed firms are more inclined to compensate their CEO with a more even proportion between cash and option compensation. CEO ownership demonstrates differences depending on listing status, as cross-listed firms on average presents lower percentage ownership compared to U.S. listed firms. The average CEO ownership for cross-listed firms and domestically listed companies are 0.588% and 0.937% respectively. Whereas the full sample presents an average of 0.662%. This suggests that companies only listed domestically are more inclined to compensate their CEO by granting a higher proportion of outstanding shares.

Return on assets does not exhibit any particular difference between cross-listed and not cross-listed firms with average values of 6.04% and 6.31% respectively. The full sample shows an average return on assets of 6.1%, ranging from the minimum value of -122.7% to the maximum of 53.3%, implying that the profitability is independent of listing status. Sales, on the other hand, shows a clear distinction depending on listing condition, as cross-listed firms demonstrates average sales of $23.5 billion compared to $11.4 billion for firms only listed in the U.S. Similarly, cash demonstrates differences between listing categorization as cross-listed firms on average hold $3.1 billion in cash, compared to $1.8 billion for U.S. listed companies. Furthermore, cross-listed firms tend to have lower levels of debt as demonstrated by an average leverage of 28.0% relative 32.1% for domestically listed firms. Capital intensity and age exhibit a similar pattern, regardless of listing status, where the average value for our whole sample is 3.7 and 57.3 respectively. Gender proclaims that the majority of the CEO's are male regardless of the listing situation. Market to book displays differences between cross-listed and not cross-listed companies with average values of 4.2 and 2.5 respectively. However, interestingly both listing categorizations presents negative minimum values, this is due to negative values of the common equity.

6. Analysis & Discussion

In the following section, the results from our diagnostic tests pre-estimation will be presented and discussed. Furthermore, we will convey our empirical findings which will be discussed and analyzed based on the theoretical framework and previous literature.

6.1 Diagnostic Tests Pre-estimation

6.1.1 Hausman test

Our sample is panel data as it includes both time-series and cross-sectional dimensions. An OLS regression doesn't account for periodic differences as it assumes equal intercepts for each observation and each year (Brooks, 2014). In order to control for this, there are two applicable estimation models, fixed effects and random effects. The Hausman tests allow us to establish the preferred estimation method applicable to our sample. The results indicated that fixed effects were the preferred method (Table 1). This test has been conducted on our two sub-samples as well where the results were in consensus with that of the whole sample (Table 1). Therefore, our regressions are performed through a fixed effects model specification.

6.1.2 Heteroscedasticity

By applying the fixed effects estimation model the potential of heteroscedasticity arises (Brooks, 2014). Therefore, an OLS estimator may experience inefficiencies in the regression output. To test for heteroscedasticity, we conduct a modified Wald-test which tests the null hypothesis of homoscedasticity. The test was performed for all our samples and indicated that heteroscedasticity was present. In order to counteract this, we have conducted an additional

regression where the inclusion of robust standard errors clustered by firm is present. This enables us to control for eventual heteroscedasticity.

6.1.3 Multicollinearity

The implementation of the OLS estimation method comes with the implied assumption that the independent variables are not correlated with one another (Brooks, 2014). Multicollinearity refers to the association between the explanatory variables. Furthermore, Brooks (2014) highlights two different distinctions of collinearity: perfect multicollinearity and near multicollinearity. Perfect multicollinearity is when two or more variables exhibits an exact relationship to one another. Near multicollinearity occurs whenever an association between two or more independent variables exhibits high correlation rather than an exact relationship. In order to assess the multicollinearity for our sample, we report a correlation matrix which demonstrates correlations below 0.36 for the majority of our independent variables. However, vega and delta exhibited a correlation of 0.73 implying near multicollinearity. Our reasoning behind this high correlation is that both vega and delta are calculated based on the Black-Scholes formula incorporating the same variables in the calculation with minor adjustments, thus, expected to demonstrate a high relationship to one another. Due to the differences in estimations, the variables explain diverse relation towards firm risk. Vega refers to the sensitivity depending on stock return volatility whereas delta captures CEOs sensitivity towards changes in stock price. This divergence inclines us to account for both vega and delta in the same regression model. Prior research suggests that one should account for delta when measuring vega (Coles, Daniel & Naveen, 2006).

6.2 Regression Analysis & Discussion

Table 4 presents our generic fixed effects model regression excluding vega and delta (equation 2). Column 1 shows the findings estimated by the fixed effects model whereas Column 2 controls for year-effects and Column 3 incorporates a robustness check which includes robust standard errors clustered by firm. Option compensation, Cash compensation and CEO ownership constitutes our main explanatory variables. Option compensation exhibit a positive and statistically significant relationship with firm risk which is consistent with Chakraborty, Gao and Sheikh (2018). This implies that option compensation encourages managerial risk-taking. The coefficient suggests that a $1,000 increase in option compensation would infer a 0.27% increase in firm risk. This is in line with the prediction of both the managerial incentive theorem as well as the agency theory. The reasoning behind this association is that the value of CEOs options is determined by the volatility of the firm. More precisely, higher volatility increases the value of their option portfolio. Thus, the CEOs are inclined to increase firm risk in order to maximize their own personal wealth. This entails that option compensation works as a good tool for decreasing agency costs related to incentive alignment between CEOs and shareholders. Cash compensation presents a negative relationship with firm risk, however, non-significant. The coefficient infers that by increasing cash compensation by $1,000, firm risk would experience a decline of 0.925%. This implies that increased cash compensation discourages managerial risk-taking but due to the non-established significance, we cannot statistically conclude whether cash compensation dispirits risk-taking. CEO ownership demonstrates a negative relationship of non-statistical significance with firm risk. This indicates that firm risk decreases as CEO ownership increases. In this particular case, a 1% increase in CEO ownership would entail a 0.32% decrease in firm risk. However, due to the insignificant coefficient, the conclusion is not statistically ensured. This could imply that, as in the case with delta, there is not enough

convexity between CEO wealth and firm risk, hence not incentivizing the CEO enough to increase the risk of the firm. Moreover, the relation of CEO ownership and firm risk in our sample, suggests that the missing of convexity induce the CEO to decrease the firm risk.

Table 5 presents the results from our main fixed effects model regression (equation 3). These regressions partially control for year-effects as well as incorporates a robustness check by including robust standard errors clustered by firm. The variables of primary interest are delta, vega, option compensation, cash compensation and CEO ownership as these are our main explanatory variables. Firstly, the coefficient of delta demonstrates a negative and statistically significant relation with firm risk, implying that delta discourages risk-taking behavior. The magnitude of the coefficient suggests that a $1,000 dollar increase in delta infers a 2.47% decrease in firm risk. This is in contrast to Coles, Daniel and Naveen's (2006) findings where a positive relation between firm risk and delta was established. delta can be seen as a way to align the incentives of managers with those of the shareholders thus, acting towards minimizing the differences in expectations between said parties. The negative relationship might indicate that higher levels of delta infer larger exposure to firm risk for the CEO relative the diversified shareholder, implying that higher deltas could lead to increased managerial risk aversion. The result indicates that we reject our third hypothesis as our finding suggests a negative rather than positive relation between delta and risk-taking.

Vega also exhibited statistical significance but demonstrated a positive relationship to firm risk which is consistent with the findings of Guay (1999) and Coles, Daniel and Naveen (2006). This indicates that firm risk is positively impacted by vega, implying that an increase in vega encourages CEOs to take on more risk. To be more precise, a $1,000 dollar increase in vega would increase firm risk by 6.17%. Our explanation for this is that an increase vega infers that a larger portion of the CEO's wealth is tied up in options which value is

determined by firm risk. This incentivizes managers to take on more risk in accordance to the managerial incentive theory. This is also a way to align the interest of the CEO and shareholders, which is supported by the notion of positive relationships as predicted by the agency theory. Considering that vega has a larger impact on firm risk relative to delta, especially by a large magnitude. We argue that in line with prior research such as Guay (1999) it is of greater importance to control the vega in order to incentivize the CEO to act in the interest of shareholders. Furthermore, vega can be argued to offset the negative relation that delta may induce on the firm risk. By managing the CEOs wealth to stock return volatility, shareholders can overcome agency costs that originate from discrepancies between agents and principals. In conclusion, vega's relation to firm risk also supports the first hypothesis, that it has a positive relation to firm risk.

Option compensation presents a positive coefficient of statistical significance. This indicates that increased option compensation encourages risk-taking. The coefficient suggests that by increasing the CEO's option compensation by $1,000 dollar, the firm would experience an increase in firm risk of 0.255%. This is also as predicted in accordance with both managerial incentive theory as well as agency theory. By increasing option compensation the firm can mitigate the risk of moral hazard as the CEO's wealth gets tied up to the wealth of the firm which aligns the CEO's interest with shareholders interest, therefore aligns their value maximization engagement. As the value of their options is dependent on the volatility of the firm, the CEO is incentivized to take on increased risk in order to increase their own personal wealth. This supports the notion of option compensation working as a good tool to decrease the agency costs related to differences in value maximization incentives between the CEO and the shareholders. It also gives additional support for our conclusion regarding vega as the CEO's risk-taking incentives promote firm risk. Furthermore, it supports our second

hypothesis as we have established a positive relation between option compensation and firm risk. Cash compensation exhibits a negative relation to firm risk, however, statistically insignificant. The coefficient implies that higher cash compensation decreases firm risk, where a $1,000 increase in cash compensation results in a 0.804% decrease in firm risk. This might indicate that CEOs place a premium on firm stability as their personal wealth, originating from cash compensation, is directly linked with firm performance. Thus, the CEO wants to mitigate the risk of potential deviation in stock performance.

Return on assets, firm size and market to book demonstrates similar characteristics as they all indicate a negative relationship with statistical significance. This implies that increased profitability, sales and growth opportunities, as measured by return on assets, firm size and market to book respectively, discourage risk-taking. The coefficients suggest that by increasing return on assets and firm size by 1%, firm risk would experience a decrease of 0.323% and 0.0796% respectively. Assuming that increased profitability infer higher firm value, the negative coefficient of return on assets suggests that CEOs are less inclined to manage firm risk as this increases the volatility of equity value which results in an enlargement of option value. Consequently, inducing the CEO to decrease the risk as she has more wealth tied up to the company. Meanwhile, the negative relation between firm size and firm risk can be argued to be a consequence of myopic behavior. Where the CEO aims to expand the size of the firm in order to maximize their own utility, even if expanding the size of the firm might disrupt future returns. The market to book coefficient, on the other hand, indicates that a one unit increase in market to book would infer a 0.0000013% decrease in firm risk. Age, gender and cash are non-statistically significant but poses a positive relationship towards firm risk. The age variable is of most interest as previous literature has proven a positively significant relationship between the two which is in line with theoretical

predictions of the quiet life hypothesis which states that higher CEO places a premium for stability. However, this was not the case in this paper as our results indicated a positive relationship as well as non-significant. The magnitude of the coefficient tells us that one year of added age would infer a 0.0942% increase in firm risk.

Table 6 and Table 7 presents the fixed effects regressions on our two sub-samples categorized depending on listing status. These regressions partially control for year-effects as well as incorporate a robustness check by including robust standard errors clustered by firm. The two sub-samples consists of 1927 and 518 observations for cross-listed and U.S. listed firms respectively. The difference in sample size may affect the statistical significance of the not cross-listed categorization sample as the findings from that regression only exhibited two variables with significance. The majority of the independent variables displays similar relationships towards firm risk as their coefficient sign are the same independent on listing status.

Delta is proven to be statistically significant with a negative effect on firm risk for cross-listed firms. Once again implying that by increasing managerial wealth the CEO becomes more exposed to firm risk in comparison to the diversified shareholder and therefore might increase the degree of managerial risk aversion. However, even though domestically listed firms demonstrates the same relation between delta and firm risk the variable is statistically insignificant but the coefficients are basically the same indicating that delta's effect on firm risk is independent on listing status. Vega exhibits a positive relationship with firm risk. However, the significance differs among the samples as cross-listed firms demonstrate non-statistical result whereas U.S. listed firms display statistical significance. The positive coefficients indicate that vega is still associated with risk-taking encouragement independent

of listing categorization, implying that even though cross-listed firms are believed to decrease the cost of capital and thus, increase firm value, it does not change the direction of vega and delta. Option compensation is positive for both domestically listed firms and cross-listed companies even though it only exhibits statistical significance for the cross-listed sample. Implying that option compensation effect on firm-risk is independent on listing status, however, as the option compensation is statistically insignificant for domestically listed firms, the association cannot be statistically ensured.

As most of the control variables does not exhibit any level of statistical significance and presents the same signs on their coefficients as our full sample regression results, we cannot conclude any differences among listing status. Due to the only difference being the statistical significance of vega between cross-listed and non-cross-listed firms we fail to accept our fourth hypothesis.

7. Conclusion

This thesis investigates the relationship between CEO compensation incentives and firm risk. Furthermore, we examine if there are any differences between cross-listed and non-cross-listed firms. To determine the relationship we rely on economic theories such as agency theory. The findings support the idea that convexity of CEOs compensation schemes incentivizes a CEO to increase the risk of the firm. Additionally, we establish that it is of higher importance for shareholders to manage vega rather than delta, as vega has a larger impact on the risk-taking than delta. Moreover, vega can offset the negative impact that delta may have on firm risk. Option compensation also has, as expected, a positive impact on firm risk as due to the convexity of options, which increases in value as the volatility of equity increases. We provide further evidence that firm size, ROA and market to book have a negative impact on firm risk. Suggesting that increased profitability, sales and growth opportunities tend to decrease managerial risk-taking.

Furthermore, we provide evidence that there are differences between cross-listed and not cross-listed firms. Our findings suggest that vega has a higher explanation degree in domestically listed firms, whereas in cross-listed firms it cannot be statistically secured. We conclude that the improvement of firm value when a firm cross-lists, increases the wealth of the CEO, hence, this replicates the same effect that vega has in a not cross-listed firm. Simultaneously, when a firm cross-list the firm risk is expected to decrease, impacting the CEOs utility function and changing the appetite for risk. However, all our main explanatory variables display the same direction of the coefficients between cross-listed and not cross-listed firms, with only minor variation in its statistical significance, indicating that there might be differences between the two but only of minor importance.

7.1 Further Research

The relation between CEO compensation and firm risk has been widely researched during the last decades. By addressing the impact of compensation incentives, such as vega and delta, on firm risk, one could attain a clearer picture of how firms can direct their CEOs' risk preference. However, this doesn't account whether compensation is short-term or long-term and CEOs not uncommonly exercises their options before they mature. Studying the duration of incentives and how this affects the risk of the firm would be of interest for further research. One might believe that there might be myopic and self-serving behavior of the CEO. Where they try to maximize their utility by managing the duration of compensation incentives. A divergence of interests may also be present in terms of duration. This would bring further understanding of how shareholders should design a CEO's contract with regard to the maturity and vesting periods of options in order to incentivize a CEO to act in the interest of the shareholder.

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Tables

Table 1: Diagnostic tests pre-estimation

Diagnostic tests pre-estimation				
Test	**Hypothesis**	**Statistic**	**P-value**	**Rejection of null hypothesis**
Hausman test - Full Sample	H0: Random Effects preferred method	67.61	0.0000	Yes
Hausman test - Cross-listed	H0: Random Effects preferred method	61.11	0.0000	Yes
Hausman test - Not cross-listed	H0: Random Effects preferred method	25.76	0.0024	Yes
Modified Wald test - Full Sample	H0: Evidence of homoscedasticity	28557.55	0.0000	Yes
Modified Wald test - Cross-listed	H0: Evidence of homoscedasticity	25538.16	0.0000	Yes
Modified Wald test - Not cross-listed	H0: Evidence of homoscedasticity	9.5e+29	0.0000	Yes

Table 2: Summary Statistics - Full Sample

Full Sample				
Variable	**Mean**	**Std.Dev.**	**Min**	**Max**
Volatility (%)	23.4	8.31	5.52	82.9
Delta ($000)	533.0	1,027	0	18,761
Vega ($000)	231.3	427.4	0	8,407
Option compensation ($000)	1,836	4,697	0	115,884
Cash compensation ($000)	1,408	1,711	0	35,5
CEO Ownership (%)	0.662	2.64	0	51.9
Return on assets	0.0610	0.0729	-1.227	0.533
Sales ($ millions)	20,906	39,668	148.9	496,785
Leverage	0.289	0.190	0	1.846
Capital intensity	3.702	5.369	0.180	36.11
Market to book	3.823	50.97	-1,107	1,404
Gender	0.960	0.197	0	1
Age	57.34	6.26	29	87
Cash ($ millions)	2,856	8,707	0	159,353

Note: The dependent variable is risk, defined as the natural logarithm of the standard deviation of annualized daily stock returns. *Delta* is the dollar change in the value of the CEO's option portfolio to a 1% change in stock price. *Vega* is expressed as the dollar change in the value of CEO's option portfolio to a 0.01 change in stock-return volatility. *Option compensation* is the fair value of all options granted during the year. *Cash compensation* is the salaries and bonuses earned for the CEO's during the year. *CEO ownership* is defined as shares owned by the CEO divided by total shares outstanding. *Return on assets* is [net income / total assets]. *Sales* is the earned revenue during the year. *Leverage* is [total long-term debt / total assets]. *Capital intensity is expressed as total assets divided by sales. Market to book* is the M/B ratio of the individual firm for each year. *Cash* corresponds to the cash and cash equivalents for each individual firm during the year. *Executive's age* corresponds to the age of each individual CEO for respective year. *Gender* is a dummy variable, 1 if male, 0 if female.

Table 3: Summary statistics - Cross-listed & Not cross-listed

	Cross-listed				Not cross-listed			
Variable	**Mean**	**Std.Dev.**	**Min**	**Max**	**Mean**	**Std.Dev.**	**Min**	**Max**
Volatility (%)	22.7	7.94	8.16	82.9	26.3	9.02	5.52	63.1
Delta ($000)	531.0	1,013	0	18,761	540.3	1,08	0	10,162
Vega ($000)	241.9	429.6	0	8,407	191.8	417.3	0	4,095
Option compensation ($000)	1,692	3,906	0	115,884	2,374	6,862	0	77,991
Cash compensation ($000)	1,465	1,825	0	35,5	1,195	1,169	0	13,068
CEO Ownership (%)	0.588	2.62	0	51.9	0.937	2.68	0	23.6
Return on assets	0.0604	0.0731	-1.227	0.533	0.0631	0.0721	-0.373	0.336
Sales ($ millions)	23,449	42,881	522.4	496,785	11,436	21,761	148.9	157,73
Leverage	0.280	0.173	0	1.846	0.321	0.238	0	1.272
Capital intensity	3.795	5.512	0.180	36.11	3.355	4.789	0.302	30.84
Market to book	4.185	48.44	-1,1	1,404	2.476	59.49	-1,107	354.6
Gender	0.951	0.215	0	1	0.990	0.0978	0	1
Age	57.49	6.077	35	87	56.79	6.879	29	78
Cash ($ millions)	3,15	9,388	0	159,353	1,765	5,343	0	59,883

Note: Volatility is the standard deviations of annualized daily stock returns. *Delta* is the dollar change in the value of the CEO's option portfolio to a 1% change in stock price. *Vega* is expressed as the dollar change in the value of CEO's option portfolio to a 0.01 change in stock-return volatility. *Option compensation* is the fair value of all options granted during the year. *Cash compensation* is the salaries and bonuses earned for the CEO's during the year. *CEO ownership* is defined as shares owned by the CEO divided by total shares outstanding. *Return on assets* is [net income / total assets]. *Sales* is the earned revenue during the year. *Leverage* is [total long-term debt / total assets]. *Capital intensity is expressed as total assets divided by sales. Market to book* is the M/B ratio of the individual firm for each year. *Executive's age* corresponds to the age of each individual CEO for respective year. *Gender* is a dummy variable, 1 if male, 0 if female. *Cash* corresponds to the cash and cash equivalents for each individual firm during the year.

Table 4: Fixed Effects Regression - Full Sample (generic regression specification)

	Full Sample		
Variables	**Fixed Effects**	**Fixed Effects**	**Fixed Effects Cluster Robust**
Option compensation	0.00185 (0.00117)	0.00270*** (0.000954)	0.00270** (0.00109)
Cash compensation	-0.0120 (0.00769)	-0.00925 (0.00627)	-0.00925 (0.00620)
CEO ownership	-0.0461 (0.280)	-0.320 (0.229)	-0.320 (0.195)
Return on assets	-0.378*** (0.0968)	-0.321*** (0.0791)	-0.321*** (0.108)
Firm size	-0.114*** (0.0242)	-0.0792*** (0.0214)	-0.0792*** (0.0302)
Leverage	0.101 (0.0657)	-0.0454 (0.0566)	-0.0454 (0.0897)
Capital intensity	0.0212*** (0.00621)	0.0105** (0.00514)	0.0105* (0.00590)
Market to book	-0.000104 (0.000091)	-0.000133* (0.0000742)	-0.000133*** (0.0000455)
Cash	-0.000647 (0.00118)	0.000275 (0.000962)	0.000275 (0.000824)
Gender	0.0182 (0.0541)	0.0334 (0.0441)	0.0334 (0.0427)
Age	0.000432 (0.00149)	0.000849 (0.00122)	0.000849 (0.00136)
Observations	2,445	2,445	2,445
R-squared	0.039	0.363	0.363
Year Effects	No	Yes	Yes

Note: The dependent variable is risk, defined as the natural logarithm of the standard deviation of annualized daily stock returns. *Delta* is the dollar change in the value of the CEO's option portfolio to a 1% change in stock price. *Vega* is expressed as the dollar change in the value of CEO's option portfolio to a 0.01 change in stock-return volatility. *Option compensation* is the fair value of all options granted during the year. *Cash compensation* is the salaries and bonuses earned for the CEO's during the year. *CEO ownership* is defined as shares owned by the CEO divided by total shares outstanding. *Return on assets* is [net income / total assets]. *Sales* is the earned revenue during the year. *Leverage* is [total long-term debt / total assets]. *Capital intensity is expressed as total assets divided by sales. Market to book* is the M/B ratio of the individual firm for each year. *Cash* corresponds to the cash and cash equivalents for each individual firm during the year. *Executive's age* corresponds to the age of

each individual CEO for respective year. *Gender* is a dummy variable, 1 if male, 0 if female. The values for *option compensation, cash compensation and cash* are expressed in $000.
*Significant at 10%.
**Significant at 5%.
***Significant at 1%.

Table 5: Fixed Effects Regression - Full Sample

	Full Sample		
Variables	**Fixed Effects**	**Fixed Effects**	**Fixed Effects Cluster Robust**
Delta	-0.0389*** (0.00906)	-0.0247*** (0.00752)	-0.0247** (0.0121)
Vega	0.1447*** (0.0245)	0.0617*** (0.0203)	0.0617** (0.0283)
Option compensation	0.000783 (0.00122)	0.00255** (0.00101)	0.00255** (0.00119)
Cash compensation	-0.0110 (0.00766)	-0.00804 (0.00628)	-0.00804 (0.00644)
CEO ownership	-0.0590 (0.278)	-0.302 (0.229)	-0.302 (0.200)
Return on assets	-0.390*** (0.0961)	-0.323*** (0.0790)	-0.323*** (0.108)
Firm size	-0.117*** (0.0240)	-0.0796*** (0.0214)	-0.0796*** (0.0298)
Leverage	0.0879 (0.0653)	-0.0480 (0.0564)	-0.0480 (0.0858)
Capital intensity	0.0208*** (0.00615)	0.0106** (0.00512)	0.0106* (0.00594)
Market to book	-0.000105 (0.0000902)	-0.000130* (0.000074)	-0.000130*** (0.0000457)
Cash	-0.000278 (0.00117)	0.000387 (0.000961)	0.000387 (0.000875)
Gender	0.0175 (0.0537)	0.0308 (0.0440)	0.0308 (0.0418)
Age	0.000179 (0.00149)	0.000942 (0.00123)	0.000942 (0.00138)
Observations	2,445	2,445	2,445
R-squared	0.057	0.367	0.367
Year Effect	No	Yes	Yes

Note: The dependent variable is risk, defined as the natural logarithm of the standard deviation of annualized daily stock returns. *Delta* is the dollar change in the value of the CEO's option portfolio to a 1% change in stock price. *Vega* is expressed as the dollar change in the value of CEO's option portfolio to a 0.01 change in stock-return volatility. *Option compensation* is the fair value of all options granted during the year. *Cash compensation* is the salaries and bonuses earned for the CEO's during the year. *CEO ownership* is defined as shares owned by the CEO divided by total shares outstanding. *Return on assets* is [net income / total assets]. *Sales* is the earned revenue during the year. *Leverage* is [total long-term debt / total assets]. *Capital intensity is expressed as total assets divided by sales. Market to book* is the M/B ratio of the individual firm for each year. *Cash* corresponds to the cash and cash equivalents for each individual firm during the year. *Executive's age* corresponds to the age of each individual CEO for respective year. *Gender* is a dummy variable, 1 if male, 0 if female. The values for *delta, vega, option compensation, cash compensation and cash* are expressed in $000.
*Significant at 10%.
**Significant at 5%.
***Significant at 1%.

Table 6: Fixed Effects Regression - Cross-listed

	Cross-listed		
Variables	**Fixed Effects**	**Fixed Effects**	**Fixed Effects Cluster Robust**
Delta	-0.0448*** (0.0109)	-0.0256*** (0.00892)	-0.0256 (0.0157)
Vega	0.1406*** (0.0283)	0.0526** (0.0231)	0.0526 (0.0351)
Option compensation	0.00182 (0.00159)	0.00379*** (0.00129)	0.00379*** (0.000893)
Cash compensation	-0.00638 (0.00816)	-0.00542 (0.00660)	-0.00542 (0.00706)
CEO ownership	0.0268 (0.290)	-0.258 (0.235)	-0.258 (0.170)
Return on assets	-0.417*** (0.103)	-0.358*** (0.0836)	-0.358*** (0.123)
Firm size	-0.138*** (0.0306)	-0.0858*** (0.0260)	-0.0858** (0.0383)
Leverage	0.0494 (0.0751)	-0.131** (0.0647)	-0.131 (0.0891)
Capital intensity	0.0179*** (0.00689)	0.0107* (0.00564)	0.0107 (0.00681)
Market to book	-0.0000884 (0.000108)	-0.0000888 (0.0000874)	-0.0000888** (0.0000443)
Cash	-0.000132 (0.00117)	0.000471 (0.000946)	0.000471 (0.000879)
Gender	0.0117 (0.0532)	0.0303 (0.0430)	0.0303 (0.0424)
Age	0.000581 (0.00164)	0.000749 (0.00133)	0.000749 (0.00155)
Observations	1,927	1,927	1,927
R-squared	0.059	0.386	0.386
Year Effects	No	Yes	Yes

Note: The dependent variable is risk, defined as the natural logarithm of the standard deviation of annualized daily stock returns. *Delta* is the dollar change in the value of the CEO's option portfolio to a 1% change in stock price. *Vega* is expressed as the dollar change in the value of CEO's option portfolio to a 0.01 change in stock-return volatility. *Option compensation* is the fair value of all options granted during the year. *Cash compensation* is the salaries and bonuses earned for the CEO's during the year. *CEO ownership* is defined as shares owned by the CEO divided by total shares outstanding. *Return on assets* is [net income / total assets]. *Sales* is the earned revenue during the year. *Leverage* is [total long-term debt / total assets]. *Capital intensity is expressed as total assets divided by sales. Market to book* is the M/B ratio of the individual firm for each year. *Cash* corresponds to the cash and cash equivalents for each individual firm during the year. *Executive's age* corresponds to the age of each individual CEO for respective year. *Gender* is a dummy variable, 1 if male, 0 if female. The values for *delta, vega, option compensation, cash compensation and cash* are expressed in $000.
*Significant at 10%.
**Significant at 5%.
***Significant at 1%.

Table 7: Fixed Effects Regression - Not cross-listed

	Not cross-listed		
Variables	**Fixed Effects**	**Fixed Effects**	**Fixed Effects Cluster Robust**
Delta	-0.0221 (0.0170)	-0.0269* (0.0149)	-0.0269 (0.0178)
Vega	0.1611*** (0.0522)	0.0976** (0.0454)	0.0976** (0.0435)
Option compensation	-0.00174 (0.00209)	0.000279 (0.00181)	0.000279 (0.00129)
Cash compensation	-0.0433* (0.0232)	-0.0243 (0.0200)	-0.0243 (0.0195)
CEO ownership	-0.757 (0.986)	-1.065 (0.854)	-1.065 (0.910)
Return on assets	-0.199 (0.269)	-0.183 (0.232)	-0.183 (0.221)
Firm size	-0.0742* (0.0424)	-0.0232 (0.0452)	-0.0232 (0.0570)
Leverage	0.199 (0.136)	0.142 (0.120)	0.142 (0.118)
Capital intensity	0.0343** (0.0149)	0.0156 (0.0130)	0.0156 (0.0131)
Market to book	-0.000131 (0.000168)	-0.000193 (0.000144)	-0.000193*** (0.0000659)
Cash	-0.0106 (0.00985)	-0.00126 (0.00850)	-0.00126 (0.00768)
Gender	-	-	-
Age	-0.00134 (0.00371)	0.00273 (0.00326)	0.00273 (0.00268)
Observations	518	518	518
R-squared	0.072	0.327	0.327
Year Effects	No	Yes	Yes

Note: The dependent variable is risk, defined as the natural logarithm of the standard deviation of annualized daily stock returns. *Delta* is the dollar change in the value of the CEO's option portfolio to a 1% change in stock price. *Vega* is expressed as the dollar change in the value of CEO's option portfolio to a 0.01 change in stock-return volatility. *Option compensation* is the fair value of all options granted during the year. *Cash compensation* is the salaries and bonuses earned for the CEO's during the year. *CEO ownership* is defined as shares owned by the CEO divided by total shares outstanding. *Return on assets* is [net income / total assets]. *Sales* is the earned revenue during the year. *Leverage* is [total long-term debt / total assets]. *Capital intensity is expressed as total assets divided by sales. Market to book* is the M/B ratio of the individual firm for each year. *Cash* corresponds to the cash and cash equivalents for each individual firm during the year. *Executive's age* corresponds to the age of each individual CEO for respective year. *Gender* is a dummy variable, 1 if male, 0 if female. The values for *delta, vega, option compensation, cash compensation and cash* are expressed in $000.
*Significant at 10%.
**Significant at 5%.
***Significant at 1%.

Appendix

Appendix 1: Estimating the portfolio value of stock options

The estimates of portfolio value of stock options are based on Black-Scholes formula for valuing European call options, modified to account for dividend payouts by Merton (1973) are calculated as:

$$Option\ value = \left[Se^{-dT}N(Z) - Xe^{rT}N\left(Z - \sigma T^{\left(\frac{1}{2}\right)}\right)\right] \quad \text{(eq. 4)}$$

$$Where\ Z = \left[\ln\left(\frac{S}{X}\right) + T\left(r - d + \frac{\sigma^2}{2}\right)\right] / \sigma T^{\left(\frac{1}{2}\right)} \quad \text{(eq. 5)}$$

N = Cumulative probability function for the normal distribution

S = Price of the underlying stock

X = Exercise price of option

s = Expected stock-return volatility over the life of the option (estimated as standard deviation of daily stock return multiplied with the number of trading days)

r = Risk-free interest rate (ln(1 + risk-free interest rate), where the interest rate is the yield).

T = Time to maturity of the option in years (the grant date and duration of the option when granted is used to compute remaining time to maturity. If grant date is unavailable, it is set equal 1 of June in the year the option is issued)

d = Expected dividend rate over the life of the option. (ln(1 + expected dividend rate). Expected dividend rate is the per-share dividend paid during each year divided by the year-end stock price)

The sensitivity with respect to a 1% change in stock price is defined as:

$$\partial(\text{option value})/\ \partial(\text{price}) * (\text{price}/100) = e^{-dT}N(Z) * (price/100) \quad \text{(eq. 6)}$$

The sensitivity with respect to a 0.01 change in stock-return volatility is defined as:

$$\partial(\text{option value})/\ \partial(\text{stock volatility}) * 0.01\ = e^{-dT}\ N'(Z) * ST^{(\frac{1}{2})} * 0.01 \qquad \text{(eq. 7)}$$

where N' = normal density function

To compute the portfolio value, we calculated delta and vega for each individual option. We continued with summing these up and multiplied the sum with number of options for each individual CEO.