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Two Essays on CEO Compensation and Investment Behavior

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ABSTRACT
Two Essays on CEO Compensation and Investment Behavior

Jonathan T. Fluharty-Jaidee

This dissertation is composed of two essays which examine the risk-taking incentives severance provides to CEOs. The first essay of the dissertation examines how severance can allow CEOs to invest in ways that increase the cost of termination. This investment maneuver plays upon the initial cost of severance as an assurance from the board to the CEO that she will not be terminated without reason. As a result, the CEO can invest in ways which reduce her likelihood of termination by reducing the pool of potential challenging CEOs who might be successful in replacing her. This 'barrier' to internal governance then allows CEOs to shirk their responsibilities and lead the quiet life.

The first essay tests the effects severance compensation on cash levels, capital expenditures, dividend yields, managerial specific investments, financial leverage, premiums paid for acquisitions, and lastly investment in R&D. Since Change-In-Control agreements occur in 73% of firms with severance agreements, this essay is the first to disentangle the incentives of either contract. Results suggest that when a CEO has a severance agreement they are likely to reduce cash levels to make it more difficult to pay out a severance package. They use the cash by increasing capital expenditures, managerial specific investments, or by overpaying for acquisitions. This essay reports confirming evidence that CEOs with severance invest less in R&D, suggesting that CEOs do shirk their responsibilities after reducing their likelihood of termination. Change-In-Control agreements, conversely, provide the incentive to increase investment in R&D, and reduce overpayment on acquisitions and managerial specific investments: suggesting that Change-In-Control agreements produce the incentive benefits that severance is intended to do.

The second essay examines compensation contracts in an *ex-post* framework using real-options. To date, severance has not been included in the calculation of incentive measures as there has never been a method of valuing severance agreements. This essay provides a present value model of compensation agreements which includes severance contracts. The valuation of severance relies upon expectations of remaining tenure, which are innovatively estimated using CEO cohort 'death tables'. The model shows that vega, a common measure of risk-taking incentives, is related to firm size which may drive results found in the literature linking vega to risky investment behavior. The model lends itself to the creation of a direct measure of risk-taking incentives, compensation gamma—the convexity of compensation portfolios.

Results from the second essay suggest a positive and significant relationship between firm size and vega. Vega's relationship to risk-taking incentives becomes less significant when gamma is included in the empirical tests. Gamma appears to be a significant determinant of risk-taking incentives and firm focus. Lastly, results show that vega, when severance is included in its construction, does not show a large change in risk-taking incentives or firm focus. When severance is included in the construction of gamma, the relationship between gamma, risk-taking incentives and firm focus reverses, providing empirical evidence that severance may reduce risk-taking incentives and increase diversification by risk-averse CEOs.

Together these essays present a conclusion that severance contracts may not produce the incentive to invest in risky projects as they are intended. Instead severance may provide incentives to invest in ways that make it costly to terminate the CEO for underperformance, reduce investment in risky-projects, and increase CEO risk-aversion. Additionally, vega's relationship to risky investment may be driven by cofounding relationship between firm size and risky investment. Gamma is a direct measure of compensation incentives and by using this measure severance is seen to reduce risk-taking incentives. These results question the use of severance in compensation agreements, especially when change-in-control agreements appear to produce the investment incentives that severance is supposed to provide.

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Essay One: Force-Fields, Risk-Taking, And Termination Pay: Severance's Barrier to Internal Governance

JEFF SMISEK'S TROUBLED TENURE AS CEO of United-Continental Holdings came to an end in September 2015, following the revelation of corrupt dealings with a US official. Smisek proved to be a problematic CEO[1]. He persistently neglected to update depreciating airliners and United-Continental hemorrhaged cash by the billions each year until declining gas prices in early 2015 allowed operating cash flows to overtake an aggressive share repurchase program—propping up share prices while underlying performance waned[2]. During his tenure, United-Continental plummeted to the lowest ranked airline among consumer groups in the United States, and Smisek's plan to strengthen and unify the workforce remained incomplete. Despite these performance issues, Smisek was only asked to step down after the corruption scandal was revealed, yet he still retained his severance package[3].

How can a CEO, who makes poor investment decisions or shirks responsibilities, resist being replaced by a better fitting rival? Provided markets are efficient monitors, a moderately better opponent should replace an incumbent CEO if she is not producing adequate returns or is damaging the firm (Lehn and Zhao 2006). However, since severance is costly and initially dissuades the board from terminating an incumbent CEO, she can invest in ways which would

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[1] Smisek was listed as a nominee for the Worst CEO of 2013 by a CNBC poll.

[2] Instead, Smisek preferred to invest in gilded linings, including renovating United Airline lounges and luxury expenditures such as 'marble cocktail tables' for first class passengers.

[3] His severance package included a $5 million lump-sum payout plus additional costs of accrued compensation; unlimited life-time flights; his corporate car; and restricted stock compensation: in all, roughly 37 million dollars.

increase the cost of termination—causing the board to need stronger justifications for termination since her departure is costlier than originally planned.

My contribution is to show how CEOs invest to alter the relative cost of severance *after* compensation contracts are negotiated. When a CEO foresees their own potential replacement because of a rival's appearance, she pre-emptively invests in ways that reduces the likelihood of success for that challenger. The incumbent CEO can achieve this goal by forcibly reducing the fit of the firm with respect to the rival CEO; by reducing the pool of potential candidates; or by simply making it more difficult to pay out the severance contract. So long as a challenging CEO's probability of producing cashflow gains appears lower than the incumbent's, the incumbent CEO *will not* be replaced. This provides a means by which, barring external events (*e.g.* a scandal, fraud, *etc*.), CEOs remain in power even while they underperform or under-invest. In the long-run, the incumbent can implement board-level entrenchment by seating her own directors and establishing loyalty programs.

These investment choices, which raise the costs of termination, introduce barriers to internal governance and allow for the CEO to act upon the perverse incentives that severance creates (*e.g.* shirking); subsequently, severance is the lynchpin which allows CEOs to initially remain in power while underperforming before they can entrench themselves.

The remainder of this essay is organized as follows: I discuss the relevant literature and develop the hypotheses in Section I. In Section II, I present the collection and summary; in Section III I discuss the empirical methodology. In Section IV, I provide an analysis of the data and discussion of the results. Section V concludes with a discussion on the implications of the findings.

I. Hypothesis Development

I.1 Literature Review

Severance is considered an important component of compensation portfolios as it is intended to spur investment and assure the CEO that they will not be fired without reason (Almazan and Suarez 2003; Inderst and Mueller 2008; Gillan, Hartzel and Parrino 2009; Manso 2011; Ju, Leland and Senbet 2014). However, there is some evidence that severance does the opposite and allows CEOs to shirk their responsibilities, make poor investment decisions, or live the ‘quiet life’ (Hicks 1935; Bertrand and Mullianathan 2003; Atanassov 2013; Muscarella and Zhao 2017). The question remains as to how CEOs can continue to underperform and not be terminated for such behavior. Since shirking, poor investment, and underperformance are observed in recently hired CEOs who have a severance contract, entrenchment cannot be the immediate answer (Muscarella and Zhao 2017).

Almazan and Suarez (2003) (A&S) model severance in an optimal compensation contract through a 4-stage negotiation process. In their model, an incumbent CEO faces the potential arrival of a challenging CEO whose quality is observable to the incumbent after the incumbent’s compensation contract is designed but before she selects her investment scheme. A&S’s solution results in a contract that includes performance pay, control rents, and *some* positive level of severance which is efficient in getting the CEO to invest in a way that produces a high probability of returns for shareholders[4].

In A&S’s model, if the board observes a rival who is moderately better than the incumbent CEO, the board finds it optimal to replace the incumbent if, and only if, the expected cashflow

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[4] The amount of severance is set relative to the performance pay and control rents to balance the incentives.

gains under the rival CEO are greater than the sum of the incumbent's expected performance pay and severance contract[5]. So long as the incumbent CEO's severance compensation is low enough relative to the expected cash-flow gains under the rival CEO, the incumbent CEO will be replaced. If severance is too low, the incumbent CEO will be replaced whenever *any* slightly better challenger arrives. Consequently, a CEO without a severance agreement may not have time to invest before she is replaced: resulting in an ever-changing management team and value destruction for the firm[6]. To solve this dilemma, A&S conclude that there must be *some* amount of severance to form a commitment to the CEO that she will not be terminated before she can invest[7].

Yet, A&S show that severance contracts are large enough only to induce investment but not *so large* that the CEO may shirk their responsibilities. However, I argue that CEOs can alter, or side-step, this constraint *after* negotiating their compensation agreement. By making specific investment choices, CEOs can reduce the set of potential rival candidates who could produce increased cashflows or increase the cost of termination directly—erecting a barrier to board governance.

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[5] Conditional on the probability of success of the challenger CEO.

[6] Referred to in Almazan and Suarez (2003) as the Time Inconsistency Dilemma.

[7] Because of these constraints, the optimal severance package is equal to the possible profits under a low-quality rival and the cost of compensating the incumbent CEO. In this case, severance compensation is set high enough to provide a credible signal to the CEO that the board will not terminate her when a slightly better CEO appear—so long as the incumbent CEO is willing to invest. However, severance pay is not set so high that the CEO is dissuaded from investing and would rather wait to be terminated.

I.2 Hypotheses

Methods for reducing a rival CEO's expected probability of success or increasing the cost of termination are not necessarily poor investment schemes and may have high probabilities of success—none-the-less they reduce the board's likelihood to terminate the incumbent.

Such investment schemes include: (1) altering the cash structure of the firm—*i.e.* reducing surplus cash, increasing capital expenditures or dividend payouts (Harford *et al.* 2008); (2) managerial specific investments, which become less-valuable (or worthless) as a result of the CEO's departure (Shleifer and Vishny 1989)[8]; or, (3) by reducing financial flexibility and overpaying for acquisitions (DeAngelo, DeAngelo and Whited 2011; Lehn and Zhao 2006). Lastly, after erecting the barrier CEOs may have the incentive to shirk resulting in under-investment in R&D (Muscarella and Zhao 2017). I consider each of these investment schemes individually as testable hypotheses below.

I.2.1 Cash and Dividends, and Capital Expenditures

To increase the relative costs of termination, the incumbent CEO may attempt to reduce available cash that could be used to pay for the severance compensation package. Harford *et al.* (2008) argue that CEOs who face weak-boards may reduce cash by spending it internally, purchasing perquisites, and increasing capital expenditures—each of which increases the control-rents the CEO obtains and decreases the likelihood of termination by reducing cash available to pay severance.

CEOs may also increase dividends. Since dividends are sticky, increasing the dividend results in a long-term commitment to shareholders, and a challenging CEO would find it difficult

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[8] See also Kale, Kedia, and Williams (2015) for applications and estimations of RSI with respect to severance.

to reduce dividends owing to their stickiness[9]. This not only reduces the viable sources of cash to the firm but directly reduces the probability of success for the potential challenging CEO. Furthermore, incumbent CEOs may appear to out-perform rivals as shareholders experience short-run increases in share performance, either through false signals of future performance or differences between short- and long-term discounts of expected dividends, despite long-run depletion of value (Miller and Modigliani 1961; Watts 1973; Baker and Wurgler 2016).

Therefore, when a CEO has a severance agreement, I expect to observe that their firms exhibit lower cash levels (*Hypothesis 1)*, increased levels of dividends (*Hypothesis 2)*, and increased capital expenditures (*Hypothesis 3)*.

Hypothesis 1: *There is a negative relationship between severance pay and cash levels of firms.*

Hypothesis 2: *There is a positive relationship between severance and dividend yield.*

Hypothesis 3: *There is a positive relationship between severance and capital expenditure intensity.*

I.2.2 Management Specific Investments and Relationship Specific Investments

Shleifer and Vishny (1989) discuss management specific investments (MSIs) and show that management makes investments that are tied to their personalities, knowledge sets, or relationship networks as a means of making themselves 'irreplaceable' to the firm. For example, MSI occurs when a CEO specifically makes an acquisition in a field she has a specific expertise but were that expertise is not widely found in rival management, (*e.g.* Elon Musk investing Tesla

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[9] See, for example, Linter (1956); Bhattacharya (1979); DeAngelo *et al*. (1992); Fama and French (2001); Jagannathan, Stephens, and Weisbach (2001); Grullon and Michaely (2002); Baker and Wurgler (2005) or a review of dividend payout policy.

Motors, Inc., an auto. manufacture, into SolarCity Corp., a solar panel manufacturer—few rival CEOs may have expertise in both auto manufacturing and solar panel manufacturing).

Because MSIs are non-recoverable expenditures, a large cost would be incurred by the firm if the incumbent were to be replaced. In the context of A&S's model, there is a foreseeable contingent loss that arises in the event of the incumbent CEO's replacement that is viewed *ex-ante* by the board; thereby, the board will only terminate the CEO when the expected profit from a rival CEO is so great as to compensate for the contingent loss of the MSI plus the incumbent's severance and other compensation.

While Shleifer and Vishny proposed management specific investment in 1989, there is a lack of empirical research surrounding MSI due to the cost and difficulty in obtaining sample data. To extract MSI one would need to match CEO knowledge sets to investment programs—which would produce a noisy measure. Due to this difficulty in establishing a direct firm-CEO specific measure of MSI, I propose using a proxy of relationship specific investment which are related to the management's personality or knowledge set.

Following Kale, Kedia and Williams (2015), relationship specific investments (RSIs) among vendor-customer pairs can serve as a proxy for MSI as it proxies for the relationship between management of the two firms. Such investments may be exceptionally specific to the CEO and the relationship upon which the investment predicates may find itself strained should the CEO be replaced—which is similar to the concept of MSI. This is realized as a reduction in the pool of high quality challengers as well as making it more expensive to terminate the incumbent CEO. I expect to observe increased MSI for CEOs compensated with severance agreements (*Hypothesis 4)*; however, since a measure of MSIs is difficult to obtain, I use RSI as a proxy.

Hypothesis 4: *There is a positive relationship between severance pay and the amount of relationship specific investment.*

I.2.3 Increased Debt and Premiums on Acquisitions

To make it less likely that a rival will succeed a CEO may attempt invest in a way that is difficult to unwind or takes a long-time to payoff. A CEO may reduce her firm's financial flexibility to make it difficult for a replacement to maneuver. Secondarily, the CEO could lever up the firm and appropriate the funds in MSI, capital expenditures, or acquisitions.

DeAngelo, DeAngelo and Whited (2011) consider the effects of unused debt capacity as a key component of flexibility and show that increased financing constraints can limit flexibility and the ability to fund future investment. Gamba and Triantis (2008) construct a model to explain financial flexibility and the reversibility of capital borrowing and how these factors affect future investment[10]. Furthermore, Fazzari *et al.* (1988) show that firms with higher financial constraints have higher sensitivity to investment cash-flows: forwarding the prior argument that lean-cash flows may cause a range of just sufficient cash under which only current management can operate. I expect to observe higher levels of leverage for CEOs who have a severance agreement *(Hypothesis 5).*

Hypothesis 5: *There is a positive relationship between severance pay and financial leverage.*

Incumbent CEOs may also overpay for firms. Lehn and Zhao (2006) perform an analysis of the likelihood that a CEO is terminated after making a 'bad' bid for the firm. They find that the

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[10] Capital structure and financing capacity's effects on firm growth and value have long since been studied in a vibrant literature: Myers (1977); Myers and Majluf (1984); Fazzari *et al.* (1988); Whited (1992); Lamont, Polk, and Saa-Requejo (2001); Moyen (2004): as a varied list covering different hypothesis on the broad topic.

probability of CEO turnover after the event of a 'bad' bid and acquisition—defined as an over-priced bid/offer—depends upon how over-priced that bid was and to the performance of the acquiring firm's shares thereafter. Lehn and Zhao (2006) provide evidence that internal conditions may work in terminating value-destructive CEOs; however, in their model a CEO who is compensated with severance is able to make more self-serving or worse bids than CEOs who do not have the protection of severance. Thereby I expect to see CEOs, who are compensated with a severance agreement, to increase premiums paid on acquisitions relative to their non-severance compensated counter-parts (*Hypothesis 6).*

Hypothesis 6: *There is a positive relationship between severance pay and premiums on acquisitions.*

I.2.4 Shirking Hypothesis

If a CEO invest in any of the previous schemes and is able to effectively reduce the likelihood the board will terminate her, she may be able to shirk their responsibilities. A&S allow for such an event so long as severance compensation is more expensive than the control-rents and pay-performance the CEO obtains due to low-success or no investment. This result only holds if the CEO is not terminated due to non-investment, which can only occur if they are protected by a barrier[11].

If a CEO can make it more expensive for the board to terminate her when it is optimal for the board to do so, she can thereafter shirk responsibilities until the board deems it favorable to

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[11] Alamzan and Suarez (2003) detail the investment compatibility constraint as a reason the CEO will invest or be terminated for not investing, the CEO can only violate the ICC when the value of severance exceeds that of control rents and pay performance—the board will observe this violation when the CEO makes severance reasonably expensive to implement, allowing them to shirk in the sequential game. The force-field is the mechanism that allows the CEO to rationally violate of the ICC.

pay her severance as well as any costs associated with her replacement. Such events do not save the firm value as they end up renegotiating with the CEO who extracts a higher severance pay to agree to the replacement (Almazan and Suarez 2003). As a result, a CEO could shirk her responsibilities and under-invest. Muscarella and Zhao (2017) find empirical evidence that CEOs who have a severance agreement are likely to exhibit shirking behavior. If shirking does occur, it is because severance allows the CEO to protect themselves from the board's termination capabilities in some way. Like Muscarella and Zhao (2017), I should observe decreased investment in R&D intensity or a negative and significant relationship between severance pay and R&D intensity if there is evidence of shirking behavior which confirms a barrier to internal governance.

II. Variable Description and Data Collection

II.1 Variable Description and Construction

This study uses data from *Compustat* and *ExecuComp* on the period ranging from 2008 to 2015 to control for potential errors in the compensation database[12]. I obtain *ExecuComp*'s TERM_PYMT and CHG_CTRL_PYMT values—each which represent termination payments and change-in-control payments total value, respectively—reported in millions of dollars. Termination Payments, *a.k.a.* severance, are cash payments made to CEOs if they are terminated 'without

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[12] Although Cadman, *et al.* (2016) document the errors in the *ExecuComp* database, a hand collected sample of 100 firms for 2007 through 2014 revealed that in more recent years the accuracy of the data has significantly improved. This may have occurred for several reasons, (1) as shown in Cadman *et al.* (2016) firms now report tables as required by SEC regulation rather than negligently reporting data in the form of a paragraph. Due to this increase in accuracy of use of tables over paragraphs, the *ExecuComp* data collectors appear have better access to data points where they previously would have cast the data to '0' or 'missing' assuming no severance or change-in-control payment existed where a table did not. As Cadman *et al.* (2016) makes use of 2006 and 2007, the years in which the SEC regulation switch-over occurred, it is perhaps not surprising that reporting has improved in later years; (2) *Compustat* IQ may have responded to the issues described in Cadman *et al.* (2016) and adjusted their data collection techniques.

cause'[13]. Change-in-Control payments, *a.k.a.* golden parachutes, result from either a single or double-trigger event following a merger or acquisition[14]. The amounts listed in the *ExecuComp* database represent the contractually obligated amounts negotiated in the prior year between the CEO and their compensation committee.

Using the values reported for TERM_PYMT as a measure for severance I scale it by Total Assets to construct the measure % *Termination Payment.* I additionally construct % *Change-In-Control Payment* in the same fashion using CHG_CTRL_PYMT. To control for cash compensation, I collect each CEO's *Salary, Bonus¸ Value of Stock Awards, Value of Option Awards, Non-Equity Incentive Compensation,* and *Other Compensation.* Each of these values are directly obtained from *ExecuComp*[15]. I also collect the data relating to tenure, reported as *CEO Continuous Tenure*, which measures the amount of time a CEO has continuously remained in office, and the *CEO Age* which is the current age they are in any given year within the panel.

Since severance is affects risk-taking behavior it is important to examine the effects of severance in the same model as measures of incentives to take risk, delta and vega. *Delta or the Portfolio* and *Vega of the Portfolio* respectively are constructed using the same methodology found in Kale and Meneghetti (2011)[16]. The values are presented in thousands of dollars ($000) change in portfolio value per a 1-dollar change in the underlying share price for *Delta of the Portfolio*, and

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[13] 'Cause' typically refers to an issue of moral turpitude and does not generally refer to a lack of performance. A CEO who is fired for poor performance would be fired 'without cause', a CEO who is fired due to a scandal may be terminated 'with cause' and not receive their severance pay; although there are exceptions to these cases.

[14] A single trigger change-in-control agreement would pay an executive simply if the firm was acquired or merged (*i.e.* the executive need not be terminated). A double trigger change-in-control agreement pays an executive should a firm be acquired or merged (the first trigger) and that executive was then let go (the second trigger). Single trigger agreements are rare in comparison to ubiquitous double-trigger agreements.

[15] Reported in thousands of dollars in *ExecuComp*, rescaled to millions.

[16] I am permanently indebted to Costanza Meneghetti (WVU Department of Finance) for providing me with the code to make these estimations from extracted *ExecuComp* data sets which follows the code provided by Lalitha Naveen on her website from Coles, Daniel and Naveen (2014). These calculations are based on the Black and Scholes option valuation and make corrections using the FAS 123R changes in *ExecuComp*.

thousands of dollars ($000) change in portfolio value per 1% change in volatility of the underlying share price for *Vega of the Portfolio*.

For firm level controls, I construct each firm's *R&D Intensit*y, following Coles, Daniel and Naveen (2006), where R&D expenditure is scaled by total assets. Likewise, I obtain firms' capital expenditures which are then scaled by Net Property, Plant and Equipment (NPP&E) to form *Capital Expenditure Intensity*. I also collect or construct other firm level variables including each firm's *Market-to-Book* ratio, *Log Sales, Book Financial Leverage*, *Market Financial Leverage, Sales Growth, Taxes, and Cash-To-Assets.* I use a rolling 60-month variance of firm's returns to compute *Volatility*. Lastly, I collect each firm's *EBITDA*, *Operating Cash Flows,* and *Financial Cash Flows*. I compute each firm's average *Dividend Yield* over the past three years as a measure of their average dividend payout relative to their share price.

As in Kale, Kedia and Williams (2015), to compute the variable for customer segment sales I form a weighted average of customer R&D using the percentage of customer sales to total sales for a supplier firm as weights taken from the customer-segments database within *Compustat*. I delineate customer R&D for each supplier firm in the matched *ExecuComp* database as *Customer R&D Intensity*.

For acquisition related data, I obtain variables for the *Date of the Announcement* of an acquisition, the *Acquirer*, the *Target*, as well as firm level controls for the Target from *SDC Platinum* for all reported acquisitions from 2008 to 2015 which are over 5 million dollars in value where the acquirer is a U.S. based firm. Additionally, I collect information about each specific deal, including the amount of ownership before and after the transaction—which allows me to construct a *ToeHold* categorical variable which is one (1) when the firm purchases less than 5% of the target firm after the deal completes and zero otherwise (Schwert 1996; Officer 2003;

Meneghetti and Williams 2017). SDC reports a deal's 'hostility' through their "Attitude" variable, allowing me to construct an indicator variable, *Hostile*, which is set equal to one (1) when the deal is deemed hostile or unsolicited and zero otherwise[17]. Similarly, I use indicator variables provided by *SDC Platinum* to control for Tender Offers (*Tender),* Asset Swaps (*Asset Swap),* and White Knights (*White)* if the acquisition fell into those categories.

II.2 Description of Data: Univariate Analysis

The sample contains all CEO-firm pairs with non-missing observations in the *Compustat* database, between 2008 and 2015. Across the full sample there are 1,424 individual firms comprising a total of 6,631 firm-year pairs and among these firm-years there are a total of 1,630 distinct CEO-firm pairs. When matching to the segment data for reported customer sales the sample size reduces to a supplier-customer-year triplet of 2,755.

Table 1 reports the mean, standard deviation, and quartile groups for variables implemented in the estimations throughout the paper. *Change-In-Control Payments*, is nearly two times the amount of *Termination Payments* at $13 million versus $6.44 million, respectively[18]. Of the 6,631 firm-years, 5,724 of those are firms which have positive *Change-In-Control Payments* and 4,800 have positive *Termination Payments*. This indicates that over the total sample 86.3% of the firm-year pairs have change-in-control agreements and 72.4% have severance agreements. Of

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[17] SDC Platinum additionally reports an "Unsolicited" variable as well as a "Change In Attitude" variable. Unsolicited is more generic variable that provides less information than that of the "Attitudes" variable as many unsolicited bids are also considered to be friendly in nature. However, it is important in some instances if one were to consider bids on a case by case basis to control for a change in attitude as provided by SDC. Otherwise a bid set may start as Hostile and switch to Friendly—particularly if a White Squire or a White Knight bid comes into play that dominates any Black Knight or Hostile bids. Since I am testing completed deals—I do not directly address this feature here and only use the ending result of the deals as to whether they are considered Hostile or not.

[18] The changes in SEC regulation requires that firms not only report cash payments of severance but any payments which occur after the CEO is released of duties. This includes life insurance, health benefits, restricted stock grants, unvested options, etc. But most importantly it also includes adjusted payments to Pensions which are often specified in the contracts "to be released in a lump-sum upon termination." Curiously the valuation for this amount of payment is a complicated equation designated often to be related to the CEO's 60th birthday and a certain level of compensation related to how long the CEO has been with the firm and how long they remain with the firm after they turn 60 and said to be an actuarial equation relating the present value of same. As such, estimating such payment would be nearly impossible for an outsider to the firm, since each firm may use whatever actuarial measurements they deem appropriate.

the distinct firms in the sample, 1,112 of the firms list a positive *Change-In-Control Payments* for all years in the sample; 142 never list a change-in-control agreement, and 170 firms have a change-in-control agreement in some years but not all. For *Termination Payments*: 296 never report a termination agreement, and the remaining 1,141 report a termination agreement at all points in the sample. Together these numbers suggest somewhat higher levels of reported severance and change-in-control payments than previously reported in the literature[19].

The average CEO in the sample is 56 years of age. CEOs must have been CEO for at least 1 year to enter in the sample and the average CEO is in office a continuous 6.42 years. It appears that the average CEO in the sample does quite well in any given year and receives an annual total (present value) compensation of $5 million ($2.5 million in the median) not including any change-in-control payments or termination payments[20].

Since the occurrence of severance and change-in-control agreements are highly correlated (*e.g.* correlation of 73%)[21], I use the continuous variables even though there is a marginal potential for collection error as reported in Cadman *et al.* (2016). Estimation using indicator variables may not accurately reflect the reality in this situation (*i.e.* dummy variable trap) and continuous variables are necessary to discern the different effects between severance and change-in-control agreements. To assuage concerns from Cadman *et al*. (2016) I collect data from 2008 onward.

III. Methodology

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[19] Extant literature tends to focus on the S&P 500 Index as a convenient sample for this analysis. Although I make use of a larger sample, a necessity with the use of simultaneous equation modeling, I also performed estimation on the convenience sample of the S&P 500 and found the same reporting of Severance and Change-In-Control agreements at roughly 41.3% of the sample. This matches results in the prior literature.

[20] Including *Salary, Bonus, Stock Awards, Option Awards, Non-Equity Incentive Pay, and Other Compensation*

[21] Correlation Matrices can be found in the Appendix II.

Vega, delta, severance and change-in-control agreements are all determined *simultaneously* by the compensation committee during the negotiation process. Thus, it is necessary to estimate a system of simultaneous equations (SSE) under 3SLS as in Coles, Daniel and Naveen (2006).

I employ a system of five equations each with the endogenous-dependent variables being *Variable of Interest* (*i.e. Cash-to-Assets*, *Dividend Yield*, *Capital Expenditure Intensity*, *Financial Leverage*, *Premium On Acquisition*, and *R&D Intensity*), *Delta of the Portfolio, Vega of the Portfolio, Termination Payment*, and *Change-in-Control Payment*. The remainder of the construction closely follows that of Coles, Daniel and Naveen (2006). **B**, **G** and **Z** represent control variable arrays and are described in Appendix II. The model for the system is given below:

$$
\begin{array}{rcl}
Variable\ of\ Interest_{i,t} & = & \gamma_{1,1}Term\ Pay_{i,t} + \gamma_{2,1}Chg.Control\ Pay_{i,t} + \gamma_{3,1}Delta\ Portfolio_{i,t} + \gamma_{4,1}Vega\ Portfolio_{i,t} + {}_1C_{i,t}\mathbf{B_1} + {}_1F_{i,t}\mathbf{G_1} + {}_1X_{i,t}\mathbf{Z_1} + a_1 + e_{i,t} \\
Delta\ of\ Portfolio_{i,t} & = & \gamma_{1,2}Term\ Pay_{i,t} + \gamma_{2,2}Chg.Control\ Pay_{i,t} + \gamma_{4,2}Vega\ Portfolio_{i,t} + {}_2C_{i,t}\mathbf{B_2} + {}_2F_{i,t}\mathbf{G_2} + {}_2X_{i,t}\mathbf{Z_2} + a_2 + e_{i,t} \\
Vega\ of\ Portfolio_{i,t} & = & \gamma_{1,3}Term\ Pay_{i,t} + \gamma_{2,3}Chg.Control\ Pay_{i,t} + \gamma_{3,3}Delta\ Portfolio_{i,t} + {}_3C_{i,t}\mathbf{B_3} + {}_3F_{i,t}\mathbf{G_3} + {}_3X_{i,t}\mathbf{Z_3} + a_3 + e_{i,t} \\
Term\ Payment_{i,t} & = & \gamma_{2,4}Chg.Control\ Pay_{i,t} + \gamma_{3,4}Delta\ Portfolio_{i,t} + \gamma_{4,4}Vega\ Portfolio_{i,t} + {}_4C_{i,t}\mathbf{B_4} + {}_4F_{i,t}\mathbf{G_4} + {}_4X_{i,t}\mathbf{Z_4} + a_4 + e_{i,t} \\
Chg.Control\ Pay_{i,t} & = & \gamma_{1,5}Term\ Pay_{i,t} + \gamma_{3,5}Delta\ Portfolio_{i,t} + \gamma_{4,5}Vega\ Portfolio_{i,t} + {}_5C_{i,t}\mathbf{B_5} + {}_5F_{i,t}\mathbf{G_5} + {}_5X_{i,t}\mathbf{Z_5} + a_5 + e_{i,t}
\end{array}
$$

(eq. 1)

Variables are changed depending on the estimation performed and the variable of interest. Specific construction of the equations can be implied from their table; where a variable's parameter estimate is missing in the specification, it is excluded from the system. All estimations use year and industry fixed effects but are not reported for brevity.

To control for effects of cash-flows on cash levels I include controls for operating, and financing cash flows. At the CEO level in include variables relating to components of the compensation portfolios and CEO characteristics which might affect incentives; such as, *Salary, Bonus, Stock Awards, Options Awards, Non-Equity Incentive, Other Compensation, CEO*

Continuous Tenure, CEO Age. I implement several firm-level controls: *Market-To-Book Ratio, Log Sales, Financial Leverage, Sales Growth, Dividend Yield, Tax Rate, Volatility*, *EBITDA*, following the prior literature to control for firm value, size, growth, profitability, and riskiness. Through-out the 3SLS SSE estimates I implement much of the same controls for each estimation with some variations depending on the dependent variable of interest. This allows me to maintain consistency across estimations and cross examine results.

IV. Results

IV.1 Corporate Cash Holdings and the Force-Fields

If the hypothesis that severance pay agreements allow the CEO to create a barrier to termination are correct and CEOs increase spending on capital expenditures (*Hypothesis 3)*, dividends (*Hypothesis 2)* or acquisitions (*Hypothesis 6)*, then I expect cash-to-asset ratios to have a negative relationship with severance (*Hypothesis 1)*; and capital expenditures, dividend yields, and premiums paid on acquisitions to have a positive relationship with severance. I test *Hypothesis 1* in the simultaneous system in *Table 2,* where *Cash-To-Assets* is the dependent variable.

In *Table 2,* the coefficients on *Termination Payment* are negative and significant indicating a negative relationship between cash levels and expectations of severance pay. To estimate the economic significance, I compute a sensitivity (elasticity) estimate of severance on cash-to-assets using the parameter estimates and sample means to form a point-estimate[22]. Coefficients from *Table 2* imply that a 1% increase in severance pay can lead to a 0.1125% drop in cash-to-assets.

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[22] Sensitivity is computed as the values produced from SSE do not directly map to economic values and their effects are marginal with respect to the entire system. $S_{termination\ on\ var.intrest} = \beta_{termpymt}(\frac{\overline{TermPymt}}{Avg.Var\ Interest})$, *i.e.* $S_{term,cashtoassets} = \beta_{termpmt}(\frac{\overline{TermPymt}}{Avg.Cash\ to\ Assets})$.

To put things in perspective a change in severance from the 50th percentile (median) to the 75th percentile ($1.8 million in the median to $6.34 million) predicts an effective 28.375% reduction in cash-to-assets ratios: were a 1% change in severance pay is approximately $60,000 at the mean.

The results from *Table 2* support the idea that severance agreements may hinder governance capabilities of the board by reducing the cash available as theorized in Jensen 1986. To determine where the cash goes I re-estimate the SSE using both *Capital Expenditure Intensity* (*Hypothesis 3)* and *Dividend Yield* (*Hypothesis 2*) as the dependent variables. Results are in *Tables 3* and *4,* respectively.

Results in *Table 3* indicate that the relationship between *Termination Pay* and *Capital Expenditure Intensity* is positive and significant. This implies that severance agreements increase investment in low-risk assets and indicates decreased risk-taking on behalf of the CEO (Coles *et al* 2006). In the case of *Change-In-Control Payments* it appears that CEO's reduce investment in low-risk projects. Additionally, I document that *Change-in-Control Payments* have a positive relationship with vega consistent with Lambert and Larcker (1985) and Hartzel, Ofek, and Yermack (2004).

Next, I investigate whether a CEO attempts to reduce cash levels by increasing dividends as in Baker and Wurgler (2016) (*Hypothesis 2*). The results of the estimation with *Dividend Yield* as the dependent variable are presented in *Table 4*. There does not appear to be a significant effect of severance compensation on dividend yields; however, there does appear to be an effect of dividend yields on the valuation of *Termination Payments* and *Change-In-Control Payments*. The results in *Tables 2, 3,* and *4* support the intuition that CEOs reduce cash levels by increasing capital expenditure (*Hypotheses 1 & 2*) but not by increasing dividend (*Hypothesis 3*).

IV.2 Management Specific Investments

Next, I test the hypothesis that incumbent CEOs make MSIs to make themselves irreplaceable to the firm and increase the effective cost of termination. To test this hypothesis since it is difficult to construct a direct measures of MSI, I follow Kale, Kedia, and Williams (2015) and use relationship specific investment (RSI). I relate the effects via severance on MSI as proxied by RSI for the abstraction of 'managerial specific' investment. As in Kale, Kedia and Williams (2015) and Kale and Shahrur (2007), I test for the increase in RSI using *customer R&D Intensity*—a weighted average of the customer sales for the supplier firm. The supplier firm is matched to the firm of a given CEO of interest, and I include the customer-level vega and delta.

Consistent with *Hypothesis 4*, *Table 5* indicates a positive and significant relationship between severance pay and the level of *customer R&D Intensity*, suggesting that CEOs do increase RSI/MSI investment when compensated with severance agreements a result that is consistent with the theory of Shleifer and Vishny (1989). This effect is economically significant, as coefficients in *Table 5* imply that a 1% increase in termination pay results in a 2.08% increase in customer R&D intensity. This suggests that increases in severance may lead to large increases in managerial specific investment as proxied through RSI.

IV.3 Financial Flexibility and Acquisition Over-Payment

Do CEOs increase firm leverage to reduce financing capacity and increase external market frictions to future borrowing? (*Hypothesis 5*) (Fazzari, *et al.* 1988; Gamba and Triantis 2008). I estimate the SSE using *Financial Leverage*, the firm's market debt ratio, as the endogenous dependent variable in the system—results are reported in *Table 6*.

The results show there is a positive and significant relationship between severance pay and *Financial Leverage* and a negative and significant relationship between change-in-control pay and *Financial Leverage*. These effects appear to be solely direct effects as neither the *Delta* or *Vega of the Portfolio* of the CEO appear to be significantly related with *Financial Leverage*. A 1% increase in severance pay predicts an increase of 0.4867% in financial leverage measures (debt to assets), or a 125.46% increase in financial leverage when moving from the 50th to 75th percentile. Given the mean of *financial leverage* in the sample is 24% this constitutes an increase of financial leverage to 54.11% (debt to assets), a significant change.

Next, I investigate the effects of severance on premiums paid for acquisitions. Do CEOs compensated with severance over-pay for acquisitions (*Hypothesis 6)* (Lehn and Zhao 2006)? As there is an error in the reported deal value from SDC with respect to fees and shares acquired in the transaction as SDC relies on reported values, I construct a Tobin's Q-style measure of the premium (*i.e.* the relative value of the total deal value to the total net assets paid for the firm at the time of the acquisition) [23]. The second reason for this specific use rather than a percentage premium of the prior share price is that it allows me to retain more than twice the number of reported mergers which otherwise would fall out of the sample due to non-reporting. Using this alternative calculation, I can employ a total of 172 unique individual bids per date-acquirer-target group compared to only 70 using the construction of premiums via share price[24]. I performed individual

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[23] The reason for this is twofold: firstly, in using the standard construction of the deal reported in price-per-share I found that this price includes the total value of the transaction—inclusive of flotation costs and fees paid to advisors of *both* firms. Such an error could alter the result, furthermore to redact the fees paid by using the SDC Platinum reported variable for *Target and Acquirer Financial Advisor Fees,* I need to be able to accurately gross up the value by the number of shares acquired in the transaction. Unfortunately, it appears that the SDC database sometimes incorrectly reports the number of shares acquired in the transaction. Secondarily, while SDC also reports the percentage of shares acquired of the total outstanding, this number is not always reported. While it is possible to traverse back and forth between the total listed deal value, using SDC's *Value of Transaction Mil* variable, and the listed deal share price, in many cases a large error is introduced.

[24] The unfortunately low amount of observations for this set is due to the multiple merging and need for likewise cross-reporting between multiple databases including *Compustat*, *ExecuComp,* CRSP, and SDC Platinum. The resulting full merge produces a combined sample of 762 observations, only 172 of which are usable due to non-reported data. It might be possible to iteratively collect by hand the remaining 590 observations to fill-the-gap, however, as the scope of this essay is not to address M&A activity

regressions (not reported) which indicate that they do produce similar results in the signs of the parameter estimates. This is sufficient to ascertain directional causation—and so I include the analysis of the 172 acquisition bids here.

This Tobin's Q-style premium measure captures the full premium on the transaction as the relative value of the assets acquired tells us the under- or over-valuation of the firm relatively speaking. Just as Tobin's Q measures the valuation of market-capital relative to assets this measure of premium should capture the relative over- or under- valuation on acquisition[25]. Using this premium as the endogenous dependent variable in the regression as well as using an indicator variable for whether the acquisition was a *ToeHold*, a *White-Knight* (or White Squire) acquisition, an *Asset Swap*, or a *Tender* offer I perform the 3SLS estimation to discern the effects of severance and change-in-control payments on premiums[26].

Using this estimation, I measure the relationship between how efficiently CEOs negotiate acquisitions and severance agreements. If severance payments allow CEOs to habitually overpay for firms they acquire, then there will be a positive and significant relationship between premiums paid for acquisition and severance pay (*Hypothesis 6)*.

Results in *Table* 7 indicate strong evidence of a positive and significant relationship between premiums paid on acquisitions and severance pay. However, there is a significant and negative relationship in the level of premiums paid and change-in-control agreements. The average Tobin's Q-style measure is a positive 28.6% and change-in-control payments may reduce this

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itself, but rather investigate evidence of increased premium due to severance using the data at hand—I do not perform this data acquisition due to the difficulty and time involved.

[25] In the construction, I use the percentage of shares acquired as a scaling factor for assets where needed and reported in order to correct for percentage purchased when it is not 100%.

[26] White-Knight and Asset Swap indicator variables were dropped from the regression and not reported in the table as they introduced direct multi-collinearity into the model.

significantly. These results suggest that severance could be a value destructive contract for firms to implement which is in contrast to Almazan and Suarez (2003), but similar to Lehn and Zhao (2006) and Gormley and Matsa (2016) who suggest that only external governance will result in termination. Moreover, there is a positive relationship between severance pay and financial leverage. With respect to economic significance, it appears that a 1% increase in severance pay results in a 0.8506% increase in the Tobin's Q measure. Since the mean of the premium measure is 127.81 a jump from 50th to 75th percentile in severance predicts premium increase by 60.97. Given that the Tobin premium measure has a standard deviation of 45.77, this is not unreasonable but does suggest a jump of one standard deviation in the amount of premium paid.

IV.4 CEO Risk-Taking, The Quiet Life and Shirking Hypothesis

If the CEO is protected by a barrier she may exhibit reduced risk-taking as there is less incentive or concern for him to take risks. This is known as the 'Quiet Life' or 'Shirking Hypothesis' proposed by Muscarella and Zhao (2017) and supported in the model provided by A&S. To exhibit the quiet life a CEO must be insured that she will not be fired for under-investing and limited returns. Thereby severance is what allows CEOs to get away with leading the quiet life.

Results in *Table 8* show that severance is negatively and significantly related to *R&D Intensity* suggesting that CEOs which are compensated with a severance agreement receive lower overall incentive to invest in risky investment projects, consistent with Muscarella and Zhao (2017) in a SSE framework. However, *Change-In-Control Payments* has a positive and significant relationship with *R&D Intensity*, implying that firms in which the CEO is compensated with a change-in-control agreement will see increased investment in risky projects. When taken together, the change-in-control agreements' incentives dominates severance agreements' negative effects.

This suggests an overall positive relationship should be observed between the simultaneous existence of change-in-control with severance agreements and risk-taking incentives (*e.g.* R&D Intensity) and could explain the positive results seen when dummy variables are used as in the extant literature.

A positive relationship between the CEO's portfolio vega and R&D intensity implies that vega is set to increase risk taking of the CEO. Looking to the simultaneous effects of severance and change-in-control payments on vega, the results show that change-in-control payments are highly influential upon the *Vega Of The Portfolio* of the CEO. This indicates that not only do change-in-control payments exhibit a direct effect on the incentive for CEOs to invest in risky projects but that they have an indirect effect by simultaneously increasing the *Vega Of The Portfolio*. The dual positive result of the vega on *R&D Intensity* and *Change-In-Control Payments* on *Vega Of The Portfolio* as well as the direct positive result of *Change-In-Control Payments* on *R&D Intensity* suggests that change-in-control agreements are responsible for incentivizing CEOs to increase investment in risky projects. This estimation model allows me to separate the incremental effects and the indirect effects imparted through the CEO's own sensitivity to changes in her portfolio value subject to the volatility of the underlying shares.

Interestingly, there still exists a discrete negative effect on risk-taking imparted by the existence of severance agreements. To my knowledge Muscarella and Zhao (2017) is the only other paper showing a negative relationship between severance and risk-taking behavior. This raises the question of the use of severance agreements to induce CEOs to make risky investments, yet the evidence suggests they may not. However, it is worth noting that provided a CEO is compensated with a change-in-control agreement *at the same time* (or alone), the effect may be a net positive owing to the dominating effects of change-in-control payments relative to severance.

Overall, this provides confirmatory evidence of Muscarella and Zhao's (2017) 'Shirking' or 'Quiet Life' hypotheses were severance *alone* is concerned. However, the incumbent CEO can only exhibit this shirking or 'quiet' life owing to their barrier to internal governance. The results are economically significant as well—a 1% increase in severance results in a 1.7465% decrease in R&D intensity.

IV.5 Contractual Changes in Severance Agreements

To further the analysis of severance's effects I re-run the above estimations on a sub-sample of CEOs who have had a contractual change in their compensation agreement. I classify a CEO who has a contractual change as one that has been given a new a severance contract (*e.g.* where one did not previously exist) or has lost a severance contract (*e.g.* where one existed before), or has had multiple changes in their agreement to provide or remove a severance agreement. Only 489 CEO-firm pairs have a contractual change, constituting roughly 30% of the sample of all unique CEO-firm pairs, a far larger proportion than was, *a priori,* expected. The directional movement—*i.e.* from no severance to severance or *vice versa*, *etc*.—is not particularly important for the estimation as the movement should be in the same direction as the change in the variable of interest. Following *Hypothesis 1*, if a CEO is newly provided with severance I should observe a significant negative effect on cash-to-assets. Conversely, when a CEO loses severance as part of the compensation agreement the estimation predicts an increase in cash-to-assets. The abridged SSE model used to test the structural break is provided here[27]:

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[27] Prior to (or after) a structural change: severance is 0; therefore, forming an interaction variable of *structural change ind.* termination payment* is not necessary, all information is captured by the constant indicator and the continuous variable for slope. The adjustment made here is akin to a piecewise estimation on the inclusion (exclusion) of severance from the compensation agreement at a specific point in time.

$$contractural\ chg\ ind.\left(term\ pymt_{i,t}\right)_{i,t} = \begin{cases} 0, & term\ pymt_{i,t} \leq 0 \\ 1, & term\ pymt_{i,t} > 0 \end{cases} \tag{2}$$

$$\begin{aligned} Dependent\ Variable_{i,t} = \alpha_{i,t} + \beta_{i,t}\left(contractual\ chg\ ind._{i,t}\right) + \gamma_{i,t}\left(term\ pymt_{i,t}\right) \\ + \boldsymbol{Z}_{i,t}\left(\boldsymbol{Controls_{i,t}}\right) + e_{i,t} \end{aligned} \tag{3}$$

The *contractual chg ind.* is applied to the other equations in the system so that the effect is captured in these estimations as well, however the sub-equations in the system are not provided in equation (3) for brevity[28]. The coefficient for *contractual chg ind.* provides the shift in constant as a CEO has a severance agreement added-to or removed-from their compensation agreement. The estimate for *Termination Payment* in this construction provides the slope effect of severance pay when the CEO has been granted a severance pay agreement.

In addressing the previous hypotheses, I run this estimation in the 3SLS SSE and examine the shift in the constant on dependent variables *cash-to-assets*, *financial leverage, dividend yield, capital expenditure intensity,* and *R&D Intensity*. I was not able to run the estimation for the premium paid on acquisitions and RSI as the sample proved to be too small. Results of the SSE with the *contractual chg. ind.* on the sub-sample of firms are presented in *Table 9*.

Results are largely consistent with the findings in the prior estimations. There are significant drops in cash-to-assets when a CEO is provided with severance lending evidence to support *Hypothesis 1*. The slope for severance is also negative and significant suggesting that, as severance increases, cash-to-assets declines. Since scaled values of severance (termination pay to assets) are used the effect is 1:1 in economic significance, indicating that cash to assets falls roughly 7.2% upon the initiation of a severance agreement.

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[28] The specifications for the sub-equations can be found in equation 1, with a full specification of the system in Appendix I.

The results on financial leverage and dividend yield are not significant although the slope effects are, indicating that it is the amount of severance that causes a relational effect rather than the initiation of a severance agreement. However, the results follow *Hypotheses 2* and *5*, and this is the first evidence of an effect on dividends.

*Capital Expenditure Intensit*y and *R&D Intensity* provide similar results to the prior SSE estimations, confirming *Hypotheses 3* and the Shirking or 'Quiet Life' Hypothesis (Muscarella and Zhao 2017). Noting that the effect is partially economically significant in this analysis: capital expenditure intensity appears to show a structural increase of 1.55% (in terms of Net PP&E) where the mean is 24%, a 6.46% growth over the mean; whereas R&D intensity shows a sharp decline of 2.632% where the sample mean itself is 3%. Following Coles, Daniel and Naveen (2006), this spread suggests a decline in risky investment and an increase in relatively less-risky investment and is also consistent with the findings of Harford *et al.* (2008) with an increase in capital expenditures as a means of using excess cash.

IV.6 Dodd-Frank §951 Exogenous Shock to Severance Pay and Performance Monitoring

The adoption of Section 951 provides an 'exogenous' shock to the level of monitoring and shareholder power regarding CEO compensation and with specific indignation towards severance agreements following the public's perception of golden-parachutes and severance packages paid to wall-street bankers during the collapse of 2008.

In the extant literature, surveyed by Yermack (2010), shareholder voting power on firms has engendered an entire sub-field of research. Say-on-pay voting has its initiation in a 1992 SEC ruling allowing shareholders to sponsor resolutions that inhibit certain types of management compensation (Subramaniam and Wang 2009). Subsequently several researchers have examined the effect of shareholder voting on managerial compensation and found that voting does have effects on both managerial compensation and firm performance (Gillan 2001; Morgan and Poulsen 2001; Cai and Walking 2011; Fischer *et al.* 2009; Carter and Zamora 2009; Conyon and Sadler 2010; Ferri and Maber 2009; Conyon 2015).

Implicit in this literature is the idea that shareholders may execute voting rights to effect change on management when it serves them best to do so. For example, according to the studies on the British adoption of say-for-pay voting, shareholders predominantly only vote against compensation when it reaches levels that are higher than expectations would suggest is reasonable (Yermack 2010). Therefore, a level of monitoring exists when the voting power rests in the hands of shareholders by allowing an external market correction to CEO compensation: removing the agency between that of the board and the shareholders.

On July 21st, 2010, then President Obama signed into law the Dodd-Frank Wall Street Reform and Consumer Protection Act (hereafter Dodd-Frank). Section 951 of Dodd-Frank lays out provisions for say-on-pay requirements as well as amending section 14A in the securities law requiring formal and full disclosure of compensation agreements and voting on same in the form of proxy statements (commonly known as DEF 14As). While disclosure of compensation agreements in increasing detail has been required since the Sarbanes-Oxley Act of 2002 (SOX), say-on-pay voting was allowed only in the proposals previously described. On Jan 25th, 2011, the SEC adopted and implemented Section 951 of Dodd-Frank and required that public firms initiate and set a schedule for say-on-pay votes within the next immediate board meeting of 2011[29].

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[29] https://www.sec.gov/news/press/2011/2011-25.htm

Following the implementation of Section 951, monitoring of CEO compensation should increase and CEOs should take actions to reduce their barriers following the adoption (*i.e.* they will increase cash-levels, and reduce capital expenditures, reduce financial leverage and premiums paid on acquisitions and increase R&D investments). Thereby, using an indicator variable for the period before and after implementation of Dodd-Frank §951, I sub-sample the prior analyses to see if CEOs do reduce their barriers. This reversal follows in the same vein as the predictions from A&S model in which strong governance leads to a reduction of CEO extraction in control rents and power to remain CEO. Equations 4, 5, and 6 and used in the estimations for *Table 10*:

$$\begin{aligned} Before\ \S951\ Ind._{i,t}\ (< 2011) &= \begin{cases} 0, & year_i \geq 2011 \\ 1, & year_i < 2011 \end{cases} \\ After\ \S951\ Ind._{i,t}\ (\geq 2011) &= \begin{cases} 0, & year_i < 2011 \\ 1, & year_i \geq 2011 \end{cases} \end{aligned} \quad ,\ for\ \forall\ i \tag{4}$$

$$\begin{aligned} Before\ \S951\ Term\ Pymt_{i,t}\ (< 2011) &= \begin{cases} term\ pymt_{i,t}, & year_i < 2011 \\ 0\ , & year_i \geq 2011 \end{cases} \\ After\ \S951\ Term\ Pymt_{i,t}\ (\geq 2011) &= \begin{cases} 0, & year_i < 2011 \\ term\ pymt_{i,t}, & year_i \geq 2011 \end{cases} \end{aligned} \tag{5}$$

$$\begin{aligned} Dependent\ Variable_{i,t} = \alpha_{i,t} &+ \beta^1_{i,t}\left(Before\ \S951\ Ind._{i,t}\right) + \beta^2_{i,t}\left(After\ \S951\ Ind._{i,t}\right) \\ &+ \gamma^1_{i,t}\left(Before\ \S951\ Term\ Pymt_{i,t}\right) + \gamma^1_{i,t}\left(After\ \S951\ Term\ Pymt_{i,t}\right) \\ &+ \boldsymbol{Z}_{i,t}\left(\boldsymbol{Controls_{i,t}}\right) + e_{i,t} \end{aligned} \tag{6}$$

Results for the estimations performed again on *cash to assets*, *financial leverage*, *dividend yield*, *capital expenditure intensity* and *R&D intensity* as dependent variables are shown in *Table 10*.

Since the construction follows that of a piecewise regression differences in the indicator constants and slope estimates are presented in *Panel B* (Indicator and Term Pymt respectively). Results in *Panel B* show that, consistent with the reversal hypothesis, in the face of monitoring or strong governance, CEOs do appear to increase cash directly after the implementation of §951.

They also appear to reduce leverage. Interestingly, although I held no priors on the change in dividend yield given that I did not find consistent results in the prior estimates to support *Hypothesis 2,* results show a large and significant increase in dividends. I also show an increase in capital expenditure intensity that is significant, although the slope of the effect of severance following Dodd-Frank is negative and significant as well. There appears no significant effect on R&D intensity.

The results are mixed but seem to indicate that where monitoring exists CEOs may reverse previously erected barriers, but where the connection is abstract (*i.e.* R&D intensity is a proxy for risk-taking or risky investment) monitoring may have little effect on the outcome. Together these results lend support to the idea that stronger governance can mitigate the control rents and protection a CEO can raise with severance agreements—couching the empirical results in the model of A&S and providing evidence of the barriers as well.

IV.7 Barriers to Internal Governance and Take-Over Intensity

If a CEO faces an exogenous market condition which increases the likelihood of termination or change in control—the original hypotheses examined should show stronger results as CEOs attempt to protect themselves from termination even more. I examine a split sample on industry take-over intensity, defined as the number of firms which are targeted for acquisition in each year (*t)* for a given industry (*I)* divided by the total number of firms in the industry for that year, $TakeOver\ Intensity_{I,t} = \frac{\#Targets_{I,t}}{\#Firms_{I,t}}$. Each firm is matched to its industry take-over intensity on a per year basis. I re-run the SSE on the sub-samples of low intensity (below the median (0.2)) and high intensity (above the median) and examine the change in their coefficient estimates in

Table 11, presented in the column labeled 'diff.' Due to a direct relationship with takeover intensity and premiums paid on acquisitions, I do not investigate this hypothesis.

The results show a consistency in general with the prior results for *Capital Expenditure Intensity*, and *Dividend Yield* is insignificant. For *Cash-To-Assets* it appears that CEOs under external market pressure decrease their levels of cash dependent upon the level of termination payment they expect to receive supporting *Hypothesis 1*.

The results on *Capital Expenditure Intensity* are less straight-forward and do not conform to *Hypothesis 3*, however, it could be the case that capital expenditure intensity is related to the level of take-over intensity: producing an unobserved endogenous effect. Relationship Specific Investment *(Hypothesis 4)* appears to increase as there is more take-over pressure in the industry, conforming to the hypothesis.

Financial leverage is also found to be increasing as takeover intensity increases (*Hypothesis 5)*, which suggests that CEOs increase the level of financial leverage, an effect here which is uniquely not counter-balanced by change-in-control payments as in the other cases, results which are consistent with Frazzari *et al.* (1988). Lastly, I find evidence that R&D intensity declines as takeover intensity increases for CEOs compensated with severance—although this effect is almost entirely mitigated by change-in-control payments, a small effect remains. This result points to a rational expectation of the board—that CEOs are expected to reduce risk-taking when they are insulated from termination with a severance agreement and external pressure proves them the extra incentive of not taking risk. In this instance of takeover intensity, it appears boards mitigate these effects by increasing change-in-control payments relative to the takeover intensity to reduce these incentives. Regardless, it appears severance could lead to a reduction is risk-taking in environments where termination or takeover pressure is high.

To provide further robustness I run a SURE estimation, for comparison to the SSE, and a Mixed-Model estimation reporting effects of risk-taking (R&D Intensity), capital expenditure, and cash-levels (reported Appendix II)—the results remain similar.

V. Conclusion

This essay addresses how it is that CEOs can resist termination and shirk responsibilities by erecting a barrier to the board's ability to terminate, which rests upon the CEO not being terminated for their lack of effort or value destructive activities. I show that if a CEO invests in a way that decreases the likelihood of success of a rival CEO or makes it costly for the board to terminate her, she can protect herself from the internal mechanisms for CEO replacement. This is only made possible because severance initially dissuades the board from terminating the CEO when she begins to make these investment choices.

As evidence of the barriers to internal governance, I document reductions in cash-levels (*Hypothesis 1)* and increased capital expenditure *(Hypothesis 3*) due to severance. However, I do not find overall evidence to support the idea that incumbent CEO's increase dividends *(Hypothesis 2)* as a method of reducing cash—and thereby it appears that most of the cash flows towards capital expenditures or acquisitions as there is also evidence of over-payment above the natural valuation of firm assets (*Hypothesis 6)*. Additionally, I document an increase in financial leverage *(Hypothesis 5)*, which might make it increasingly difficult to operate or make future investments (DeAngelo, DeAngelo, and Whited 2011). Furthermore, I show that these effects, except for capital expenditure intensity, are increasing with external takeover pressure.

This study differs from A&S by showing that given specific types of investments and financial adjustments CEOs can violate A&S's constraints while remaining consistent with the framework—causing a loop-hole in the model. This results in boards choosing the *ex-ante* 'optimal' level of severance compensation only to find *ex-post* that their CEO *does not* make the expected investments and uses (abuses) the binding mechanism of severance as a means to throw up a 'force-field' between herself and the board. As a result, CEOs have a means by which to shirk their duties or lead a 'quiet life'—even upon initially taking office.

These results are important not only for boards of firms and compensation committees, who are investigating the use of severance contracts, but also for policy makers who may be reasonably skeptical of the positive effects these separation agreements are intended to provide. Overall, my evidence suggests that severance contracts not only reduce managerial risk-taking but also may destroy shareholder value as CEOs have an incentive to protect themselves from termination and thereafter act selfishly: increasing agency costs. Coincidentally, Muscarella and Zhao (2017) explicitly document long-term shareholder value destruction as a result of severance agreements.

Consequently, it is concerning that boards—who should bear in mind their fiduciary responsibilities to shareholders—would use severance packages when it appears that *change-in-control agreements* provide the incentives of increased investment in worth-while risky projects and are, *evidently*, value creating.

At the very least, this evidence should spur research on the topic of managerial risk-taking and value creation of severance and change-in-control agreements and warrants new investigations using modern data that reflects recent regulatory changes and reporting environments.

TABLE 1: Descriptive Statistics

Variables	**Obs.**	**Mean**	**Standard Deviation**	**Min.**	**25%**	**Median**	**75%**	**Max.**
Termination Payments Scaled (%)	6631	0.08%	0.54	-	-	0.10	0.12	0.17
Change-In-Control Scaled (%)	6631	0.11%	0.46	-	0.10	0.12	0.13	0.18
Termination Payments (mil $)	6631	6.44	15.10	-	-	1.80	6.34	298.86
Change-In-Control Payments (mil $)	6631	13.02	20.60	-	1.97	6.79	16.67	431.85
Delta of the Portfolio ($000)	6631	511.18	1,003.04	-	48.93	179.99	533.81	7,277.54
Vega of the Portfolio ($000)	6631	119.74	201.37	-	9.26	43.58	136.39	1,242.79
Salary ($000)	6631	740.17	386.38	-	489.38	690.00	950.00	4,800.00
Bonus ($000)	6631	136.36	638.80	-	-	-	-	23,128.79
Stock Awards ($000)	6631	1,844.60	5,458.55	-	33.99	821.00	2,383.55	380,000.00
Option Awards ($000)	6631	1,040.61	2,568.10	-	-	292.51	1,228.69	68,349.00
Non-Equity Incentives ($000)	6631	1,116.03	1,662.66	-	49.78	648.00	1,472.25	31,575.00
Other Compensation ($000)	6631	178.32	867.98	-	15.74	49.99	158.51	46,347.77
Market to Book Ratio	6631	0.35	0.94	-	0.01	0.05	0.22	6.50
Log Sales	6603	7.35	1.64	3.35	6.27	7.29	8.40	11.48
Sale (mil $)	6622	7,037.63	24,622.58	-	522.37	1,465.67	4,451.80	470,000.00
Cash To Assets Ratio	6631	0.17	0.17	-	0.05	0.12	0.25	0.75
Financial Leverage	6631	24%	176%	0%	2%	18%	31%	12094%
Dividend Yield	6631	1.08%	4.13%	-	-	-	0.39%	30.23%
R&D Intensity	6631	3.29%	5.39%	-	-	0.47%	4.62%	27.45%
Capital Expenditure Intensity	6631	24.45%	15.89%	2.0%	13%	20%	31.52%	80.25%
Tax Rate	6631	23%	42%	-226%	17%	31%	37%	158%
CEO Continuous Tenure (years)	6631	6	4	1	3	5	9	23
Sales Growth	6631	330%	9576%	-100%	-5%	6%	19%	646110%
CEO Age (years)	6614	56	7	28	51	56	61	76
Volatility	6631	0.41	0.04	0.33	0.38	0.44	0.45	0.45
EBITDA (mil $)	6621	1,110.80	3,960.12	(2,336.03)	61.85	199.19	668.30	78,669.00
Operating Cash Flow (mil $)	6621	869.72	3,264.76	(3,150.00)	43.28	146.53	491.00	59,725.00
Tobin's Q	6631	552.52	10,987.90	-	-	1.34	21.04	570,000.00
Return on Assets (ROA)	6631	4%	33%	-1476%	2%	5%	9%	314%
Profit Margin	6631	-9%	507%	-30118%	2%	6%	10%	408%
Total Asset Turnover	6631	1.12	0.77	-	0.63	0.92	1.42	13.18
Operating Expense Margin	6631	106%	509%	-3148%	86%	92%	97%	30217%
Total Assets (mil $)	6631	8,033.96	33,437.32	0.09	530.06	1,545	4,780	800,000

TABLE 1: Descriptive Statistics. Presented above are the descriptive statistics for the firm-year pairs, the sample runs 2009 to 2015 in total there are roughly 6,631 observations with the few exceptional cases where the values are reported missing. Computed and shown are the cross sectional year-firm means and standard deivations as well as their quintile distributions. The quintile distributions can give a sense of scope to the distributions of the data set. As can easily be seen in R&D Intensity there is a large problem with natural zeros--I attempt to correct for this using a mixed model found in section *6.3 Mixed Model Analysis: Simultaneous TOBITs to Treat Natural Zeros.* Where appropriate the values are reported in percentages. Termination Payment, Change-In-Control Payments, EBITDA, Operating Cash Flow, Sales and Total Assets are all reported in millions were indicated. All other CEO level compensations are reported in thousands.

TABLE 2: Cash Levels and Severance

PANEL A: Cash-To-Assets

	Cash-to-Assets	Delta of the Portfolio	Vega of The Portfolio	Termination Payment	Change of Control Payment
Termination Payments (mill $)	-0.00297 ***	8.64431 ***	-4.81290 ***		1.20995 ***
Change In Control Payments (mil $)	-0.00075 *	-6.19375 ***	4.68451 ***	0.76638 ***	
Delta of The Portfolio ($000)	0.00003 ***		0.15766 ***	0.00294 ***	-0.00329 ***
Vega of The Portfolio ($000)	0.00043 ***	4.41714 ***		-0.01452 ***	0.02313 ***
Salary	0.00001 *		-0.01873 ***	-0.00392 ***	0.00582 ***
Bonus	-0.00001 *		0.01110 ***	0.00090 ***	-0.00112 ***
Stock Awards	0.00000 ***		-0.00137 ***	-0.00012 ***	0.00019 ***
Option Awards	-0.00001 ***			-0.00074 ***	0.00090 ***
Non-Equity Incentive	0.00001 ***		-0.00045	0.00012	-0.00003
Other Compensation	-0.00000		0.00794 ***	0.00124 ***	-0.00156 ***
Market to Book Ratio	-0.00548 ***	-21.80134 *	6.50077 ***		-0.10747
Log Sales	-0.06293 ***	-89.23306 ***	30.46164 ***		-0.24471 **
Financial Levearge		-3.55866	0.41723	0.01401	-0.00961
Sales Growth	-0.00001	-0.03202	0.01130		
Dividend Yield	0.00352 ***			-0.00898	0.02040
Tax Rate	-0.02111 ***				
CEO Continuous Tenure	-0.00221 ***	19.31547 ***		0.03875	-0.10635 **
CEO Age	-0.00090 ***			0.01772	-0.02333
R&D Intensity		-555.40829 ***	242.84991 ***	-3.52219 ***	0.27605
Capital Expenditure Intensity		501.72274 ***	-19.02534	0.22177	-1.75957
Volatility		-1001.73508 ***	276.90902 ***	10.11679 ***	-14.49288 ***
EBITDA				0.00001	-0.00002
Financial Cash Flows					
Operating Cash Flows				0.00009	-0.00016
Constant	0.64445 ***	907.43766 ***	-341.64790 ***	-5.03598 ***	9.37801 ***
Observations	6576	6576	6576	6576	6576

TABLE 2:Cash Levels and Severance. This table reports the results for the 3SLS regressions relating to the estimation of Cash-To-Assets as explained by *dollar value* Termination Payments, Change-In-Control Payments, Vega of the Portfolio and Delta of the Portfolio as well as CEO and firm level controls. Although not reported each system has industry and year fixed effects specified as strictly exogenous to the system. The system estimates Capital Expenditure Intensity, Termination Payments, Change-In-Control Payments, Vega of the Portfolio, and Delta of the Portfolio as endogenous factors specified by the remainder of the system. The estimations indicate that there is a negative relationship between the amount of severance paid to a CEO and the reduction in cash levels overall. ** indicates significance at the 10% level, ** indicates signifiance at the 5% level, *** indicates signifiance at the 1% level*

TABLE 3: Dollar Value Severance and Capital Expenditure Intensity

PANEL A: Capital Expenditure Intensity

	Capital Expenditure Intensity	**Delta of the Portfolio**	**Vega of The Portfolio**	**Termination Payment**	**Change of Control Payment**
Termination Payments (mil $)	0.00175 ***	7.32818 ***	-5.18498 ***		1.21663 ***
Change of Control Payments (mil $)	-0.00134 ***	-5.90277 ***	4.93635 ***	0.76827 ***	
Delta of The Portfolio ($000)	0.00005 ***		0.15870 ***	0.00250 ***	-0.00311 ***
Vega of The Portfolio ($000)	-0.00007 ***	4.53463 ***		-0.01425 ***	0.02218 ***
Salary	-0.00001 *		-0.01712 ***	-0.00322 ***	0.00513 ***
Bonus	-0.00000		0.01068 ***	0.00084 ***	-0.00106 ***
Stock Awards	0.00000 ***		-0.00137 ***	-0.00015 ***	0.00020 ***
Option Awards	-0.00000			-0.00072 ***	0.00089 ***
Non-Equity Incentive	-0.00000		0.00024	0.00016 *	-0.00010
Other Compensation	-0.00000 *		0.00856 ***	0.00127 ***	-0.00159 ***
Market to Book Ratio	-0.00299	-20.59958 *	6.29622 ***		-0.08436
Log Sales	-0.01657 ***	-75.50736 ***	25.84642 ***		-0.03845
Financial Levearge	-0.00352 ***	1.18925	0.30453	0.04916	-0.03625
Sales Growth	-0.00002	-0.00338	0.00902		
Dividend Yield	-0.00187 ***			0.00403	0.01373
Tax Rate	0.00566				
CEO Continuous Tenure	-0.00332 ***	20.73021 ***		0.06167 *	-0.11860 ***
CEO Age	-0.00191 ***			0.04327 **	-0.03632
R&D Intensity		-794.70164 ***	164.52065 ***	-2.72779 ***	2.16616 *
Capital Expenditure Intensity		1478.56533 ***	-65.12693 ***	9.75671 ***	-8.14301 ***
Volatility		-1103.60874 ***	273.90386 ***	10.50461 ***	-14.60660 ***
EBITDA				-0.00015	0.00013
Operating Cash Flows				0.00032	-0.00038
Constant	0.45262 ***	623.69782 ***	-289.61611 ***	-9.56580 ***	10.59598 ***
Observations	6576	6576	6576	6576	6576

TABLE 3: Dollar Value Severance and Capital Expenditure Intensity--Panel A. Panel A indicates the results for the 3SLS regressions relating to the estimation of Capital Expenditure Intensity as explained by *dollar value* Termination Payments, Change-In-Control Payments, Vega of the Portfolio and Delta of the Portfolio as well as CEO and firm level controls. Although not reported each system has industry and year fixed effects specified as strictly exogenous to the system. The system estimates Capital Expenditure Intensity, Termination Payments, Change-In-Control Payments, Vega of the Portfolio, and Delta of the Portfolio as endogenous factors specified by the remainder of the system. ** indicates significance at the 10% level, ** indicates signifiance at the 5% level, *** indicates signifiance at the 1% level*

TABLE 4: Dividend Yield and Severance

PANEL A: Dividend Yield

	Dividend Yield	**Delta of the Portfolio**	**Vega of The Portfolio**	**Termination Payment**	**Change of Control**
Termination Payments(mil $)	-0.40663	179.44679 ***	-20.34437		0.55742 ***
Change of Control Payments(mil $)	-1.13454 ***	-514.49875 ***	102.22616 ***	0.87048 ***	
Delta of The Portfolio ($000)	-0.00036		0.20609 ***	0.00011 ***	-0.00022 ***
Vega of The Portfolio ($000)	-0.00194 **	4.60502 ***		-0.00030 ***	0.00072 ***
Salary	0.00042 *		-0.00161	0.00004	0.00014 ***
Bonus	-0.00028 **		0.00113	0.00003	-0.00004 ***
Stock Awards	-0.00001		-0.00011	0.00000	0.00000
Option Awards	0.00008 **			-0.00001 ***	0.00002 ***
Non-Equity Incentive	0.00003		0.00104	0.00001	0.00000
Other Compensation	-0.00001		-0.00132	0.00001	-0.00001
Market to Book Ratio	-0.31074 ***	-35.57373 **	7.66928 **		-0.01851 ***
Log Sales	0.23823 ***	-154.79035 ***	35.30235 ***		-0.04601 ***
Financial Levearge	-0.01588	-8.17718	1.68724	0.00328	-0.00844 ***
Sales Growth	0.00226 ***	-0.09590	0.02511		
Dividend Yield				-0.02039 ***	-0.01952 ***
Tax Rate	0.15815				
CEO Continuous Tenure	0.00613	6.81000 ***		-0.01257 ***	0.00838 ***
CEO Age	0.00391			-0.00131	-0.00168 *
R&D Intensity		-244.91099 ***	59.55280 ***	-0.04596	0.05230
Capital Expenditure		415.87327 ***	-83.07433 ***	0.03529	0.05463
Volatility		-1501.81719 ***	335.58083 ***	-0.13889	-0.07319
EBITDA				0.00001	-0.00001
Financial Cash Flows					
Operating Cash Flows				-0.00000	-0.00000
Constant	0.10904	2018.54931 ***	-467.55586 ***	0.06856	0.93317 ***
Observations	6576	6576	6576	6576	6576

TABLE 4: Dividend Yield and Severance. This table reports the results for the 3SLS regressions relating to the estimation of Dividend Yields as explained by *scaled* Termination Payments, Change-In-Control Payments, Vega of the Portfolio and Delta of the Portfolio as well as CEO and firm level controls. Although not reported each system has industry and year fixed effects specified as strictly exogenous to the system. The system estimates Capital Expenditure Intensity, Termination Payments, Change-In-Control Payments, Vega of the Portfolio, and Delta of the Portfolio as endogenous factors specified by the remainder of the system. ** indicates significance at the 10% level, ** indicates signifiance at the 5% level, *** indicates signifiance at the 1% level*

TABLE 5: Relationship Specific Investment And Severance

PANEL A: Relationship Specific Investment

	Customer R&D (WA)	
	Model 1	Model 2
Termination Payment	0.00551 **	0.00325 *
Change-in-Control Payment	-0.01353 *	-0.00618 *
DELTA	0.00917	0.00359
VEGA	-0.00233 ***	-0.00114 ***
Salary	-0.00015	0.00004
Bonus	-0.00062	-0.00031
Stock Awards	0.00315 **	0.00355 **
Non-Equity Incentive	-0.00017	-0.00055
Other Compensation	-0.00033	-0.00033
Market-to-Book Ratio	-0.00055	-0.00061
Log Sales	-0.00115 *	-0.00621 **
Sales Growth	1.25333 ***	1.11332 **
Financial Leverage (market)	-0.00316	-0.06223 **
ROA (firm)	-0.00915 ***	-0.01051 ***
Supplier R&D Intensity	0.09812 ***	0.10951 ***
CEO Continuous Tenure	0.00000	0.00000
CEO Age	0.00052	0.00012
Customer VEGA	0.02353 ***	0.02661 ***
Customer DELTA	-0.00614 **	-0.00563 *
Customer Financial Leverage	0.00966	0.00955
Customer Sales Growth	2.56001 ***	1.56331 ***
Year Fixed Effects	YES	YES
Industry Fixed Effects	NO	YES
Observations	2723	2723
R Squared	0.32	0.36

TABLE 5: Relationship Specific Investment and Sevearnce. This table reports the results for the OLS regressions relating to the estimation of RSI as explained by scaled Termination Payments, Change-In-Control Payments, Vega of the Portfolio and Delta of the Portfolio as well as CEO, firm level, and customer controls. The construction of the estimates follow the work of Kale, Kedia, and Williams (2015). Differentially the items of interest here are the factor-loadings on Termination Payment. Model 1 does not have industry fixed effects, Model 2 does have industry fixed effects. * indicates significance at the 10% level, ** indicates signifiance at the 5% level, *** indicates signifiance at the 1% level

TABLE 6: Financial Leverage and Severance

PANEL A: Financial Leverage

	Financial Leverage	Delta of the Portfolio	Vega of The Portfolio	Termination Payment	Change of Control Payment
Termination Payments	0.01814 ***	8.10740 ***	-5.13166 ***		1.21778 ***
Change In Control Pay	-0.01439 ***	-6.42538 ***	4.82894 ***	0.76824 ***	
Delta of The Portfolio (	-0.00006		0.16205 ***	0.00286 ***	-0.00326 ***
Vega of The Portfolio (	0.00038	4.60652 ***		-0.01577 ***	0.02314 ***
Salary	0.00008		-0.01973 ***	-0.00361 ***	0.00548 ***
Bonus	-0.00002		0.01069 ***	0.00090 ***	-0.00112 ***
Stock Awards	0.00000		-0.00104 ***	-0.00013 ***	0.00019 ***
Option Awards	0.00001			-0.00070 ***	0.00086 ***
Non-Equity Incentive	0.00001		0.00040	0.00015	-0.00008
Other Compensation	-0.00002		0.00800 ***	0.00125 ***	-0.00157 ***
Market to Book Ratio	-0.01059	-23.38838 **	6.23377 ***		-0.09053
Log Sales	-0.04564 **	-100.89421 ***	26.06175 ***		-0.08059
Financial Levearge		10.83703	-1.38394	0.95510 ***	-0.96318 ***
Sales Growth	0.00000	-0.03708	0.00980		
Dividend Yield	0.00452			-0.00794	0.01914
Tax Rate	-0.04029				
CEO Continuous Tenur	0.01500 **	17.53750 ***		0.03105	-0.09273 **
CEO Age	-0.00239			0.02924	-0.03368
R&D Intensity		-707.39779 ***	164.06653 ***	-1.35665	0.94964
Capital Expenditure Intensity		465.81617 ***	-58.92394 ***	1.42668	-1.79621
Volatility		1056.19855 ***	266.38093 ***	10.69286 ***	-14.45348 ***
EBITDA				-0.00019	0.00016
Financial Cash Flows					
Operating Cash Flows				0.00036	-0.00041
Constant	0.65479 ***	1034.41803 ***	-288.51974 ***	-6.78062 ***	9.09821 ***
Observations	6576	6576	6576	6576	6576

TABLE 6: Financial Leverage and Severance. This table indicates the results for the 3SLS regressions relating to the estimation of Financial Leverage as explained by *dollar value* Termination Payments, Change-In-Control Payments, Vega of the Portfolio and Delta of the Portfolio as well as CEO and firm level controls. Although not reported each system has industry and year fixed effects specified as strictly exogenous to the system. The system estimates Financial Leverage, Termination Payments, Change-In-Control Payments, Vega of the Portfolio, and Delta of the Portfolio as endogenous factors specified by the remainder of the system. The results show that CEOs compensated with a severance package can be reasonably expected to increase financial leverage levels significantly as a function of the amount they are paid--indicating potential increased overall firm risk. **indicates significance at the 10% level, ** indicates signifiance at the 5% level, *** indicates signifiance at the 1% level*

TABLE 7: Severance's Effect on Premium Paid Above Asset Value

PANEL A: Tobin Style Premium Measure (Deal Value/Replacable Asset Value)

	Tobin Style Premium Measure	**Delta of the Portfolio**	**Vega of The Portfolio**	**Termination Payment**	**Change of Control Payment**
Termination Payments (mil $)	3.67292 ***	-148.100290 **	47.85174 ***		-0.00771
Change of Control Payments (mil $)	-16.55802 ***	-387.669330 ***	281.61732 ***	0.11703	
Delta of The Portfolio ($000)	-0.00408 ***		0.16918 ***	-0.00078 ***	0.00002
Vega of The Portfolio ($000)	-0.01126 ***	4.159970 ***		0.00607 ***	0.00097 ***
Salary	-0.00537 ***		-0.15733 ***	-0.00064 ***	0.00016 ***
Bonus	0.00594 ***		-0.18208 ***	0.00098	0.00029 ***
Stock Awards	-0.00143 ***		-0.00352	-0.00016 ***	0.00001 **
Option Awards	-0.00085 ***			0.00001	-0.00005 ***
Non-Equity Incentive	-0.00070 ***		0.03712 ***	0.00021 ***	-0.00005 ***
Other Compensation	0.04172 ***		0.90268 ***	-0.00224 **	-0.00072 ***
Market to Book Ratio	30.42049 ***	-1593.571620 ***	105.53091 ***		0.04021
Log Sales	1.05541 ***	-105.923960 ***	31.01829 ***		-0.06406 ***
Financial Levearge	25.07283 ***	753.358120 ***	-79.46124 **	0.32109	-0.10009 ***
Sales Growth	1.75116 ***	133.459230 ***	-45.66565 ***		
Dividend Yield	1.70787 ***			0.12801 ***	-0.03173 ***
Tax Rate	-4.53242 ***				
CEO Continuous Tenure	2.91200 ***	-77.169670 ***		-0.05228 ***	0.01070 **
CEO Age	-0.85180 ***			-0.05643 ***	-0.01905 ***
R&D Logged Intensity					
Capital Expenditure		716.879940 ***	370.16589 ***	2.57563 ***	0.20503 ***
Volatility		3585.469100 ***	18.60159	1.85143	0.46509 ***
EBITDA				0.00000	-0.00003 ***
Financial Cash Flows					
Operating Cash Flows				0.00002	-0.00001
ToeHold	0.97724 ***				
Hostile	-10.79160 ***				
Tender	-0.36010				
Constant	28.42941 ***	683.914650	-654.17765 ***	2.98231 ***	2.35120 ***
Observations	172	172	172	172	172

TABLE 7: Severance's Effect on Premium Paid above Asset Value. In order to estimate the effect of severance on mergers and acquisitions (M&A) over-payment I attempted to use several types of estimations, however, the observations inherently involved are almost always very small. While this clearly introduces small sample bias this is the net effect of incremental merging across datasets without replacement or casting of missing variables. Other proxies for M&A activity or over-payment produce similar results in the signs, that is severance increases over-payment and change-in-control decreases it, but, I report this proxy here owing to the errors intrinsic in using the other proxies. This proxy allows me to elude the errors in the other proxies and confidently estimate the effect. ** indicates significance at the 10% level, ** indicates signifiance at the 5% level, *** indicates signifiance at the 1% level*

TABLE 8: Severance's Effect on Risk-Taking

PANEL A: R&D INTENSITY

	R&D Intensity	**Delta of the Portfolio**	**Vega of The Portfolio**	**Termination Payment**	**Change of Control Payment**
Termination Payments (mil $)	-0.00894 ***	2.54861	-1.87291 ***		1.24710 ***
Change of Control Payments (mil $	0.00520 ***	-1.21792	2.78493 ***	0.75360 ***	
Delta of The Portfolio ($000)	-0.00003 ***		0.14853 ***	0.00240 ***	-0.00265 ***
Vega of The Portfolio ($000)	0.00069 ***	4.39128 ***		-0.00622 ***	0.00699 ***
Salary	-0.00003 ***		-0.01963 ***	-0.00505 ***	0.00710 ***
Bonus	-0.00001 ***		0.01036 ***	0.00070 ***	-0.00078 ***
Stock Awards	0.00000 ***		-0.00167 ***	-0.00011 ***	0.00016 ***
Option Awards	-0.00001 ***			-0.00082 ***	0.00117 ***
Non-Equity Incentive	0.00000 **		-0.00266 **	0.00003	0.00005
Other Compensation	0.00000 **		0.00561 ***	0.00116 ***	-0.00145 ***
Market to Book Ratio	-0.00552 ***	-20.58030 *	6.53013 ***		-0.03751
Log Sales	-0.04496 ***	-121.96693 ***	44.01592 ***		0.23969 **
Financial Levearge	0.00169 *	-2.33313	-0.30195	0.04857	-0.04774
Sales Growth	-0.00001	-0.03868	0.01355		
Dividend Yield	-0.00071 **			-0.01105	0.02385
Tax Rate	-0.01494 ***				
CEO Continuous Tenure	-0.00168 ***	20.15085 ***		0.04264	-0.08788 **
CEO Age	-0.00028			0.00004	0.00271
R&D Intensity		503.22194 ***	604.98174 ***	-18.02735 ***	21.36946 ***
Capital Expenditure		493.28600 ***	-56.50963 ***	2.03633 **	-2.44845 **
Volatility		-842.62976 ***	180.96797 ***	12.17381 ***	-15.02836 ***
EBITDA				-0.00011	0.00010
Operating Cash Flows				0.00018	-0.00026
Constant	0.40516 ***	166.91230 ***	-420.27409 ***	-3.12796 *	2.11542
Observations	6576	6576	6576	6576	6576

TABLE 8: Severance's Effect on Risk-Taking--Panel A. Panel A indicates the results for the 3SLS regressions relating to the estimation of R&D Intensity as explained by *dollar value* Termination Payments, Change-In-Control Payments, Vega of the Portfolio and Delta of the Portfolio as well as CEO and firm level controls. Although not reported each system has industry and year fixed effects specified as strictly exogenous to the system. The system estimates R&D Intensity, Termination Payments, Change-In-Control Payments, Vega of the Portfolio, and Delta of the Portfolio as endogenous factors specified by the remainder of the system. The estimations are not significantly different in terms of sign than those found in *Table 3. * indicates significance at the 10% level, ** indicates signifiance at the 5% level, *** indicates signifiance at the 1% level*

TABLE 9: Identification Break: No Severance to Severance (*vice versa*)

Dependent Variable	Cash To Assets	Financial Leverage	Dividend Yield	Capital Expenditure Intensity	R&D Intensity
Contractual Chg. Ind.	**-0.07178 ***** **(0.0000)**	**0.14584** **(0.4396)**	**-0.21944** **(0.3491)**	**0.01555 ***** **(0.0000)**	**-0.02632 ***** **(0.0033)**
Termination Payments Scaled	-0.05972 *** (0.0811)	0.01492 *** (0.0000)	0.16822 *** (0.0001)	0.00652 *** (0.0001)	-0.00378 *** (0.0000)
Change in Control Payments Scaled	0.00370 *** (0.8557)	-0.00703 *** (0.0000)	-0.16833 *** (0.0000)	0.00159 * (0.0999)	-0.00041 (0.2372)
Delta of The Portfolio ($000)	-0.00003 *** (0.0000)	0.00007 (0.5604)	-0.00049 *** (0.0013)	0.00003 *** (0.0000)	-0.00002 *** (0.0000)
Vega of The Portfolio ($000)	0.00014 *** (0.0000)	-0.00074 (0.2498)	0.00275 *** (0.0006)	-0.00014 *** (0.0000)	0.00023 *** (0.0000)
Salary	-0.00003 *** (0.0070)	0.00006 (0.7904)	0.00003 (0.9059)	-0.00004 *** (0.0003)	0.00000 (0.2307)
Bonus	0.00000 (0.7944)	0.00006 (0.4125)	-0.00011 (0.2601)	0.00001 * (0.0610)	-0.00001 *** (0.0000)
Stock Awards	0.00000 ** (0.0261)	0.00000 (0.6091)	0.00000 (0.7609)	0.00000 *** (0.0001)	0.00000 (0.1033)
Option Awards	0.00000 * (0.0590)	0.00001 (0.8514)	-0.00008 (0.1458)	0.00000 * (0.0861)	0.00000 * (0.0811)
Non-Equity Incentive	0.00001 *** (0.0002)	0.00007 (0.1850)	0.00006 (0.3020)	0.00000 (0.1942)	0.00000 ** (0.0211)
Other Compensation	0.00000 *** (0.6302)	0.00001 (0.8427)	-0.00004 *** (0.5448)	0.00000 *** (0.5595)	0.00000 *** (0.4783)
Market to Book Ratio	0.00434 (0.1875)	0.01443 (0.8329)	-0.25269 *** (0.0029)	0.00019 (0.9538)	-0.00110 (0.3553)
Log Sales	-0.02810 *** (0.0000)	-0.15178 ** (0.0214)	-0.13543 * (0.0987)	0.00183 (0.5603)	-0.01445 *** (0.0000)
Tax Rate	-0.01107 (0.1283)	0.06594 (0.6641)	0.21731 (0.2464)	0.01306 * (0.0651)	-0.00921 *** (0.0000)
CEO Continuous Tenure	0.00177 ** (0.0179)	0.03275 ** (0.0334)	-0.01959 (0.3064)	-0.00243 *** (0.0009)	0.00074 *** (0.0014)
CEO Age	-0.00126 *** (0.0059)	-0.00713 (0.4510)	-0.00534 (0.6495)	-0.00286 *** (0.0000)	-0.00041 *** (0.0036)

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TABLE 9: Identification Break: No Severance to Severance (*vice versa*) (cont.)

Cash To Assets		-1.03248 **	3.37168 ***	0.08755 ***	0.08575 ***
		(0.0169)	(0.0000)	(0.0000)	(0.0000)
Financial Leverage	-0.00280 ***		-0.00177	-0.00315 ***	0.00162 ***
	(0.0053)		(0.9450)	(0.0014)	(0.0000)
Dividend Yield	0.00481 ***	0.00394		-0.00227 ***	-0.00034
	(0.0000)	(0.8135)		(0.0044)	(0.1777)
Capital Expenditure Intensity	0.13020 ***	-1.47531 ***	-0.75024		0.06608 ***
	(0.0000)	(0.0009)	(0.1740)		(0.0000)
R&D Intensity	1.01815 ***	6.70000 ***	-4.95179 ***	0.43064 ***	
	(0.0000)	(0.0000)	(0.0017)	(0.0000)	
Constant	0.42086 ***	1.77211 **	2.77949 ***	0.37067 ***	0.12900 ***
	(0.0000)	(0.0170)	(0.0026)	(0.0000)	(0.0000)
Unique CEO-firm pairs	489	489	489	489	489
Observations	2,358	2,358	2,358	2,358	2,358

TABLE 9: Identification Break: No Severance to Severance (Vice Versa) Creating a sub-sample for CEOs whose compensation package changed during their time in office regarding severance. CEOs in the sub-sample either did not initially receive severance and then later had it added to their compensation agreements; recieved severance initially and then had it removed from their compensation agreements; or varyingly had severance added or removed from compensation multiple times during their tenure as CEO. The directional movement (no severance then severance, or severance then no severance, or multiple breaks) is not relevant to the analysis as the hypothesis predicts a change in the dependent variable when severance exists (vs. does not exist). Constructing an indicator variable for when a CEO has severance versus when they do not in any given year for a CEO-firm pair and inserting it into the SSE 3SLS provides the same consistent type of estimators achieved in the prior analysis but also allows for the identification of the effect of severance directly in its origination. Being that CEOs take these actions upon severance's initiation into their compensation portfolio this test helps to identify whether the hypothesis presented are causally linked to severance. The effective construction follows that of an 'event analysis' where the parameter loadings on the *Contractural Chg. Ind.* estimate the 'shock' to the dependent variable produced by newly providing (or removing) severance to a given CEOs compensation portfolio. Roughly 30% of all CEO-firm pairs experience a break in compensation where severance is added or removed from the CEO's compenastion portfolio during their tenure, what was expected to be a rarity is fairly common. Estimation is performed in the SSE because it is assumed that the inclusion of severance (or removal) into the compensation portfolio is simultaneously determined with parameters of compensation. The remainder of the estimations follow the same constructs as those found in tables 2 to 4 and 6 to 8, however they are not reported here for brevity. Values in parenthesis are p-values. ** indicates significance at the 10% level, ** indicates significance at the 5% level, *** indicates significance at the 1% level.*

TABLE 10: Dodd-Frank Act §951 Implementation Piecewise Estimation

PANEL A: Piecewise Estimation with Dodd-Frank §951 Indicator Instrumenting for Term Pymt

Dependent Variable	Cash To Assets	Leverage	Dividend Yield	Capital Expenditure Intensity	R&D Intensity
Before §951 Indicator (< 2011)	0.5739 ***	0.0010	0.3048	0.5547 ***	0.1579 ***
	(0.0000)	(0.9903)	(0.4625)	(0.0000)	(0.0000)
After §951 Indicator (>=2011)	0.5804 ***	-0.0471	0.8767 **	0.5763 ***	0.1584 ***
	(0.0000)	(0.5656)	(0.0384)	(0.0000)	(0.0000)
Before §951 Term Pymt (< 2011)	0.0010 ***	0.0016	0.0168 *	0.0010 ***	-0.0003 **
	(0.0059)	(0.3889)	(0.0825)	(0.0081)	(0.0142)
After §951 Term Pymt (>=2011)	0.0005	0.0007	0.0325 ***	0.0002	-0.0001
	(0.1578)	(0.6764)	(0.0001)	(0.6068)	(0.4005)
Change In Control Payments Scaled	0.8573 ***	-9.1544 ***	-20.0052 ***	1.1838 ***	0.2945 ***
	(0.0009)	(0.0000)	(0.0026)	(0.0000)	(0.0004)
Delta of Portfolio ($000)	0.0000 ***	-0.0001 ***	0.0000	0.0000 ***	0.0000
	(0.0001)	(0.0000)	(0.8266)	(0.0000)	(0.5588)
Vega of Portfolio ($000)	0.0001 ***	-0.0004 ***	-0.0005 *	0.0000	0.0001 ***
	(0.0000)	(0.0000)	(0.0740)	(0.3217)	(0.0000)
Salary	0.0000 ***	0.0002 ***	0.0006 ***	0.0000 ***	0.0000 ***
	(0.0000)	(0.0000)	(0.0001)	(0.0000)	(0.0011)
Bonus	0.0000	0.0000	0.0000	0.0000 *	0.0000 ***
	(0.3692)	(0.1288)	(0.9621)	(0.0502)	(0.0030)
Stock Awards	0.0000 ***	0.0000 ***	0.0000	0.0000 ***	0.0000 ***
	(0.0000)	(0.0024)	(0.2250)	(0.0000)	(0.0000)
Options Awards	0.0000 ***	0.0000	0.0000	0.0000	0.0000 ***
	(0.0000)	(0.5974)	(0.2910)	(0.1571)	(0.0000)
Non-Equity Incentive	0.0000 ***	0.0000 ***	0.0000	0.0000 **	0.0000 **
	(0.0000)	(0.0015)	(0.1233)	(0.0441)	(0.0218)
Other Compensation	0.0000 *	0.0000	0.0001	0.0000	0.0000 *
	(0.0637)	(0.1119)	(0.3395)	(0.4412)	(0.0976)
Market to Book Ratio	0.0000	0.0000	-0.0005	0.0000	0.0000
	(0.6430)	(0.9777)	(0.6225)	(0.8330)	(0.4188)
Log Sales	-0.0471 ***	0.0339 ***	-0.0165	-0.0220 ***	-0.0140 ***
	(0.0000)	(0.0000)	(0.6591)	(0.0000)	(0.0000)
CEO Continuous Tenure	0.0007 *	0.0017	-0.0354 ***	-0.0022 ***	0.0006 ***
	(0.0970)	(0.4422)	(0.0016)	(0.0000)	(0.0001)
CEO Age	-0.0015 ***	0.0014	0.0069	-0.0026 ***	-0.0006 ***
	(0.0000)	(0.2615)	(0.2894)	(0.0000)	(0.0000)
Observations	6,631	6,631	6,631	6,631	6,631
R-Squared	0.2114	0.0383	0.0146	0.1229	0.1816

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TABLE 10: Dodd-Frank Act §951 Implementation Piecewise Estimation (cont.)

PANEL B: Differences in Constant and Slope

	Predicted Sign									
After §951 Indicator - Before §951 Indicator	(+)	0.0077 **	(-)	-0.0599 ***	(+/-)	0.5419 ***	(-)	0.0234 ***	(+)	0.0007
		(0.0440)		(0.0020)		(0.0000)		(0.0000)		(0.5520)
After §951 Term Pymt - Before §951 Term Pymt	(-)	-0.0007	(+/-)	0.0008	(+/-)	0.0179	(+)	-0.0010 **	(-)	0.0002
		(0.1070)		(0.7040)		(0.1010)		(0.0150)		(0.2180)

TABLE 10: Dodd-Frank Act §951 Implementation Piecewise Estimation As a result of Dodd-Frank §951 adoption by the SEC on Jan 25th, 2011, firms were required to provide 'say-on-pay' votes to shareholders beginning immediately with the next shareholder meeting. This change to the voting power of shareholders with respect to internal firm decisions deminimizes an agency gap between shareholders and the board in decisions on executive pay agreements. Inherently the initiation of the §951 adoption by the SEC would institute an increase in governance power and monitoring via external markets as CEOs now face higher scrutiny and reprimand for decisions from institutional investors, block-holders, and activist investors who can carry a proxy on 'say-on-pay' to fruition. Such a shift in monitoring and shareholder external governance should result in the CEO reversing the perverse effects of severance much in the way that Almazan and Suarez (2003) predict that CEOs with strong boards (and thereby strong governance) will be unable to extract control rents or renegotiate compensation upon the arrival of a rival CEO conditional on quality of said rival. As such I expect to see a reversal in the predicted signs in a piecewise estimation from the estimations preformed previously--that is a reversal of the hypotheses. In using a piece-wise regression I can observe the instantaneous shift after the event and a change in slope following the event for the variable of interest (Termination Payment). While I predict that there will be an immediate reversal as the CEO solves the game inductively, as in Almazan and Suarez (2003) and initiates new investment decisions upon the adoption of §951 by the SEC, it is not expected that any increase in Termination Pay after the event would alter the previous hypothesis and that the effect should remain consistent. The results are mixed, but consistent with the idea that an increase in monitoring or shareholder power led to a reversal of the predicted hypothesis for Cash levels and firm leverage with significance. R&D Intensity exhibits a reversal but it is insignificant, and interstingly dividend yield shows a significant jump following the adoption although given the lack of findings in prior analysis I held no priors in this prediction. Capital Expenditure Intensity provides no reversal from the prior analysis except in the case of slope which was not expected to change but does. Results are displayed in the table above with emphasis predominantly in Panel B (the differences). Values in parenthesis are p-values, ** indicates significance at the 10% level, ** indicates significance at the 5% level, *** indicates significance at the 1% level.*

TABLE 11: TakeOver Intensity and Force-Fields

	PANEL A			PANEL B				
	TakeOver Intensity Low			TakeOver Intensity High				
	coef.	p-value	Std. Err.	coef.	p-value	Std. Err	Diff.	Z-Score
Cash-To-Assets								
Term Payment	-14.590 ***	0.000	0.460	-19.811 ***	0.000	0.635	-5.221 ***	-6.659
Chg. Control Payment	11.567 ***	0.000	0.370	16.139 ***	0.000	0.439	4.572 ***	7.956
Delta	0.000 ***	0.001	0.000	0.000 ***	0.000	0.000	0.000 ***	-21.60
Vega	0.000 ***	0.000	0.000	0.000 ***	0.000	0.000	0.000	1.740
CAPEX Intensity								
Term Payment	7.613 ***	0.000	0.543	-6.757 ***	0.000	0.539	-14.37 ***	-18.79
Chg. Control Payment	-0.546	0.157	0.386	5.789 ***	0.000	0.423	6.335 ***	11.05
Delta	0.000 ***	0.000	0.000	0.000 ***	0.000	0.000	0.000 ***	41.56
Vega	0.000 ***	0.000	0.000	0.000 ***	0.000	0.000	0.000 ***	3.895
Div. Yield								
Term Payment	0.114 ***	0.000	0.180	0.363 ***	0.000	0.142	0.248	1.082
Chg. Control Payment	-0.049 ***	0.000	0.130	-0.250 ***	0.000	0.114	-0.201	-1.165
Delta	0.000 ***	0.000	0.000	0.000 ***	0.014	0.000	0.000 ***	4.601
Vega	0.000 ***	0.000	0.000	0.000 ***	0.000	0.000	0.000 ***	8.635
Relationship Specific Investment								
Term Payment	-2.814	0.102	1.720	11.636 ***	0.000	1.402	14.45 ***	6.511
Chg. Control Payment	9.219 ***	0.000	1.220	-1.884	0.101	1.121	-11.10 ***	-6.703
Delta	0.000 ***	0.000	0.000	0.000 ***	0.000	0.000	0.000 ***	20.21
Vega	0.002 ***	0.000	0.000	0.001 ***	0.000	0.000	0.000	-2.200
Financial Leverage								
Term Payment	-0.016 ***	0.000	0.000	0.103 ***	0.000	0.008	0.119 ***	15.62
Chg. Control Payment	0.012 ***	0.000	0.005	-0.012	0.845	0.006	-0.024 ***	-3.183
Delta	0.000 ***	0.000	0.000	0.000 ***	0.000	0.000	0.000 ***	-52.83
Vega	0.000 ***	0.000	0.000	0.003 ***	0.000	0.000	0.003 ***	124.3
R&D Intensity								
Term Payment	-0.006 ***	0.003	0.002	-0.021 ***	0.000	0.001	-0.015 ***	-6.250
Chg. Control Payment	-0.004 ***	0.011	0.002	0.009 ***	0.000	0.001	0.013 ***	7.176
Delta	0.000 ***	0.000	0.000	0.000 ***	0.000	0.000	0.000 ***	-124.0
Vega	0.000 ***	0.000	0.000	0.000 ***	0.000	0.000	0.000 ***	102.5

TABLE 11: TakeOver Intensity and Force-Field. This table depicts only the 4 estimates of the SSE for Term Payment, Change in Control Payment, Delta and Vega, it does not show their interactive effects through each equations estimation, because primarily this table examines whether the hypothesis hold when intensity for take-over increases--and the CEO faces more risk of termination or change in control. I find that for the hypothesis examined here are consistent when examined with take-over itnensity with the exception of CAPEX Intensity. When takeover intensity is high, a CEO faces more pressure and should exhibit increasing barriers. This table shows that the difference of the parameter estimates when takeover intensity is high v. low is either negative (decreasing) or positive (increasing) for a given hypothesis. For cash-to-assets, the result indicates a decreasing cash-to-asset value with increasing levels of severance as takeover intensity increases, suggesting that CEOs facing more pressure do reduce cash-levels. This table also shows that change in control payment helps to miitigate this effect as investigated over take-overs which change in control payments are meant to protect the CEO against. However, it appears that netted with the diff. in change in control payments--the effect is not eliminated. For CAPEX Intensity, the effect observed is different from that reported in table 3, however, it may be the case that CAPEX intensity is endogenously related to take-over intensity, i.e. firms may spend less on capital expenditures when take-over intensity in an industry is high as capital expenditures may make it difficult to fend off take-over attempts and may also make it more likely a firm will be acquired. For Dividend Yield, I continue to show no true effect, the differences are insginficant. For Relationship specific investment the effect observed here is using the SSE, which is different than the OLS employed by Kale, Kedia and Williams (2015) and also presented in table 5, however, it remains consistent. As CEOs face high takeover pressure they appear to increase relationship specific investment significantly, suggesting that they are decrasing the liklihood of a rival CEO's success in a takeover. Financial Leverage increases when takeover intensity is high--which may be an artifact of a relationship with take-overs: a high level of leverage often makes firms less desireable for acquisition so long as they are solvent, never-the-less the result is consistent with the hypothesis. R&D intensity is also seen to be decreasing, but the effect apperas to be mitigated by change in control payments almost entirely, suggesting that when CEOs face take over pressure they have less incentive to innovate, but change in control payments can help defer this effect.

Essay Two: A General Model of Managerial Incentives and Risk-Taking

> *Managers whose compensation is a* ***concave function of firm value*** *have incentives to reduce firm cash flow variability. Hence, such managers might reject variance-increasing positive net present value (NPV) projects.*
>
> *–Clifford Smith and René Stulz (1985)*

TRADITIONAL MEASURES OF MANAGERIAL RISK-TAKING incentives include delta (*i.e.* performance-pay sensitivity, or PPS) and vega (*i.e.* volatility sensitivity). While these measures have been used extensively in the literature, they do not incorporate the effect of severance compensation (Bizjak *et al.* 1993; Core and Guay 1999; Guay 1999; Cohen *et al.* 2000; Coles *et al.* 2006; Anderson and Core 2013)[30]. Additionally, these measures are an indirect proxy of compensation incentives as they do not measure convexity of the compensation contract with respect to firm value (Smith and Stulz 1985; Guay 1999; Coles *et al.* 2006).

To address these concerns, I develop a real-option model of CEO compensation that can be applied to all types of compensation and allows for the computation of incentive measures that include the effect of severance. Using this model, I derive compensation gamma, a direct measure

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[30] There is an ongoing debate as to whether severance increases risk-taking or reduces it and this is confounded in regard to how severance interacts with other types of compensation. Holmström (1979) and Holmström and Milgrom (1987) indicated that firm specific risks should reduce pay-performance sensitivity of the CEO owing to the 'equilibrium' concept of CEO compensation—that is higher firm risk necessitates higher compensation to assuage the risks. This result was supported by Aggarwal and Samwick (1999) but has yielded conflicting results in Prendergast (2002). Daniel, Coles, and Naveen (2006) show that there is a 'vega' effect which strongly relates to traditional measure of CEO risk-taking such as R&D intensity or CAPEX intensity. Conyon, Core and Guay (2009) shows that risk-adjusted CEO compensation is not significantly different than that of CEOs in Britain—yet American CEOs take on dramatically higher equity risk. Furthermore, there is conflict over what exactly causes the risk-taking incentive—is it stock or stock options? Guay (1999) and Parrino and Weisbach (1999) both show that stocks produce very little risk-taking incentive for the CEO; whereas Booth (2009) argues that stock options are the best method for incentivizing the CEO to take risks. Worse still is the conflict over what exactly the effect of severance compensation packages has on CEO risk-taking. Ju, Leland and Senbet (2002) argue that put options are 'analogous' to severance packages—which implies that severance packages function as a type of insurance—which for rational individuals generally increases ex-post insured risk-taking behavior (Holmström (1979)). This argument is certainly supported by Daniels *et al.* (2006), but a working-paper by Muscarella and Zhao (2017) show that this may no longer be the case with striking evidence to suggest that CEOs no-longer face incentives to produce risk but are actually incentivized *not* to take it.

of compensation convexity which helps to correct for vega's relationship to firm size, share price and firm riskiness. Such relationships may ultimately bias empirical results and cause inconsistent estimates through firm size when vega is used as a measure of incentives.

I then empirically test the validity of gamma and vega from the model using CEO actuarial 'death tables' as a novel means of predicting remaining tenure for a CEO[31]. I examine the effect of gamma and vega, with and without severance, on CEO risk-taking and find that gamma is generally positively related to risky investment. Vega's effect, on the other hand, is unclear. I also show that severance may reduce risk-taking incentives and firm focus. This suggests that gamma and vega do not have the same implications as incentives measures, and severance may not provide as much benefit to firms as previously thought.

The remainder of this essay is constructed as follows: Section I, contains the derivation of the model. In Section II, I discuss the differences between gamma and vega with the assistance of graphics of compensation portfolios. In Section III, I describe the construction of actuarial 'death tables' for CEO tenure. Section IV uses empirical estimates of gamma and vega in univariate, OLS, and 3SLS Simultaneous equation regressions to test the differences between gamma and vega and the effects severance has on measures of risk-taking incentives and firm focus. Lastly in Section V, I discuss implications of the results and conclude.

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[31] A rather small contingency of the literature examines CEO tenure, Career horizons, decision horizons, or hazard ratios of employment. This area of the literature serves as a fertile ground for increased research, given the inherently important effects of expected tenure on CEO behavior and risk-taking. See Antia, Pantzalis, Park (2010), Brookman and Thistle (2009).

I. The Model

Almazan and Suarez (2003), Ju, Leland and Senbet (2004), and Inderst and Mueller (2008) each expound upon the intended benefits of severance in increasing investments in variance increasing projects, as severance acts as an assurance that the CEO will not be terminated should the project ultimately reduce the value of the firm. Thereby it is intuitive that severance agreements should affect a CEO's sensitivity to firm value and sensitivity to volatility (*i.e.* delta and vega, respectively)—yet these measures do not account for the effects of severance[32].

Furthermore, severance and option compensation have long been modeled separately as individual parts of an *ex-ante* principal-agent framework between a CEO and her shareholders (Grossman and Hart 1986; Hart and Moore 1990; Hart 1995; Bebchuck and Fried 2003; Frydman and Jenter 2008; Edmans and Gabaix 2009). However, this *ex-ante* treatment does not consider how CEOs behave *after* their contracts are negotiated and what incentives they truly experience (Williamson 2002). This essay's contribution is to 1) use an *ex-post* model of compensation contracts to examine their incentives; 2) include the effect of severance in measures of those incentives; and 3) improve the accuracy of those measures.

I.1 CEO Compensation Structure

CEOs are compensated with some combination of executive stock options, share grants, cash compensation (*i.e.* salary, bonus, or some other long-term incentive plan[33]), and perhaps some

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[32] Until recently, the amount of severance to be paid out in a contract was not disclosed. Owing to changes in accounting regulation (Sarbanes Oaxley (2002) and Dodd-Frank Act (2009)) have resulted in a requirement that shareholders vote on CEO (and other CEO level officer and director) compensation and that these agreements are disclosed in detail. Before 2006, the existence of a severance agreement had to be disclosed, following 2006 the amount was needed. Cadman *et al.* (2008) and Muscarella and Zhao (2017) discuss the collection of these severance agreements. Fluharty-Jaidee (2017) finds that following 2008 the reporting in the *ExecuComp* data-base is consistent and dramatically improved allowing me to the amount of severance.

[33] See Balsam (2002), Bebchuck and Freid (2004), Canyon (2006), and Booth (2009), for example, which all provide detailed explanations on the history and use of CEO compensation and the nature of the compensation parts and their individual incentive components. Yermack (2006) addresses change-in-control payments.

amount of severance. For this model, I restrict the compensation to four types: 1) *cash and other compensation*, which includes any compensation which does not relate to firm value or severance; 2) *stock compensation*, which includes granted or restricted stocks; 3) *executive stock options* (ESOs), which includes all exercisable and unexercisable options (vested and unvested)[34]; and 4) *severance*, which provides a lump-sum payment should the CEO be terminated without cause[35]. Therefore, a hypothetical CEO has a compensation portfolio given in present value terms as: $\pi = severance + cash + stocks + options$. I discuss the valuation of each individually.

Severance can be modeled as an insurance contract via a digital-barrier option[36]. A digital-barrier option is a type of option in which the payout is one (1) if the barrier is crossed and zero otherwise[37]. Digital-barrier options are a useful method of modeling severance as they provide an immediate fixed payment after a certain limit has been reached—*i.e.* the CEO has reached a point where the board deems it necessary to terminate them and they receive a fixed payout equal to their severance agreement. In my model, the barrier is determined uniquely by share price, although it is worthwhile to mention that the barrier does not need to relate to the share price *at all*; however, share price provides a convenient and intuitive way to proxy the performance of the CEO (Warner *et al.* 1988)[38].

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[34] For simplicity I do not investigate the effects of vested, unvested, or exercisable and unexercisable options, although they can be modeled for using the model by allowing them to come into effect only after a specific amount of time.

[35] For an investigation on the incentives of change-in-control payments see Yermack (2006). Change-in-Control Payments are included in severance as a style and is not intended to imply they are the same or unimportant.

[36] In an older version of their paper Ju, Leland and Senbet (2003) had a footnote which indicated it would be appropriate to value severance using a digital barrier option. They have since removed that footnote—but not to be remiss and to provide credit I would like to indicate that I had obtained the initial idea for modeling severance in this way from these authors.

[37] For example, should share's price drop below a set barrier of $30, a barrier option immediately executes and acquires a value of $1; should it expire above $30 (*i.e.* never crosses below the barrier) it is worthless. Digital refers to 1/0, and barrier to the execution condition of the option.

[38] A dynamic digital barrier option is an added layer of complexity, not detailed here, in which the termination time of the option is unknown as well as the barrier itself is temporally unrestricted in value—that is to say, the barrier is allowed to move over-time and there is no known expiration time at any given point in time. This would be perhaps the most general rendition of the model and most accurately reflects reality, however, I leave this for future research. I provide a brief review of the valuation of digital barrier options in Appendix II which follows closely the construction by Rubinstein and Reiner (1991)

A down, knock-*in* digital-barrier option, which pays out a fixed amount if a barrier is crossed from above, is used for the valuation of *Severance*. The fixed payout amount is represented as Q in Rubenstein and Reiner (1991) and the same notation is used in this model: $V_{Q_t} = Q_t e^{-r_t \tau} \Phi(-d_{2t}^{Q})$, where Q_t is the contracted level of severance at time t; r_t is the risk-free rate a time t; and $\Phi(-d_{2t}^{Q})$ is the value of the risk adjusted probability from Black and Scholes (1973) for a specific d_2 defined for severance[39]. $\Phi(.)$ represents the cumulative standard normal distribution[40].

Cash, conversely, is represented with a down, knock-*out* digital-barrier option, which ceases to pay out once the barrier is crossed from above. The down-and-out option is important as CEOs do not receive their cash or bonus compensation upon termination. In the extant literature one would assume cash payment regardless of termination—I make the distinction so that the hypothetical CEO does not obtain both a severance payment and cash compensation at the same time.

Stock compensation is represented by the number of shares granted or held (g) times the difference between the granting, or purchase, price (B_{t_0}) and the current share price (S_t). When the shares are granted to the CEO, $S_t - B_{t_0} = 0$ (*i.e.* $S_o = B_{t_0}$), as the CEO has no basis in the position. This captures the incremental value of the shares: $V_s = g\left(S_t - B_{t_0}\right)$. These shares exist as property of the CEO until they are sold by the CEO; an assumption of the model which may

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[39] The notation of the super-script Q is used here since options and severance valuation may have different risk-adjusted probabilities for the hypothetical CEO; the super-script O is used to indicate the risk-adjusted probabilities for the ESOs.

[40] $\Phi(x) = \frac{1}{\sqrt{2\pi}} \int_{-\infty}^{x} e^{-\frac{x^2}{2}}$

differ from reality—however it does not have large effects on the conclusion[41]. *ESOs* are valued using Black-Scholes (1973) for European options[42].

The last part of the compensation portfolio is the catch-all category of *other compensation* which includes all other compensation that a CEO may obtain in the course of employment but which they expect to lose upon termination; including, pension funds, health-care, perquisites, long-term contingent bonuses, *et al.* This form of compensation is the vaguest, but reasonably so: it is also vaguely described in the DEF-14 and DEF-14As. For this form of compensation, I assume some components may continue after termination[43], and it is common for CEOs to have such perquisites which follow even after their tenure of office. However, in the DEF-14As this compensation may not be included in the severance package value and are included in other compensation. Other compensation which ceases to exist upon termination would be of importance to a CEO facing the prospect of termination and would play heavily into their investment choices[44]. To incorporate this loss of compensation into the model I include a term in the same valuation as cash which also ceases to be provided to the CEO upon termination.

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[41] The final result of the model is a second order derivative, in which case gS_t falls out of the model. Whether the shares are restricted or unrestricted upon the termination of the CEO can be considered an unnecessary complication as one could simply formulate the valuation of the shares along with a down, knock-out type digital barrier provision attached to it for those shares considered unrestricted, as with the cash compensation. Thereby, one would be repeating the 'other compensation' part of the compensation portfolio with those unrestricted shares and adding mere complication and little more verisimilitude to the model; for these purposes I *willfully* ignore whether the shares are restricted or unrestricted for parsimony.

[42] Since the options can be exercised opportunistically by the CEO, valuation as an American style option has merits. However, I restrict the present derivations to the simpler European-style option valuation owing to their ease of differentiability and the relative verifiability (Chen, Lee & Shih (2010)). Within the scope of examining delta, vega and gamma I do not expect this to have large effects on the analysis—though using American options could reveal many interesting artifacts of compensation and risk-taking incentives.

[43] Such as the case for Karl Otto Lagerfeld, whose DEF-14A for Fendi, owned by LVMH Moët Hennessy Louis Vuitton SE, and Chanel S.A. fashion houses dictates that he be allowed to use his office, a secretary, a limo and the use of the [a] corporate air-craft, when not already in use, for personal transportation for a year after being terminated from his position. As Creative Director of Fendi, Chanel and Lagerfeld Fashion houses Karl O. Lagerfeld has executive status and sometimes wields implicit executive authority on par with that of the President or CEO. [LVMH Moët Hennessy Louis Vuitton SE (2015), Form DEF-14A (2015). Retrieved from SEC EDGAR website http://www.sec.gov/edgar.shtml]

[44] Continuous payment of other compensation in the model simply shifts upward in the vertical intercept of the compensation profile and falls out in differentiation since such compensation occurs regardless of performance of the CEO and would not affect risk-taking (it's an employment independent endowment); ergo, continuous compensation lends little benefit to the model.

I.2 Delta, Vega and Gamma

Delta (or PPS) serves as a first-order measure of how a CEO's compensation portfolio's total value changes in relation to a change in the value of the of the firm (*i.e.* $\partial V/\partial S$), while vega is a first-order measure of the change in the value of the compensation portfolio to change in the volatility of the firm's share price (*i.e.* $\partial V/\partial \sigma$). Gamma is the second-order derivative of the compensation portfolio with respect to firm value (*i.e.* $\partial^2 V/\partial S^2$). The gamma of the portfolio determines the curvature of the portfolio.

CEOs with convex compensation portfolios have explicit benefits to invest in variance increasing projects with positive NPVs (Smith and Stulz 1985). Contrary to its use in the literature, vega does not measure the incentive to invest in risky projects because it does not measure convexity—it measures only the *sensitivity* of the portfolio to risk.

Making a risk-averse CEO highly sensitive to changes in risk (*i.e.* increasing vega) does not necessarily indicate that they will be incentivized to increase investment in risky projects—indeed they may be incentivized to *reduce* investment in high volatility projects to reduce the firm's risk to match their own preferred level of risk as they know their compensation is highly sensitive to volatility (*e.g.* hedge the risk). Yet, this is the very argument that is made when vega is used as a barometer of risk-taking incentives in CEO compensation portfolios (Holmström 1979; Holmström and Milgrom 1987; Aggarwal and Samwick 1999). Therefore, it is not clear what type of incentives vega provides, since vega only shows how sensitive a CEO's compensation portfolio is to a firm's underlying risk.

Since gamma is a singular measure of local convexity, the incentives are clear. When gamma is *negative* the compensation portfolio is concave with respect to firm value indicating a *dis-incentive* to invest in variance increasing projects. When gamma is *positive* the compensation portfolio is convex with respect to firm value indicating an *incentive* to invest in variance increasing projects.

I.3 The General Model

Using the prior simplified construction of the compensation profile, I add the digital-barrier valuation to *severance* and *cash* (with other compensation) and use Black-Scholes for the ESOs to obtain the expanded present value payout function $\pi_{s_t}(.)$:

$$\begin{aligned}\pi_{s_t}\left(Q_t, r_t, \tau, S_t, K_{Q_t}, K_{O_t}, \sigma_t, q_t, C_t, g_t, B_{t_o}, d_2^Q, d_1^O, d_2^O, Oth._t\right) = \\ = Q_t e^{-r\tau}\Phi\left(-d_2^Q\right) + (C + Oth.)_t e^{-r\tau}\Phi\left(d_2^Q\right) + g\left(S_t - B_{t_o}\right) \\ + \left(S_t e^{q\tau}\Phi\left(d_1^O\right) - K_{O_t} e^{-r\tau}\Phi\left(d_2^O\right)\right) \qquad (1)\end{aligned}$$

Q_t is the amount of severance in the compensation portfolio for a specific period in time (usually set annually), r_t is the risk-free rate at time *t* used as the rate of discount. S_t is the firm's share price at any point in time and K_{Q_t}, K_{O_t} are the strike prices for both the severance package (Q_t) and the ESO package (O_t). The strikes are different because termination is expected to occur only after a specific lower barrier is crossed, and ESOs usually have a strike above the current price to encourage long-run performance. σ_t is the measure of the underlying firm's volatility for a given time t; q_t is the dividend yield of the firm in the given time t, and g_t is the number of shares granted or otherwise provided to the CEO (cumulative, net of exercise) for a given time *t*. C_t and $Oth._t$ are the cash and other compensation portions of the compensation contract and represents all the compensation for the CEO not included in other groups and which is assumed to stop after the CEOs are terminated. Contractually this compensation is often known well in advance, so cash and other compensation, as in Q, is given at a point in time *t*, but set annually.

d_2^Q, d_1^O, d_2^O are computed as in the Black-Scholes framework, with the exception that d_2^Q relates to the parameters associated with the severance package (particularly K_{Q_t}), and d_1^O, d_2^O are associated with the ESOs (K_{O_t}). Derivations for the following equations can be found in *Appendix IV.*

The delta for a compensation portfolio is given by equation (2):

$$\Delta_P = \Delta_Q + (\Delta_C + \Delta_{Oth.}) + \Delta_S + \Delta_O \tag{2}$$

The derivative of delta is gamma, and portfolio gamma is the summation of individual gammas of the components, so the gamma of a compensation portfolio is given in equation (3):

$$\Gamma_P = \Gamma_Q + (\Gamma_C + \Gamma_{Oth.}) + \Gamma_S + \Gamma_O \tag{3}$$

Expanding equation (2) using valuation models from Rubenstein and Reiner (1991) and Black and Scholes (1973), the delta of the portfolio is given by:

$$\Delta_P = \frac{-Qe^{-r\tau}\phi(-d_2^Q)}{S_t\sigma\sqrt{\tau}} + \frac{(C + Oth.)e^{-r\tau}\phi(d_2^Q)}{S_t\sigma\sqrt{\tau}} + g + e^{-q\tau}\Phi(d_1^O) \tag{4}$$

Taking the derivative of equation (4), the gamma of the portfolio is given by:

$$\Gamma_P = \frac{Qe^{-r\tau}\phi(-d_2^Q)d_1^Q}{S_t^2\sigma^2\tau} + \frac{-(C + Oth.)e^{-r\tau}\phi(d_2^Q)d_1^Q}{S_t^2\sigma^2\tau} + \frac{e^{-q\tau}\phi(d_1^O)}{S_t\sigma\sqrt{\tau}} \tag{5}$$

Allowing *NetSev* to be defined as severance less cash and other compensation, $NetSev = Q_t - C - Oth.$, equation (5) can be simplified into a termination component and an ESO component:

$$\Gamma_P = \text{NetSev}\frac{e^{-r\tau}d_1^Q\phi(d_2^Q)}{S^2\sigma^2\tau} + \frac{e^{-q\tau}\phi(d_1^O)}{S_t\sigma\sqrt{\tau}} \tag{6}$$

Similarly, vega of the compensation portfolio is given by:

$$\mathrm{v_P} = \frac{\mathrm{Qe^{-r\tau}\phi(-d_2^Q)d_1^Q}}{\sigma} + \frac{\mathrm{-(C + Oth.)e^{-r\tau}\phi(d_2^Q)d_1^Q}}{\sigma} + \mathrm{S_t e^{-q\tau}\phi(d_1^O)\sqrt{\tau}} \tag{7}$$

Rearranging the terms, vega can be simplified to equation (8):

$$\mathrm{v_P} = \mathrm{NetSev}\frac{\mathrm{e^{-r\tau}d_1^Q\phi(d_2^Q)}}{\sigma} + \mathrm{S_t e^{-q\tau}\phi(d_1^O)\sqrt{\tau}} \tag{8}$$

The difference between gamma in equation (6) and vega in equation (8) is given by the Black-Scholes-Merton framework*:*

$$\mathrm{v_P} = \frac{\partial \mathrm{V_P}}{\partial \sigma} = \sigma\tau \mathrm{S}^2\left(\frac{\partial^2 \mathrm{V_P}}{\partial \mathrm{S}^2}\right) = \sigma\tau\mathrm{S}^2\Gamma_\mathrm{P}\left(S_t, \sigma_t, \tau, \mathrm{d_2^Q}, \mathrm{d_1^Q}, \mathrm{d_1^O}, r_t, \mathrm{K_{Q_t}}, \mathrm{K_{O_t}}\ NetSev\right) \tag{9}$$

Equation (8) shows that vega is increasing in share price. Since vega increases in share price through d_1^O and S_t, there may be relationships between vega and other firm characteristics. Additionally, when volatility increases (σ) firms with high share prices have CEOs with increasingly large vega and this is particularly true for CEOs who have a high remaining tenure (τ) as it increases this effect even more. Equation (9) implies that, *ceteris paribus*, CEOs of firms with a high share price have higher vega.

I.4 Gamma, Vega and Risk-Taking Behavior

Vega and Gamma have different implications as measures of risk-taking incentives. As equations (6) and (9) show, gamma is decreasing in volatility, which is consistent with rational expectations of risk-taking (Guay 1999; Belghitar and Clark 2016). Vega, on the other hand, is increasing in volatility (through d_1^O)[45]. Thereby, equation (8) suggests that while volatility is increasing a CEO faces increased incentives to take risk so long as vega is a positive measure of risk-taking incentives. CEOs experiencing conditions of increased volatility should exhibit a declining appetite for risk due to an increase in risk-premia used in discounting projects' expected cashflows—decreasing investment opportunity set with less projects exhibiting positive NPVs (Guay 1999). Gamma follows the behavioral prediction that increasing volatility results in a declining, or negative, incentive.

Equation (9) shows that vega increases exponentially in share price $(i.e.\ lim(S \rightarrow \infty^{+})\ of\ \mathrm{v_P} = \infty^{+})$. Vega also increases as ESOs become more at- or in-the money, an issue which is compounded as time to expiration (or termination) increases. This suggests that CEOs have unbridled incentives to take risk—which is inconsistent with diminishing marginal utility and benefits.

Gamma initially increases as share prices approach strike prices and ESOs are out-of-the money, increasing the incentive to take risk to move the ESOs in-the-money. When ESOs become in-the-money, Gamma begins to converge to zero—consistent with declining marginal utility. Equation (6) shows a negative relationship between gamma and share price, but it is convergent $(i.e.\ lim\ (S \rightarrow \infty)\ of\ \Gamma_p = 0)$ and not exponential[46].

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[45] $\frac{\partial d_1^O}{\partial \sigma} = -\frac{d_2^O}{\sigma}$,implies that d_1^O is increasing in volatility when the ESOs are out-of-the money (so long as $q \leq r + \frac{\sigma^2}{2}$which is normally the case, and increasing in volatility when the ESOs are in the money so long as log-returns relative to the strike remain below the expected return process (*i.e.* $\ln\left(\frac{S_t}{K}\right) < \left(r_t - q_t + \frac{\sigma^2}{2}\right)\tau$).

[46] A negative relationship between firm size and gamma would bias down relationship matching incentives to risk-taking behavior. Where vega is positively associated with firm size and firm size may drive investment in risky projects, a high vega may be associated with high investment in risky projects spuriously. High firm size is associated with slightly lower gamma, but if gamma is positively associated with risky investment the conclusion remains the same. The downward bias in gamma moves against the endogenous relationship vega suffers from.

A positive relationship between share price, or firm size, and vega could explain vega's supposed relationship to risk-taking incentives. Firm size and associational accounting metrics that also vary with firm size—*i.e.* increased R&D intensity, lower CAPEX intensity, increased financial leverage, lower growth rates, higher cash flows, higher dividends and lower firm riskiness—may be the reason behind the positive relation between vega and risk-taking measures (Guay 1999; Core and Guay 2002; Coles *et al.* 2006; Hayes *et al.* 2012; Anderson and Core 2013). Additionally, as the model suggests that gamma is negatively related to firm size, so it is important to test the relationship between gamma and firm-size to see if the negative association holds empirically.

I.5 Gamma, Vega and Time to Termination and Pressure to Perform

It has been theorized that individuals behave irrationally, take on increased risk, or 'go-for-broke' when the expectation of failure is approaching or apparent (Golbe 1988; Eberhart and Senbet 1993). Time to maturity (or termination) (τ) affects gamma and vega differently. Vega, however, decreases as τ approaches 0. Interestingly, increased levels of severance may mitigate the 'go-for-broke' effect, although, this is not observed through vega which exhibits no change with respect to time due to the termination condition. Vega also decreases as ESOs approach their expiration and are near at-the-money.

Gamma increases as τ approaches zero; therefore, as a measure of risk-taking incentives it behaves as predicted by the behavioral literature. Gamma also provides for increased risk-taking if options are near at-the-money and ESOs are expiring is soon; although if ESOs are in-the-money, a CEO has less incentive to increase risk-taking further as they face decreasing marginal incentives the further in-the-money the ESOs become—an artifact of gamma that is in line with the gain and risk-aversion effects under prospect theory (Kahneman and Tversky 1979).

Vega is increasing in time to termination and time to expiration for ESOs. This implies that CEOs who either do not expect to be fired soon or have a long-time until their ESOs expire have an increased incentive to take risk: which is inherently counter intuitive given an implicit reduction in pressure to perform. Gamma, on the other hand, were long-time to maturities exist, dictates a near zero (or negative) incentive to take risk—a rational result if the CEO feels little pressure to perform (Weisbach 1988; Borokhovich, Parino, and Trapani 1996; Fich and Shivdasani 2006; Hsu, Hsiao and Li 2009; Faleye, Hoitash and Hoitash 2011)[47].

Thus, while vega and gamma share similarities, gamma is a direct measure of convexity of compensation portfolios and therefore a better measure of risk-taking incentives.

II. Compensation Portfolios and Convexity

In the previous discussion I have asserted that it is the convexity (*i.e.* shape) of the compensation agreement that drives the incentive to take risk. To visually examine the shape of compensation agreements I depict the present value of contracts across share prices—recalling that share price also acts as the proxy for when the CEO will be terminated. In the following figures, I show CEO compensation portfolios along with gamma and vega for various levels of severance,

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[47] τ's effect on gamma is non-linear.

which generally takes on values equivalent to two or four times cash and bonus compensation, typically ranging from 2 to 8 million dollars[48].

In *Figure 1*, I have used a volatility value of 0% for visual representation of compensation payouts[49]. The magenta line represents a CEO who has no severance compensation agreement. The red line represents the termination barrier, crossing below this line represents the termination event. The black dashed lines, varied by the amount of severance, show how severance directly increases the total payout after the termination event is crossed.

The green line depicts the strike price of the ESOs—represented in the formula as K_o—and is placed arbitrarily at 55. The vertical blue line represents the grant price for shares and is arbitrarily 50 dollars a share. The termination barrier is set at 40 dollars a share—which is represented in the formula as K_Q. Increasing or decreasing the termination barrier, or strike and grant prices, will not largely affect the geometry of the compensation portfolio[50].

When volatility increases to 10% in *Figure 2* it causes a smoothing of the payout function. Increasing volatility further to 20%, 30%, *etc.*, smooths the payout even more. This shows evidence of vega's relationship to smoothness, not convexity, of the compensation portfolio.

In *Figure 3*, I show for a range of share prices the value of gamma on the compensation structure with the same parameters in *Figure 2.* As the gamma for compensation packages with

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[48] In order to remain congruent with reality in which many CEOs face compensation severance that are structured with these sort of provisions, severances may actually change in value over the tenure of the CEO owing to these constructions in the contracts, this is why severance is used here with a subscript for time.

[49] A volatility of 0% results in a completely rigid payout structure, clearly delineating the individual components.

[50] The only impossibility imposed by reality is that the initial termination barrier cannot be above the strike prices for the options or the grant price for the stock—this would imply that the CEO is granted shares for which they may not be able to increase the value of the shares or options and would be nearly immediately terminated. A scenario such as this would be equivalent to functionally saying to the CEO that they will be paid if they raise share price by some improbable amount—say 200%—but fired and lose the value of all of their compensation, except severance pay if applicable, if they do not immediately reach that goal the day they start.

severance is often above the magenta line (no severance), the model predicts that severance should provide increased risk-taking incentives while the CEO is employed under certain values for firm riskiness, time to maturity (termination) and discount rates.

In *Figure 4*, I have depicted vega, using the same parameters in *Figures 2* and *3*. Vega and gamma share a similar structure, but vega is large, and always positive, and would become larger as share prices increase. In *Figure 3*, gamma declines after the ESOs are in-the-money and gamma converges to zero as share prices increase, which is consistent with Kahneman and Tversky (1979) and Tvede (1999). These figures help to understand and think about compensation portfolios as the equations can prove to be unwieldy and difficult to interpret; next I test the intuition of the model and its predictions for associations between vega, risk-taking incentives and firm size empirically.

III. Vega and Gamma and Risk-Taking Analysis

The model predicts a positive relationship between vega and share prices or firm size, but how strong the relationship is, and whether the relationship affects vega's relationship to risky investment, remains an empirical question. In this section I first construct measures of remaining tenure from CEO 'death tables' which is used as τ in the computation of vega and gamma following equations (6) and (8). I then use these vega and gamma estimates in univariate and multivariate tests to determine if there is a link between vega and firm size that might explain vega's relationship to measurements of risky investment such as R&D and CAPEX. Based on the model's predictions, I expect to find a positive relationship between vega and firm size and a negative relationship between gamma and firm size.

Since firm size and investment in R&D Intensity are positively related, and firm size and investment in CAPEX Intensity are negatively related—firm size may drive the positive link between vega and R&D Intensity and the negatively association to CAPEX Intensity (Guay 1999; Core and Guay 2002; Coles *et al.* 2006). The model predicts that gamma is negatively related to firm size, which biases against the likelihood of finding a positive and significant relationship to investment in R&D for gamma. The model also allows me to examine whether including severance in the computation of vega or gamma alters the relationship with firm size and ultimately the relationship to CEO risk-taking.

Lastly, I use simultaneous equation models to test if vega remains a determinant of risk-taking incentives and firm riskiness through diversification (*i.e.* firm focus) when gamma is included in the model. Lastly, I use the simultaneous regressions to test how severance effects the incentives measured by vega and gamma. Based on the model, severance should increase risk-taking incentives using either vega or gamma as a measure—although this depends on a given set of parameters, and empirical tests are necessary to determine the overall effects.

III.1 Data Collection and Univariate Statistics

I collect firm-level variables as measures of firm size from *Compustat* and merge CEO-level variables from *ExecuComp* for all non-missing CEO-firm pairs over the period of 2008 to 2015—resulting in 1,453 unique firms with 1,441 unique CEOs for 6,295 observable firm-year pairs. All variables are winsorized where appropriate at the 1% level. Univariate statistics for variables are reported in *Table 1* and described below.

Share Price is the last price of the firm on the last trading day of the year in any given year (PRCC_F) listed in *Compustat* and has a mean (median) of 37.94 (28.07). *Ln(Assets)* is the natural log of total assets for a firm in a given year and has a mean (median) of 7.39 (7.29). *Ln(Market Value of Equity)* is the log of the market capitalization on the last day of the year in any given year with a mean (median) of 3.24 (3.33); *Ln(Book Value of Equity)* is the log value of reported shareholders equity with a mean (median) of 2.35 (2.43). *Market-to-Book* is a measure of firm value as a ratio of market equity to book equity with a mean (median) of 3.11 (2.33). *Book Leverage* is a measure of book value of debt to total assets with a mean (median) of 21% (18%) and is used to control for the leverage of the firm.

Tobin's Q is a measure of firm value relative to net replaceable assets and has a mean (median) of 84.64 (0.29). *Volatility* is the rolling 60-month variance for a firm's share returns and has a mean (median) of 41% (44%) reported as standard deviation.; *Volatility* may be a determinant of vega and gamma and may also have a relationship to firm size. *Sales Growth*, computed as the log-difference of sales year-over-year, has a mean (median) of 0% (7%). *Surplus Cash*, the cash from assets-in-place divided by total assets (see Coles *et al*. 2006), has a mean (median) of 6% (6%). *Stock Return* is the total holding period return of a firm's shares for a given year and has a mean (median) of 0% (8%). Lastly, *Return on Assets* (ROA) computed as net income over total assets has a mean (median) of 5% (9%) and is used as a measure of firm profitability.

CEO-level variables include *Percentage of Cash-to-Total Compensation* and has a mean (median) of 29% (20%). *Percentage of Stock- and Option-to-Total Compensation* has a mean and median of 47% (55%), and while not used in the estimations as it would sum to 100%, the percentage of compensation that is severance is 24% (20%). These percentages are used to control for the composition of compensation portfolios while being indiscriminate with respect to firm size. CEO compensation *Delta* (or PPS) is a known determinant of vega and has a mean (median) of 542.86 (193.31). It represents a $1000 dollar change in compensation for the CEO given a $1 dollar change in the underlying share price. *CEO Age* has a mean (median) of 55.23 years (55 years), and current continuous *Tenure* has a mean (median) of 5.95 years (5 years). Lastly, using the previous death table analysis, *Expected Remaining Tenure* may be a determinant of vega and gamma as well.

Using 'death table' estimates and estimation method discussed in the next sub-sections *III.2* and *III.3*, vega and gamma are constructed with and without the effect of severance. *Vega* without severance has a mean (median) of 127.21 (142.03); *Vega* with severance has a mean (median) of 118.76 (135.35). *Gamma* without severance has a mean (median) of 0.48 (0.25), and *Gamma* with severance has a mean (median) of 0.27 (0.22). This is initial empirical evidence that severance may not increase risk-taking incentives overall, as theory might suggest, but reduce them.

III.2 Time to Termination and Death Tables

To estimate delta, vega or gamma and include the effects of severance one needs an estimate of when the termination event will occur[51]. The termination of a CEO depends on several factors including firm performance, scandals, age of the CEO, relative tenure to industry medians, general market performance, acquisition performance, entrenchment, CEO matching, and shares ownership (Jovanoic 1979a & 1979b; Hambrick & Mason 1984; Coughlin and Schmidt 1985; Warner *et al.* 1988; Weisbach 1988; Denis *et al.* 1997; Denis and Kruse 2000; Allgood and Farrell 2002; Parino *et al.* 2004; Henderson, Miller and Hambrick 2006; Walters, Kroll and White 2007; Brookman and Thistle 2009; Antia *et al.* 2010).

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[51] I price the termination event at-the-money for simplicity, although a dynamic barrier—were the K is dependent on some function K(.) would prove more realistic—yet infinitely more difficult to handle. There are several papers in the risk literature which deal with Weibull distributions and expectations via AFT or Hazard models that can be employed to estimate a barrier given a host of covariate factors.

In the extant literature there is a select, albeit small, group of papers focused on the decision horizon (*e.g.* career horizon) and termination risk of a CEO and how these measures relate to firm performance. This essay differs in respect to this literature by being the first to construct and examine CEO cohort 'death tables'—the actuarially defined time a CEO will continue to remain in office based on the cohort-year they became CEO[52]. This section is not concerned with the effect of tenure on firm-performance or risk-taking incentives but the prediction of remaining tenure.

The standard method of estimating remaining tenure, as noted in Brookman and Thistle (2009) (BT), is to use a logit model and predict odds of termination. BT extend this literature by using survival analysis to predict the hazard ratio of CEO termination. They find that 82% of CEOs have a tenure lasting less than 13 years, after which the risk of termination tends to fall.

Antia, Pantzalis and Park (2010) (APP) provide a compound method of determining CEO decision horizon based on the CEO's relative tenure and age to the median industry tenure and CEO age. APP show that CEO tenures have on averaged decreased from approximately eight years to four years on a sample running 1996 to 2003. While both methodologies by BT and APP are comprehensive measures and provide a great deal of pertinent information, the hazard ratio measures the instantaneous risk of failure and cannot be used to compute remaining expected time to failure. Additionally, while APP is measured in full years, due to the industry adjusted effects the decision horizon (DH) variable can be negative or positive: making it impossible to construct a measurement of remaining time[53].

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[52] Also called 'life tables' or 'mortality tables'.

[53] Negative where the CEO is older than the median CEO in the industry, or they have remained a CEO longer than the median tenure in the industry.

A solution to this problem is to compute expected remaining tenure as an actuary would compute expected remaining life in pricing a life-insurance contract. Using standard methods of constructing 'death tables', equations for which are given in *Tables 2* and *Appendix III*, I capture each CEO's start year from *ExecuComp* and examine how many CEOs within that start year remain CEO at their firm each year thereafter. I examine this for CEOs in the period of 1997 to 2015 and construct cohort expectations of remaining tenure, a selection of which is presented in *Table 2*[54]. Using these tables, I assign remaining tenure on a per year basis for each CEO cohort. To determine the total tenure a CEO can expect to have, I add the *expected remaining tenure* to their *current tenure* in a given year.

Averaging across the sample I find that CEOs have an expected total tenure term of roughly 16 years, slightly higher than the results found by BT and significantly longer than the 8 to 4 years given by APP. However, while the total tenure term is on average expected to be 16 years, more recently hired CEOs have shorter expected remaining tenure. For the full sample, the rate of decay for expected remaining tenure increases after CEO experiences approximately 8.3 years—the rate of decay increases after only 5.7 years for CEOs who came into office with the past decade (2005 to 2010). After 14 years, CEOs experience a rapid decay of remaining tenure expectancy, as seen in *Table 2: Panel C*. Additionally average expected remaining tenure is 2.98 years, which is directly in line with the 4 years in APP's DH estimation as the CEO can only rationally expect to remain CEO for that much longer[55].

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[54] The sample window runs 1997 to 2015, however the sample pulls back to 1965 to determine CEO survivorship and deletes any who became a CEO before 1965. In the estimates, a only sub-sample of CEOs who have 'died' (were terminated, changed control, or actually died) were used to avoid survivorship bias these estimates were then used to provide predictors to all CEOs (in the next section)—even those who are 'living' (still CEO of the same firm).

[55] All life estimates use a half-year population and death expectation—this is purely for simplicity and is standard in use of actuarial 'crude' measures.

Consistent with BT I find evidence that CEOs who pass the 13-year mark of tenure have decreased likelihood of termination—with the standardized average tenure expectancy increasing, which indicates of a survivorship effect. Much like the life expectation of infants increase significantly once they are over the age of five, so does the tenure expectancy of CEOs—although it warrants stating that very few CEOs ever make it past 'the toddler years'. Those who do make it past 13 years of tenure likely have high levels of entrenchment, percentages of ownership or low governance boards and may remain CEO for quite a long time. For example, within the sample the longest tenure term observed was 53 years. I use the expected remaining tenure estimates produced by these 'death tables' in the construction of estimates for vega and gamma.

III.3 Univariate Analysis of Firm Size and Risk-Taking Incentives

To test whether vega or gamma have a relationship with share price or firm size and the effects severance has on investment and risk-taking behavior, I construct estimates for gamma and vega which include severance. To do so I first need empirical estimates of remaining tenure and use those values in computing vega and gamma. I then compare gamma and vega across different quartiles based on firm size and measures of risky investment to determine if there is a relationship as the model suggests.

To obtain CEO-firm-year specific estimates of remaining tenure, I run a first stage estimation using the cohort *expected remaining tenure* from the death tables as an explanatory variable for a CEO's tenure in any given year, along with covariates to control for firm characteristics, CEO compensation, market cycle characteristics, CEO age, and industry medians for age and tenure which may affect a CEO's likelihood to be terminated in any given year. The first stage estimation of the model is presented in *Table 3: Panel A*. I use results of the fitted model to provide an estimate for τ used to compute gamma and vega for a given CEO in a given year, sample averages are reported with other univariate statistics in *Table 1*.

I break firms into quartiles based on *Share Price*, *Ln(Assets)*, *R&D Intensity*, and *CAPEX Intensity*. I compute the average gamma and vega, each with and without severance, for each quartile as well as the correlation between gamma and vega and the determinants and report the results in *Panel B*.

Table 3, Panel B, reports a positive and significant relationship between vega, share price, and firm size which is consistent with Core and Guay (2002), and my model, but inconsistent with Aggarwal and Samwick (2002). Baker and Hall (2002) suggest that firm size plays a role in CEO incentives so long as the activity of the CEO is considered; however, they note that with respect to firm size CEO incentives are constant or declining ‘slightly’—which is not consistent with *Table 3's* results for vega but is consistent with the result for gamma. Only gamma computed on ESOs alone (*Gamma No Term.*) indicates a negative correlation with firm size—which is to be expected following equation (9).

Panel B also shows there is a positive and significant relationship between R&D intensity and both gamma and vega. There is a negative and significant relationship between vega and CAPEX intensity and no relationship between gamma and CAPEX intensity.

These results are similar to Coles *et al.* (2006)’s findings; however, in Coles *et al.* (2006) R&D intensity and CAPEX intensity are seen as substituted risky investment—were an increase in R&D intensity and decline in CAPEX intensity represented risky project substitution under assumed capital rationing[56]. Since R&D intensity is positively correlated with firm size and CAPEX intensity is negatively correlated to firm-size, the fact that vega is *also* positively related to firm size may indicate that the relationship between vega and R&D intensity or CAPEX intensity is not clear. Since results in *Table 3* and equation (6) suggest gamma is negatively related to firm size and there is a positive and significant relationship to R&D intensity, the relationship between gamma and risky investment at the very least is not being driven by firm size.

Overall, *Table 3* reports initial evidence of a significant and positive relationship between vega, firm size and share price. There is a negative relationship between vega and capital investment, but a positive relationship with vega and R&D. There is a negative relationship between gamma and share price, but only when severance is not included—a result that is consistent with the pricing of ESOs and the effects of moneyness. A positive relationship between gamma and investment in R&D—and a negative relationship to firm size—suggests that the risky investment incentives measured by gamma are not driven by firm size, while vega's may be which is consistent with Core and Guay (2001) that firm size may drive the relationship between delta, volatility and risk-taking in Aggarwal and Samwick (1999). Next I examine these relationships with multivariate analysis to control for other determinants which may affect risk-taking behavior and incentives.

III.4 Multivariate Analysis

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[56] Coles *et al.* (2006)'s argument that investment substitution between R&D and CAPEX suggests increased risky investment—as R&D is proposed to be riskier than CAPEX—rests upon the assumption that CAPEX relates solely to investment in property, plant and equipment (PP&E). However, capital spending includes cashflows for acquisitions as well—which may be significantly riskier than R&D due to uncertainty. A decrease in CAPEX intensity and an increase in R&D intensity may not indicate a substitution affect occurs, since one needs to disentangle spending on PP&E and M&A.

To further examine the relationship between vega, gamma and firm size I run OLS regressions testing determinants of vega and gamma. Additionally, to examine how severance affects these relationships, I run OLS on vega and gamma with severance included. Results from the OLS regressions are reported in *Table 4*.

In *Panel A*, vega is the dependent variable and does not have severance included in its computation. The results show that *Share Price*, *Ln(Assets)*, and *Ln(Book Value of Equity)* have a positive and significant relationship with vega. When included together in Model 6, *Share Price* and *Ln(Assets)* remain key determinants of vega, while there is a negative and significant relationship between *Ln(Market Value of Equity)* and vega. This may be an effect through volatility as large market capitalizations lead to reduced share volatility. Interestingly, long-run share volatility appears to be negatively, but insignificantly, related to vega. *Delta* and *Percentage of Stock- and Option-To-Total Comp*. are positive and significant determinants of vega, as expected.

Panel B shows the same OLS regressions of firm size on vega with severance. Results remain similar except for the relationship between share price and vega which is now insignificant. The results in Panel A and B suggest that vega does have a positive and significant relationship with firm size either through share price or size of assets, and that severance does not alter this relationship, which is consistent with the predictions of the model and equation (8).

Next, Panel C and D test the relationship between *Gamma* and share price as equation (6) suggests a negative association due to ESOs; however, when severance is included the negative relationship to share prices is mitigated and there should be no effect. Results in Panel C show that there is a negative and significant relationship between *Gamma* (without severance) and share price, and other measures of firm size are negatively associated with *Gamma* as well. When all included in Model 6 of Panel C, only *Ln(Assets) and Ln(Market Value of Equity)* have continued negative and significant relationships with *Gamma*, while *Market-To-Book* is also positive and significant indicating that a relationship between firm value and gamma may exist.

The same tests are run for *Gamma* with severance and results are reported in Panel D. Panel D reports no relationship between share price and measures of firm size and *Gamma* with severance. It is worth noting that in both Panels C and D, adjusted R-squared of the regressions are low or negative, indicating these determinants do a poor job of explaining the variation of gamma compared to Panels A and B where the adjusted R-squared is relatively high.

Results in *Table 4* have similar implications to *Table 3*: gamma without severance has a negative relationship with share price and a positive relationship with firm value, but when severance is included these relationships cease to exist. Vega has a consistently positive and significant relationship with firm size regardless of whether severance is included or not which is consistent with the arguments of Guay (1999), Core and Guay (2001).

The results from both *Tables 3* and *4* suggest that vega is indeed related to firm size, and gamma—especially when severance is included—is not. Given that results from *Table 3* suggest that gamma is positively related to R&D intensity and results in both *Table 3* and *4* show gamma has a negative relation to firm size, which is consistent with the model: it seems that gamma's relationship to risky investment is not driven by firm size.

Vega, on the other hand, does appear to have a strong relationship with firm size which may be the driver of the proposed link between vega and risky investment. Next, I examine whether gamma or vega is a better measure of risky investment and firm focus as reported in Coles *et al.* (2006). If gamma and vega are placed in the same model, since vega appears to be related to firm size and gamma is a true measure of convexity (*i.e.* incentives), I should expect to see that gamma is a more significant determinant of risky investment or firm focus than vega.

III.5 Simultaneous Equations on Risk-Taking and Firm Focus

If gamma is a better measure of risk-taking incentives than vega, then it is appropriate to test gamma where vega has been used in the past to see if different results arise. Given that I have constructed gamma and vega with severance it is worthwhile to test the effects of severance as well. Coles *et al.* (2006) showed strong evidence that vega is positively related to investment in risky projects and improved firm focus, therefore I re-run their simultaneous equation regression (3SLS-SSE) models using the same construction of variables found in their paper.

In running the models, I first estimate my sample in the same tests as their SSEs: results remain similar although there are slight differences in size of the estimates which may result from different sample periods. Estimates from these 'calibration' tests are reported in Model 1 of *Table 5* and *6*.

First, in *Table 5*, I run a test on investment behavior of CEOs using investment in R&D and CAPEX as proxies for risky investment, much like before in *Table 2*. Having established similar results to Coles *et al.* (2006) in Model 1, I re-run the test and include *Gamma* (without severance) and report the results as Model 2 of *Table 5*. Estimates indicate that while the relationship of vega to R&D and CAPEX is the same as that found under Coles *et al.* (2006) the effect is reduced, and *Gamma* shows positive, significant and admittedly large effect on both R&D and CAPEX. This implies that gamma is a stronger determinant of risky investment than vega.

In Model 3, I include the effect of severance in the computations for gamma and vega and re-run the SSE for R&D and CAPEX. Results indicate that the effect of vega is unchanged, but the effect of gamma is reduced almost entirely. Additionally, gamma shows a negative and significant relationship with R&D, which implies a reduction in incentives to invest in risky projects. Severance does not seem to affect vega's measurement of risk-taking incentives, which is interesting since it is known that severance does affect incentives in some way. The results from Model 3 do, however, indicate that severance reduces risk-taking incentives—which is empirically different than what the model might initially suggest. In terms of the model in Section 1, Equation (6) suggests that severance can reduce overall gamma when volatility and dividend yield is high, and discount rates are low. Noting the sample period of 2008 to 2015—it is entirely consistent given interest rate and volatility regimes that severance does reduce risk-taking incentives.

Next, I test the relationship between vega, gamma and firm focus. Firm focus is a measure of CEO investment diversification and thereby firm riskiness. CEO's with high risk-taking incentives may not diversify and increase firm focus, CEOs with limited incentives to take risk may diversify the portfolio of the firm to reduce firm cash-flow variability. Therefore if gamma, or vega, are true measures of risk-taking incentives, then there should be a positive relationship between gamma, vega, and measures of firm focus (Amihud and Lev 1981; Comment and Jarrell 1995; Coles *et al.* 2006).

Using the Herfindahl-Hirschmann-Index (HHI) on segment sales, which has a mean (median) of 0.20 (0.23), and the log number of business segments reported in *Compustat*, which has a mean (median) of 0.79 (1.61), I re-run the SSE estimations in the same construction as Coles *et al.* (2006).

Calibration tests reported in Model 1 of *Table 6* show similar results to Coles *et al.*: a positive and significant relationship between sales concentration and vega and a negative and significant relationship to the number of segments. In Model 2, when *Gamma* (without severance) is included in the model, results indicate that vega now has a negative and significant relationship with sales concentration and a positive and significant relationship with number of segments. *Gamma*, on the other hand, reports results similar to those found originally in Coles *et al.* (2006), but which are much larger.

When severance is incorporated in Model 3, vega again shows little change, but, as in *Table 4*, the effect of gamma is significantly reduced. With severance, gamma appears to have a negative and significant relationship with sales concentration but a positive and significant relationship to number of segments. The difference of results between Models 2 and 3 indicates that severance may move CEOs towards segment diversification and result in a reduction of firm focus.

Results of the SSE's in *Table 5* and *6* provide evidence that gamma has a stronger relationship to risky investment measured through R&D and CAPEX than vega when included in the same model as vega. When severance is included vega shows little change to incentives, gamma indicates a complete reduction in the incentive to invest in risky projects. Additionally, when gamma is included in the same model as vega, vega becomes associated with reduced firm focus and gamma is strongly positively related with firm focus. When the effect of severance is included, gamma again shows a reduction in firm focus while vega shows little change.

Overall the empirical results show that vega has a positive relationship with firm size. When gamma is included in simultaneous equations with vega, vega's role as a determinant of risk-taking incentive or firm riskiness through diversification is significantly reduced. Gamma's effects are consistent with what would be expected as a measure of risk taking incentives; Gamma is positively related to investment in R&D, and there is some evidence to suggest gamma may be a determinant of investment in capital expenditure as well. Gamma is also positively related to firm focus—suggesting CEOs with high gamma have reduced risk-aversion and less need to diversify, consistent with gamma being a measure of risk-taking incentives. While initially vega appears to be positively related to firm focus—the relationship reverses when gamma is included in the same model.

Lastly, vega does not seem to be affected by the inclusion of severance, while it is known that severance affects CEO risk-taking incentives. Gamma shows a marked change in it's relationship to risky investment and firm focus when the effects of severance are included. This suggests that severance, however theoretically useful in providing incentives to invest in variance increasing projects or reduce CEO risk-aversion, is empirically shown to reduce these incentives overall.

V. Discussion and Conclusion

Implications of CEO risk-taking incentives based on vega and gamma are different, and this is supported by the empirical evidence. Relationships between vega, firm size, share prices, and volatility indicate that gamma may be a better estimate of risk-taking incentives than vega. Additionally, the model suggests gamma fits the behavioral aspects of CEO risk-taking incentives more appropriately, particularly with respect to time to termination, declining utility of wealth, and prospecting (Kahneman and Tversky 1979). Lastly, gamma is a direct measure of convexity of the CEO compensation structure with respect to firm wealth.

This essay contributes a flexible model of compensation portfolios which includes severance compensation and accounts for the loss of cash and other compensation upon termination. To do so I use 'death tables' as a novel way to construct estimates of remaining tenure. Thereby, I bridge the gap in the literature allowing measurements of CEO risk-taking to be computed which also include the incentives of severance.

These extensions to the theory and mechanical analysis of CEO compensation, as well as the nicety of CEO ‘death tables’, open a field of research which can be expanded into examining the total effects of risk-taking and to finally begin to answer the question as to whether severance *does or does not* increase CEO risk-taking. Preliminary results suggest that it may not always be the case, although this is left to further research.

With respect to this essay, however, the figures presented depict that under ‘normal’ circumstances severance does increase the overall risk-taking incentives of a CEO (*e.g.* values above the magenta line) and suggests that under some circumstances the literature is correct and severance helps to induce risk-taking[57]. Empirically, however, results indicate that when severance is included in the measures of risk-taking incentive there is a significant decline in investment in risky projects and firm focus. This leads to the conclusion that severance *could* provide incentives to invest in variance increasing projects but under current market and firm specific parameters, it *may not* do so.

These results are important for the field and for practitioners alike—CEOs in theory benefit from severance agreements as far as risk-taking is concerned, but reality may be far different. Additionally, this essay provides practitioners a means of measuring CEO incentives based on proposed, or already agreed upon, compensation packages which include the effects of severance. Lastly, as an empirical observation to contemporary CEOs, we can say that time in office is a declining function, particularly with respect to older CEOs, and that decision and career horizons are diminishing rapidly at the time of this writing. This increased pressure to perform is likely to be met with increased, and indiscriminate, risk-taking: which is a concerning paradox for CEOs

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[57] See increased gamma above termination barrier in *Figure 3* for increased levels of severance. However, the normality of circumstances depends on factors which make the current market, not normal. In cohesion with the results found in Muscarella and Zhao (2017), interest rates may affect CEO risk-taking incentives negatively.

and the greater market. As CEOs struggle to meet performance standards they may invest in less worthwhile projects or invest in ways which improve performance or cut costs at the expense of stakeholders, such as employees—and severance will provide a fall back to the CEO, regardless.

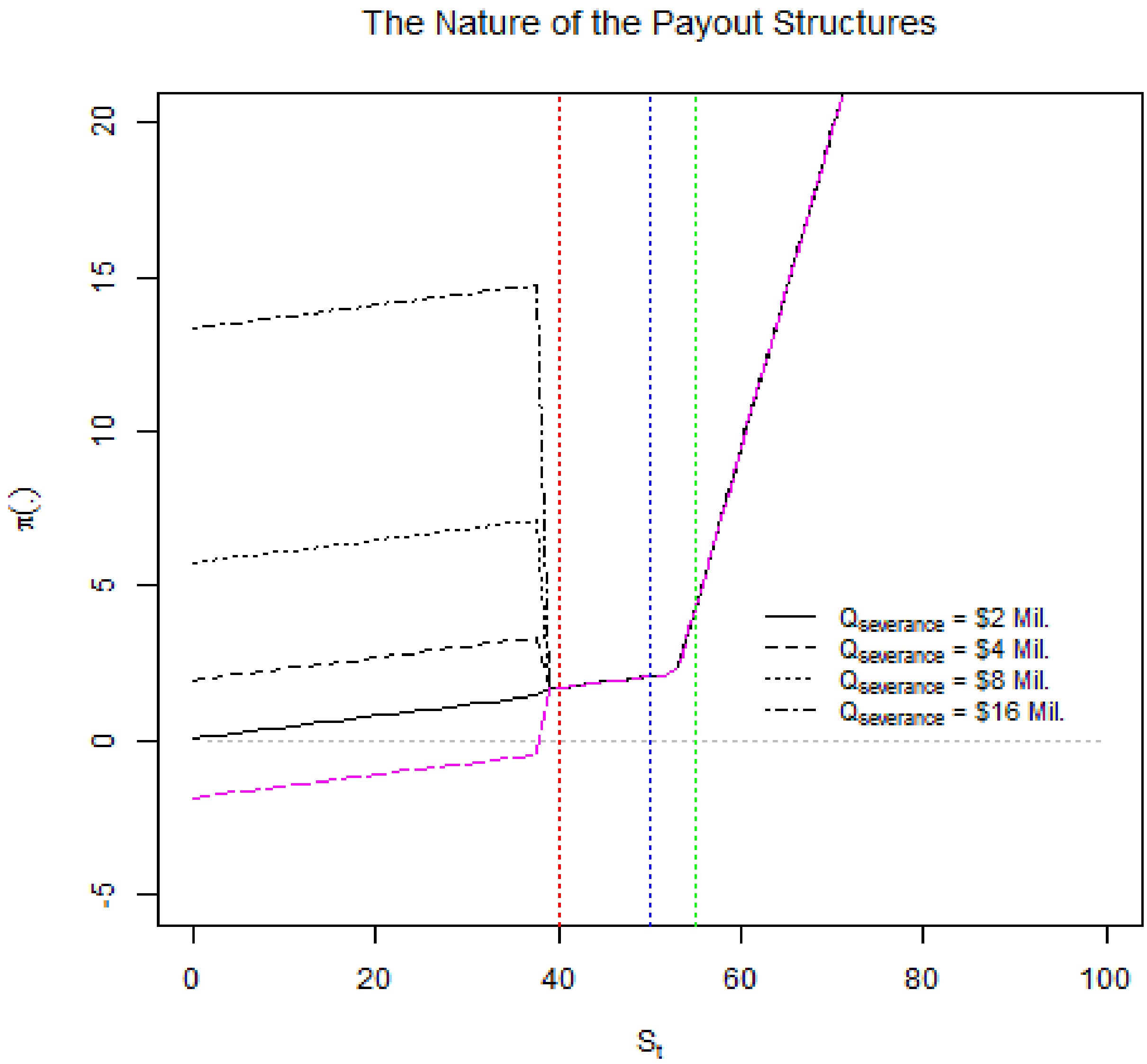

Figure 1: The Nature of Payouts. *A graphical representation of payouts. Here the amount of severance, Q, is given at various parameters, 2, 4, 8 and 16 million. The other parameters in the depiction are taken from the averages or medians experienced by CEOs within the larger sample C = 0.876; g = 1/27; q = 1.08%; Oth. = 1.294; T = 10; rf = 0.25%; STD = 0%, where the rf represents the current rate regime and is 0.25%. The red vertical dotted line indicates the termination barrier—proxied by the strike of the digital call and put options which is arbitrarily set at 40. The green line represents the strike of the vanilla call-options again arbitrarily set at 55. The blue vertical dotted line represents the share price issuance for the granted shares, here give at B = 50. The magenta hashed-line represents a payout portfolio in which the CEO is not compensated with a severance contract.*

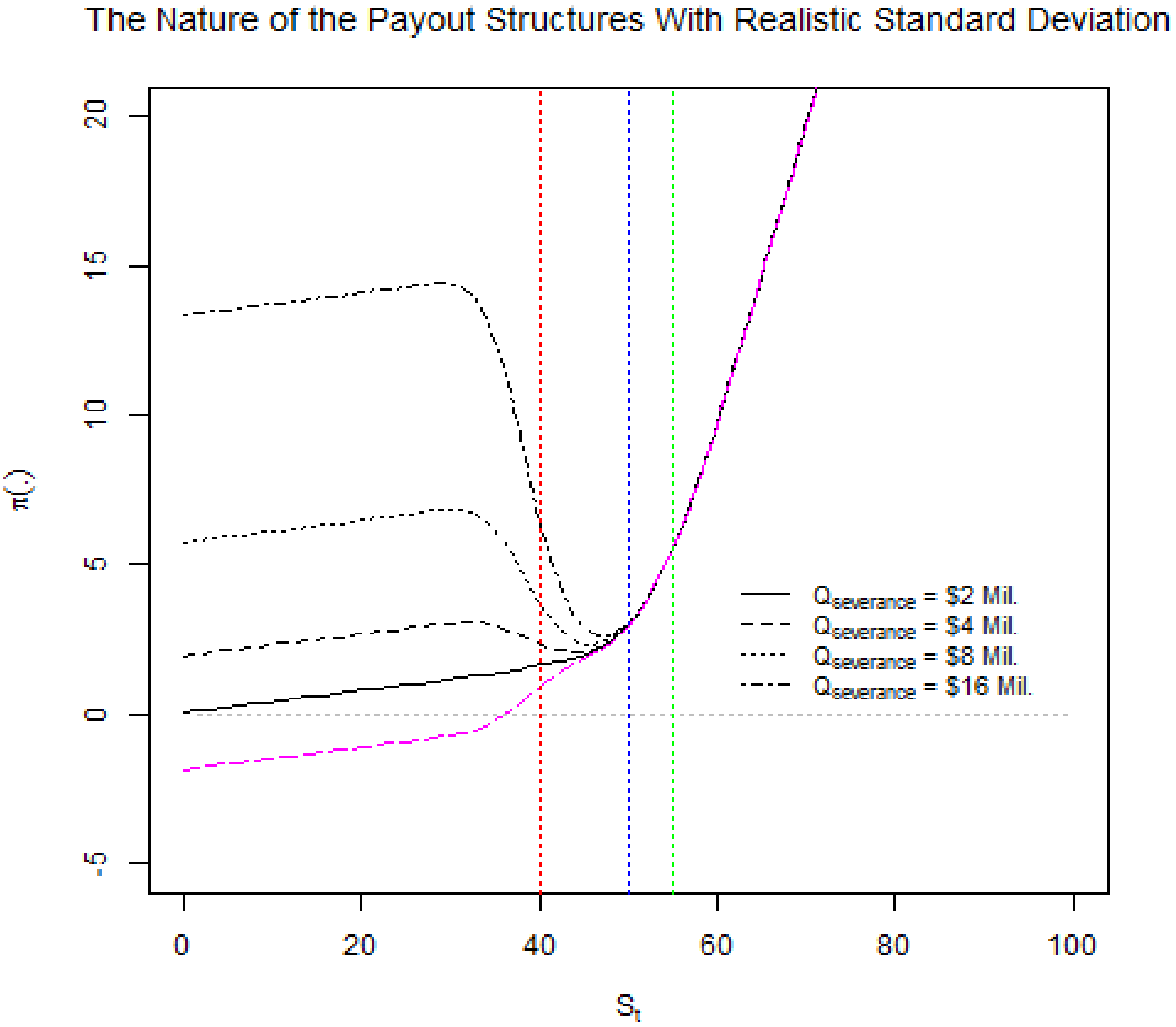

Figure 2: The Nature of Payout Structures with Realistic Standard Deviation: *A graphical representation of payouts. Here the amount of severance, Q, is given at various parameters, 2, 4, 8 and 16 million. The other parameters in the depiction are taken from the averages or medians experienced by CEOs within the larger sample C= 0.876; g = 1/27; q = 1.08%; Oth. = 1.294; T = 10; rf = 0.25%; STD = 10%, where the rf represents the current rate regime is 0.25%. The red vertical dotted line indicates the termination barrier—proxied by the strike of the digital call and put options which is arbitrarily set at 40. The green line represents the strike of the vanilla call-options again arbitrarily set at 55. The blue vertical dotted line represents the share price issuance for the granted shares, here give at B = 50. The magenta hashed-line represents a payout portfolio in which the CEO is not compensated with a severance contract.*

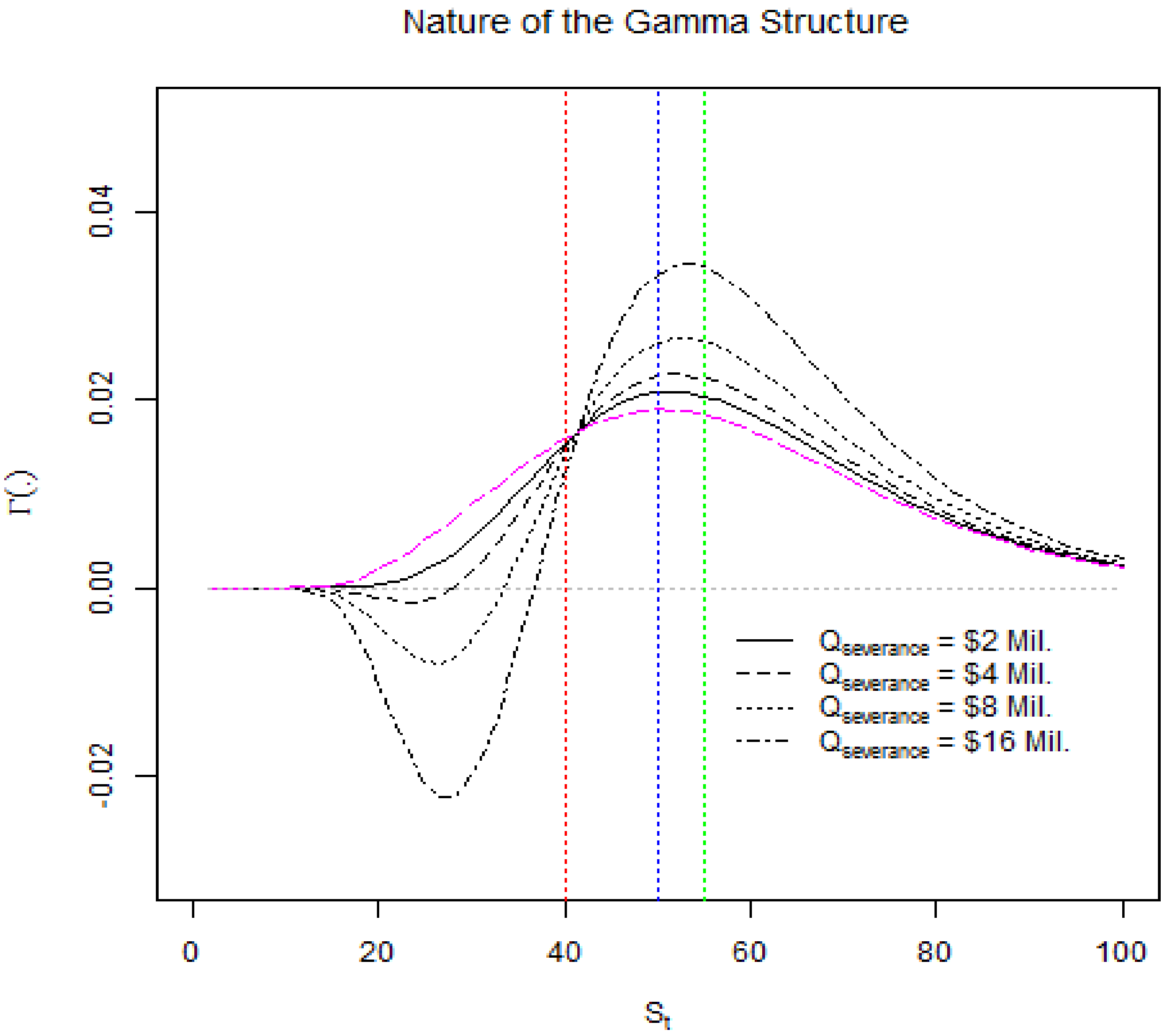

Figure 3: Nature of the Gamma Structure *A graphical representation of the gamma of the compensation structure. Here the amount of severance, Q, is given at various parameters, 2, 4, 8 and 16 million. The other parameters in the depiction are taken from the averages or medians experienced by CEOs within the larger sample C = 0.876; g = 1/27; q = 1.08%; Oth. = 1.294; T = 10; rf = 0.25%; STD = 10%, where the rf represents the current rate regime and is 0.25%. The red vertical dotted line indicates the termination barrier—proxied by the strike of the digital call and put options which is arbitrarily set at 40. The green line represents the strike of the vanilla call-options again arbitrarily set at 55. The blue vertical dotted line represents the share price issuance for the granted shares, here give at B = 50. The magenta hashed-line represents a payout portfolio in which the CEO is not compensated with a severance contract.*

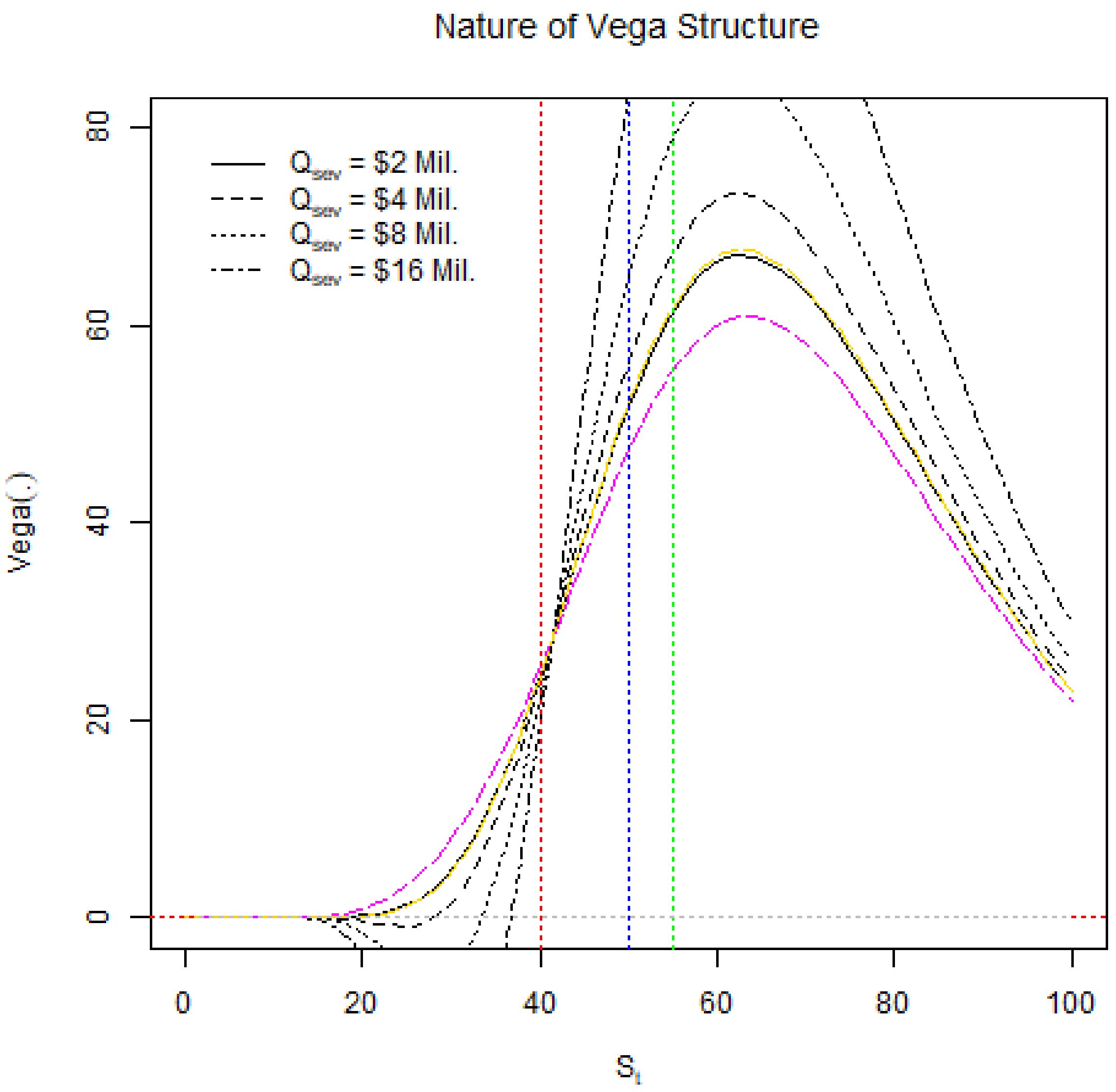

Figure 4: Nature of the Vega Structure *A graphical representation of the vega of the compensation structure. Here the amount of severance, Q, is given at various parameters, 2, 4, 8 and 16 million. The other parameters in the depiction are taken from the averages or medians experienced by CEOs within the larger sample C= 0.876; g = 1/27; q = 1.08%; Oth. = 1.294; T = 10; rf = 0.25%; STD = 10%, where the rf represents the current rate regime and is 0.25%. The red vertical dotted line indicates the termination barrier—proxied by the strike of the digital call and put options which is arbitrarily set at 40. The green line represents the strike of the vanilla call-options again arbitrarily set at 55. The blue vertical dotted line represents the share price issuance for the granted shares, here give at B = 50. The magenta hashed-line represents a payout portfolio in which the CEO is not compensated with a severance contract.*

Table 1: Univariate Statistics

Variable	**Obs.**	**Mean**	**S.D.**	**Min**	**0.25**	**Median**	**0.75**	**Max**
Expected Remaining Tenure	6,295	2.98	2.19	0	1.06	2.58	4.53	14.84
Expected Total Tenure	6,295	10.52	7.64	0	5.00	8.70	13.89	51.00
Current Tenure	6,295	7.91	7.28	1.00	3.00	6.00	11.00	53.00
Continuous Tenure	6,295	5.95	4.27	1.00	3.00	5.00	8.00	22.00
CEO Age	6,273	55.23	7.25	28.00	50.00	55.00	60.00	76.00
Total Compensation (severance included) (thousands)	6,295	24,890	35,038	0	5,071.79	12,300.52	29,506.57	410,000.00
Severance to Total Comp	6,295	0.24	0.23	0	0	0.20	0.42	1.00
Cash to Total Comp	6,295	0.29	0.26	0	0.10	0.20	0.38	1.00
Stock and Option to Total Comp.	6,295	0.47	0.38	0	0.24	0.55	0.78	1.00

Variable	**Obs.**	**Mean**	**S.D.**	**Min**	**0.25**	**Median**	**0.75**	**Max**
Delta	6,295	542.86	1,043.04	0	58.64	193.31	548.38	7,277.54
Vega (without severance)	6,295	127.21	210.43	0	11.93	47.39	142.03	1,242.79
Total Vega (with severance)	6,295	118.76	216.05	0.00	8.94	43.52	135.35	1,460.79
Gamma (without severance)	6,295	0.48	2.75	0	0.01	0.07	0.25	106.25
Total Gamma (with severance)	6,295	0.27	4.93	(253.67)	0.01	0.06	0.22	106.22

Variable	**Obs.**	**Mean**	**S.D.**	**Min**	**0.25**	**Median**	**0.75**	**Max**
Price Per Share	6,295	37.94	46.80	1.00	15.07	28.07	47.44	920.00
Ln(Assets)	6,295	7.39	1.63	2.03	6.25	7.29	8.45	13.59
Ln(Market Value of Equity)	6,261	3.82	2.54	0	1.92	3.80	5.55	12.14
Ln(Book Value of Equity)	6,163	2.35	0.90	0	1.90	2.43	2.93	6.10
Market-To-Book	6,288	3.11	3.51	0	1.46	2.32	3.69	22.06
R&D Intensity	6,295	0.03	0.05	0	0	0.01	0.05	0.27
CAPEX Intensity	6,295	0.25	0.16	0.02	0.13	0.20	0.32	0.80
HHI	6,295	0.20	0.16	0.03	0.09	0.14	0.23	1.00
Ln(Number of Segments)	6,295	0.79	0.95	0	0	0	1.61	4.60
Volatility	6,295	0.41	0.04	0.33	0.38	0.44	0.45	0.45
Tobin's Q	6,295	84.64	375.51	0	0	0.29	12.60	3,059.31
Sales Growth	6,283	0	1.07	(8.95)	(0.06)	0.07	0.19	8.44
Book Leverage	6,270	0.21	0.20	0	0.03	0.18	0.31	3.47
Return on Assets (ROA)	6,295	0.05	0.33	(2.20)	0.02	0.06	0.09	24.09
Stock Return	6,294	0	0.78	(4.77)	(0.27)	0.08	0.35	4.12
Surplus Cash	6,289	0.06	0.10	(2.45)	0.02	0.06	0.11	0.86

TABLE 2: CEO LIFE TABLES

The life tables are computed using standard mortality and life analysis on a cohort basis (using so-called 'crude' estimates). (e.g. see , *Life Table and Mortality Analysis, Chin Long Chiang* and other texts) The estimates given in the tables follow the equations in the panel sections. The tables provide some information such as an immediate decline in the expected tenure over time, while not all estimates are reported for brevity, those values occuring the future are forecasted using a linear time-series. I adjusted the analysis using 'Expected Life At Birth' calculations (reported in the appendix as Standardized), to curtail the declining effect of year over year estimation--however the decline was persisitent. It appears that more recent CEOs simply face declining career terms at a given firm. These findings are consistent with those of Antia, Pantzalis and Park (2010), although results here present slightly higher numbers than their estimates. Tables are a selected excerpt of CEOs who became CEOs from 1998 to 2010, it does not display all values used in the later regression analysis.

PANEL A: Survivorship $l_x = \frac{n_x}{n_o}$

Year Became	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Tenure Year													
1999	1.000	1.000											
2000	1.000	1.000	1.000										
2001	1.000	1.000	1.000	1.000									
2002	1.000	1.000	1.000	1.000	1.000								
2003	1.000	1.000	1.000	1.000	1.000	1.000							
2004	1.000	1.000	1.000	1.000	1.000	1.000	1.000						
2005	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000					
2006	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000				
2007	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000			
2008	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000		
2009	0.950	1.000	1.000	0.955	1.000	1.000	1.000	0.988	0.987	0.988	1.000	1.000	
2010	0.900	0.964	0.919	0.955	0.939	1.000	0.951	0.950	0.924	0.964	0.989	1.000	1.000
2011	0.850	0.821	0.865	0.909	0.898	0.927	0.869	0.913	0.873	0.892	0.943	0.925	1.000
2012	0.800	0.714	0.865	0.864	0.878	0.818	0.820	0.888	0.848	0.867	0.897	0.875	0.976
2013	0.750	0.643	0.838	0.818	0.837	0.764	0.787	0.863	0.810	0.819	0.816	0.863	0.941
2014	0.700	0.607	0.838	0.818	0.776	0.745	0.787	0.825	0.772	0.795	0.805	0.788	0.906
2015	0.650	0.536	0.784	0.773	0.673	0.709	0.738	0.750	0.747	0.771	0.747	0.750	0.847
2016	0.500	0.536	0.676	0.705	0.633	0.655	0.689	0.688	0.671	0.711	0.713	0.688	0.741

PANEL B: Average Remaining Tenure $e_x = \Sigma \sum_{i=x}^{X} \frac{L_x}{n_x}$ $L_x = \frac{\mathrm{n_x} + \mathrm{n_{x-1}}}{2}$

Year Became	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Tenure Year													
1999	15.600	15.595											
2000	14.600	14.595	15.870										
2001	13.600	13.595	14.870	14.939									
2002	12.600	12.595	13.870	13.939	13.594								
2003	11.600	11.595	12.870	12.939	12.594	12.564							
2004	10.600	10.595	11.870	11.939	11.594	11.564	11.740						
2005	9.600	9.595	10.870	10.939	10.594	10.564	10.740	11.021					
2006	8.600	8.595	9.870	9.939	9.594	9.564	9.740	10.021	9.763				
2007	7.600	7.595	8.870	8.939	8.594	8.564	8.740	9.021	8.763	9.032			
2008	6.600	6.595	7.870	7.939	7.594	7.564	7.740	8.021	7.763	8.032	8.014		
2009	5.921	5.595	6.870	7.293	6.594	6.564	6.740	7.116	6.856	7.123	7.014	6.888	
2010	5.222	4.783	6.432	6.293	5.992	5.564	6.063	6.377	6.292	6.289	6.090	5.888	6.378
2011	4.500	4.528	5.803	5.583	5.241	4.961	5.588	5.619	5.627	5.758	5.363	5.324	5.378
2012	3.750	4.133	4.803	4.850	4.351	4.556	4.893	4.763	4.780	4.904	4.612	4.600	4.496
2013	2.967	3.536	3.942	4.092	3.539	3.846	4.076	3.887	3.981	4.164	4.018	3.660	3.646
2014	2.143	2.715	2.942	3.092	2.779	2.927	3.076	3.040	3.152	3.275	3.068	2.961	2.768
2015	1.269	2.010	2.110	2.244	2.125	2.052	2.248	2.295	2.242	2.361	2.265	2.084	1.926

Panel C: Standardized Cross-Cohorot Averages (see Appendix for Standardized formula)

Tenure Year	1	2	3	4	5	6	7	8	9	10	11	12	13
CS Remaining Tenure	14.751	13.807	12.880	11.991	11.114	10.416	9.911	9.314	8.837	7.849	7.099	6.389	6.042
Ten Year (cont.)	14	15	16	17									
CS Remaining Tenure	5.753	3.798	1.091	0.431									

Table 3: Estimating Gamma and Vega and Quartile Estimates

In Panel A, the results of the first stage estimation are presented, the estimation performed extremely well with an adjusted R-square of 0.9937 and residual analysis shows randomly distributed errors. The sample runs on those CEOs who were terminated within the period of 2007 to 2015 (2014 being the final observed termination year). We used the expected remaining tenure predicted from the life analysis calculations in section III. The CEOs current tenure is their tenure in any given year. Other variables follow the construction of Antia, Pantzalis, and Park (2010). Average Industry Tenure and Average Industry age are determinants used where Antia, Pantzalis and Park (2010) used Decision Horizon as a dependent, then independent in a 2SLS framework. Current age is the current age of the CEO in that given year, Ln(Assets) proxies for firm size, ECOMP is the percentage of equity compensation in the portfolio--my results show this is not a significant predictor. SCOMP is the percentage of severance compensation which is also not a significant predictor in a linear framework. Volatility is the historical 60 month volatility of the firm, financial leverage is the debt to equity ratio using market values. Percentage Ownership is the percentage of shares held by the CEO used as a proxy for CEO control we show significance but a negative expectation on max tenure, it is likely that the effect is non-linear. Tobin's Q is the relative measure of firm value. The bulk of the predictive power focuses in E(Remaining Tenure) and Current Tenure, each with a T-score of 114.25 and 443.53 respectively. The negative and significant effects on year dummies represents the incrased termination haxard contemporary CEOs face. Predicted Averages provided below.

$$Max\ Tenure\,e_{it} = a_i + \gamma_{it}\,E(Remaining\ Tenure)_{it} + \beta_{it}\,(Current\ Tenure\,e_{it}) + B\mathbf{X_{it}} + \boldsymbol{AZ_t} + \mathrm{e_{it}}$$

In Panel B, the predicted estimates from the above equation taken from the results in Panel A, are used to compute gamma and vega, which I then examine across quintiles of certain determinant variables of CEO risk-taking including share price, firm size, R&D intensity, and CAPEX intensity. I also compute the correlations which are reported in the fifth column. Total observations used in Panel B is 6,295, recall that the 1886 in Panel A are only of CEOs who were terminated in the period, the predictors are applied to all CEOs based on predictive covariates. The T estimate used for gamma and vega is computed from Max Tenure - Current Tenure for a given CEO-year. The results indicate a relationship between vega and share price and firm size, where there is little evidence of such a relationship for gamma (ESO gamma should decline slightly with share price, as the -0.1759 correlation predicts). We also see that despite no relationship gamma is predictive of increased R&D expenditure, and has a non-linear relationship with CAPEX expenditure, which is not inconsistent with the literature. Firms with low CAPEX expenditure may be using the funds in more risky projects, where as firms with extremely high CAPEX expenditure are likely taking risks through their CAPEX. Gamma presents results which are consistent with these scenarios. Gamma and Vega No Term. are estimated for just ESOs, Total Gamma and Vega include the entire compensation portfolio (i.e. severance, cash, other.) Standard deviations are given in parentehsis in Panel B, ***, **, * indicates signifiance at 1%, 5%, and 10% level respectively.

Panel A		
Dependent Varaible	Max Tenure	
Predictor	Beta	P-Value
E(Remaining Tenure)	**1.0694**	**0.000**
Current Tenure	**0.9959**	**0.000**
Average Industry Age	-0.0132	0.158
Average Industry Tenure	**0.0179**	**0.068**
Current Age	**-0.0086**	**0.000**
Ln (Assets)	**0.0292**	**0.001**
ECOMP	-0.0604	0.283
SCOMP	-0.0691	0.241
Volatiltiy	-0.1903	0.822
Financial Levearge (mkt.)	0.0297	0.634
Percent Ownership	**-0.5553**	**0.072**
Tobin's Q	0.0000	0.459
Constant	**1.5300**	**0.010**
Year		
2007	0.0144	0.826
2008	**-0.2746**	**0.000**
2009	**-0.2375**	**0.007**
2010	**-0.3361**	**0.000**
2011	**-0.3857**	**0.000**
2012	**-0.5086**	**0.000**
2013	**-0.5314**	**0.000**
2014	**-0.5141**	**0.000**
Adj -R	**0.9937**	***
Obs.	1886	
Predicted Averages (Applied Sample 2007-2014)		
Remaining Tenure (T)	2.982	(2.190)
(Mean) Max Tenure	10.894	(0.096)
Gamma No Term.	0.478	(0.035)
Vega No. Term	127.206	(2.652)
Total Vega	118.764	(2.723)
Total Gamma	0.266	(0.062)

Panel B					
Quartile	1st	2nd	3rd	4th	Correlation
Share Price					
Gamma No Term.	0.233	1.477	0.133	0.069	-0.1759 ***
	(0.494)	(5.344)	(0.270)	(0.121)	
Vega No Term.	44.541	95.978	142.614	225.811	0.3137 ***
	(79.906)	(155.310)	(206.491)	(293.838)	
Total Gamma	0.197	0.687	0.118	0.060	-0.0444
	(0.498)	(9.840)	(0.270)	(0.122)	
Total Vega	39.241	90.799	137.306	207.826	0.2858 ***
	(84.018)	(159.523)	(208.179)	(309.219)	
Firm Size (Ln(Assets))					
Gamma No Term.	0.664	0.297	0.433	0.520	0.0203
	(3.280)	(1.043)	(3.246)	(2.792)	
Vega No Term.	28.447	58.866	127.953	293.599	0.4593 ***
	(40.998)	(90.355)	(165.599)	(312.803)	
Total Gamma	0.215	0.081	0.339	0.428	-0.0124
	(7.186)	(4.846)	(3.379)	(3.293)	
Total Vega	26.157	54.246	117.544	277.152	0.4224 ***
	(41.566)	(96.155)	(179.906)	(325.028)	
R&D Intensity					
Gamma No Term.	0.380	0.282	0.382	1.179	0.0776 ***
	(2.665)	(0.846)	(1.178)	(4.681)	
Vega No Term.	109.263	167.733	156.953	132.539	0.0684 ***
	(185.431)	(233.998)	(254.944)	(225.994)	
Total Gamma	0.196	-0.098	0.284	0.902	0.0399 ***
	(4.394)	(8.645)	(0.991)	(4.250)	
Total Vega	99.663	159.641	150.526	126.613	0.0735 ***
	(195.408)	(234.084)	(254.217)	(228.708)	
CAPEX Intensity					
Gamma No Term.	0.580	0.371	0.384	0.576	0.0070
	(2.144)	(2.329)	(3.177)	(3.175)	
Vega No Term	108.719	169.203	141.035	89.821	-0.0451 ***
	(182.325)	(256.123)	(224.859)	(155.202)	
Total Gamma	0.400	0.037	0.164	0.462	0.0001
	(2.658)	(7.166)	(5.702)	(2.519)	
Total Vega	100.896	159.783	131.609	82.726	-0.0428 ***
	(189.919)	(256.811)	(228.779)	(170.133)	

Table 4: OLS Regressions on Measures of Incentives and Firm Size

Table 4: OLS Regressions on Measures of Incentives and Firm Size: OLS estimations of determinants of Vega, without severance in Panel A and with severance in Panel B, and Gamma, without severance in Panel C and with severance in Panel D. Measures of firm size include the natural log of share price, log assets, log market value of equity, log book value of equity, and market-to-book ratio. Compensation controls includes percentage of cash-to-total compensation (inclusive of other compensation), the percentage of stock and options to-total compensation, and expected remaining tenure. Controls for risk and valuation include book leverage (debt divided by total assets), Tobin's Q, and firm volatility computed using rolling 60-month periods of returns. Results in Panel A indicate that share price (model 1), log assets (model 2), and book value of equity (model 4) are positive and significant determinants of vega. Model 6 shows that when all included share price, log assets, and log market value of equity are all significant determinants of vega--however log market value of equity is negative, which may point to an effect through volatility as larger market capitalization leads to reduced volatility--and thereby lower vega. Panel B shows similar results except share price becomes insignificant as a determinant of vega--yet firm size still appears significant. Values reported in square brackets are t-stats, ***, **, and * represent significance at the 1%, 5%, and 10% levels.

Dependent Variable	Panel A: Vega (not incl. severance)						Panel B: Full Comp. Vega (incl. severance)					
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Share Price	0.325*					0.396*	0.136					0.162
	[1.65]					[1.83]	[0.68]					[0.74]
Ln(Assets)		24.88***				26.13**		20.46**				25.45*
		[2.85]				[2.29]		[1.98]				[1.95]
Ln(Market Value of Equity)			-4.651			-11.02***			-4.969			-9.150***
			[-1.44]			[-3.46]			[-1.36]			[-2.69]
Ln(Book Value of Equity)				12.71**		-1.056				10.52*		-0.545
				[2.48]		[-0.15]				[1.84]		[-0.07]
Market-to-Book					-6.652	-3.370					-6.548	-3.774
					[-1.24]	[-0.52]					[-1.25]	[-0.55]
Delta	0.0349***	0.0367***	0.0378***	0.0370***	0.0377***	0.0348***	0.0313***	0.0318***	0.0341***	0.0319***	0.0326***	0.0325***
	[5.05]	[5.16]	[5.15]	[5.13]	[5.22]	[4.93]	[4.35]	[4.33]	[4.59]	[4.29]	[4.38]	[4.47]
Percentage of Cash-to-Total Comp.	-48.02	-44.90	-47.30	-44.18	-47.03	-49.27	-49.92	-47.90	-61.19*	-46.40	-49.70	-60.65*
	[-1.44]	[-1.35]	[-1.39]	[-1.31]	[-1.42]	[-1.42]	[-1.36]	[-1.31]	[-1.72]	[-1.25]	[-1.36]	[-1.68]
Percentage of Stock and Option to-Total Comp.	53.79***	54.45***	57.26***	54.23***	55.59***	54.34***	50.42***	50.36***	49.97***	52.19***	51.35***	50.14***
	[3.63]	[3.68]	[3.80]	[3.64]	[3.76]	[3.54]	[3.09]	[3.09]	[3.04]	[3.17]	[3.16]	[3.01]
Expected Remaining Tenure	-5.267	-4.736	-4.974	-0.592	-4.428	-2.578	-5.813	-5.809	-6.203	-1.021	-5.593	-2.624
	[-0.73]	[-0.66]	[-0.68]	[-0.09]	[-0.62]	[-0.39]	[-0.70]	[-0.70]	[-0.73]	[-0.14]	[-0.67]	[-0.36]
Book Leverage	3.427	-13.48	-2.169	22.60	1.539	-17.94	5.748	-6.715	1.355	25.22	5.906	-13.35
	[0.20]	[-0.74]	[-0.13]	[1.08]	[0.09]	[-0.71]	[0.28]	[-0.30]	[0.07]	[1.10]	[0.29]	[-0.44]
Tobin's Q	0.00301	0.00339	0.00411	0.00329	0.00393	0.00348	-0.00136	-0.00135	0.00370	-0.00140	-0.000882	0.00352
	[0.96]	[1.10]	[1.38]	[1.08]	[1.31]	[1.07]	[-0.23]	[-0.23]	[1.06]	[-0.24]	[-0.15]	[0.96]
Volatility	-140.3	-138.8	-157.2	-141.8	-146.3	-196.2	223.8	223.7	119.9	177.6	216.1	45.01
	[-1.01]	[-1.01]	[-1.13]	[-1.01]	[-1.05]	[-1.40]	[1.20]	[1.20]	[0.74]	[0.98]	[1.16]	[0.29]
Constant	270.4***	92.46	180.7**	186.4***	296.9***	29.51	167.7*	14.26	121.2	95.12	180.5**	-35.65
	[3.85]	[1.16]	[2.44]	[2.65]	[4.28]	[0.36]	[1.85]	[0.15]	[1.43]	[1.15]	[2.01]	[-0.39]
Observations	6290	6290	6256	6158	6290	6125	6290	6290	6256	6158	6290	6125
Adjusted R-Squared	0.140	0.139	0.136	0.136	0.136	0.148	0.126	0.127	0.140	0.128	0.126	0.147

Table 4: OLS Regressions on Measures of Incentives and Firm Size (cont.)

Table 4: OLS Regressions on Measures of Incentives and Firm Size (cont.) : OLS estimations of determinants of Vega, without severance in Panel A and with severance in Panel B, and Gamma, without severance in Panel C and with severance in Panel D. Measures of firm size include the natural log of share price, log assets, log market value of equity, log book value of equity, and market-to-book ratio. Compensation controls includes percentage of cash-to-total compensation (inclusive of other compensation), the percentage of stock and options to-total compensation, and expected remaining tenure. Controls for risk and valuation include book leverage (debt divided by total assets), Tobin's Q, and firm volatility computed using rolling 60-month periods of returns. Results in Panel C indicate that gamma not including severance has negative and significant relatonships with share price (model 1), log assets (model 2), log market value of equity (model 3), and log book value of equity (model 4), when taken together (model 6) gamma has negative and significant relationships with log assets and log market value of equity. These results are not unexpected as gamma mathematically declines as share price increases above the strike price of options. Firm value is positively and significant determinant of gamma. These suggest that CEOs of larger firms have less incentives relative to CEOs of smaller firms--which is consistent as CEOs from smaller firms have higher growth rathes which is consistent with gamma's relationship to firm value. When severance is taken into account gamma appears to show almost no significance with firm size or value. Values reported in square brackets are t-stats, ***, **, and * represent significance at the 1%, 5%, and 10% levels.

Dependent Variable	Panel C: Gamma (not incl. severance)						Panel D: Gamma (not incl. severance)					
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Share Price	-0.00331***					-0.000831	0.00270					-0.00642
	[-3.96]					[-1.27]	[1.27]					[-1.17]
Ln(Assets)		-0.521***				-0.295*		1.358				0.723
		[-4.71]				[-1.91]		[1.60]				[0.89]
Ln(Market Value of Equity)			-0.333***			-0.282***			0.783			0.969
			[-6.23]			[-5.17]			[1.06]			[1.07]
Ln(Book Value of Equity)				-0.255***		0.0207				0.873*		0.0925
				[-3.51]		[0.19]				[1.80]		[0.16]
Market-to-Book					-0.0250	0.0983***					-0.00224	-0.454
					[-1.27]	[2.98]					[-0.08]	[-0.92]
Delta	-0.0000394*	-0.0000498**	-0.0000282	-0.0000406*	-0.0000644***	-0.00000774	-0.000152**	-0.000171**	-0.000217	-0.000130*	-0.000131**	-0.000162
	[-1.69]	[-2.13]	[-1.28]	[-1.85]	[-2.78]	[-0.35]	[-1.99]	[-2.03]	[-1.57]	[-1.77]	[-2.06]	[-1.51]
Percentage of Cash-to-Total Comp.	0.504**	0.454*	0.353	0.278	0.490*	0.188	-0.937	-0.828	-0.554	-0.985	-0.926	-0.585
	[1.98]	[1.79]	[1.42]	[1.36]	[1.91]	[0.93]	[-0.41]	[-0.38]	[-0.28]	[-0.43]	[-0.41]	[-0.30]
Percentage of Stock and Option to-Total Comp.	0.297*	0.299*	0.285*	0.323**	0.283*	0.318**	0.772	0.740	0.804	0.811	0.785	0.908
	[1.84]	[1.85]	[1.78]	[2.00]	[1.75]	[1.99]	[1.16]	[1.10]	[1.19]	[1.21]	[1.18]	[1.40]
Expected Remaining Tenure	-0.0750	-0.0746*	-0.0808*	-0.0734*	-0.0867*	-0.0576	0.0571	0.0366	0.0513	0.0371	0.0659	0.00451
	[-1.63]	[-1.65]	[-1.77]	[-1.72]	[-1.90]	[-1.33]	[0.82]	[0.57]	[0.71]	[0.55]	[0.88]	[0.07]
Book Leverage	0.852***	1.168***	0.646**	0.195	0.894***	0.593**	0.598	-0.161	1.155	1.800	0.569	0.877
	[3.06]	[4.20]	[2.46]	[0.91]	[3.20]	[1.98]	[1.15]	[-0.30]	[1.22]	[1.60]	[1.12]	[0.83]
Tobin's Q	-0.0000246	-0.0000244	-0.0000115	-0.0000172	-0.0000315*	-0.00000854	-0.00000185	-0.0000157	-0.0000436	-0.0000319	0.00000436	-0.0000392
	[-1.43]	[-1.49]	[-0.67]	[-1.10]	[-1.82]	[-0.53]	[-0.07]	[-0.47]	[-0.82]	[-1.04]	[0.15]	[-0.89]
Volatility	-0.328	-0.324	-1.592	0.567	-0.396	-0.273	1.236	1.165	4.037	-1.735	1.260	0.843
	[-0.18]	[-0.18]	[-0.84]	[0.38]	[-0.21]	[-0.18]	[0.31]	[0.29]	[0.80]	[-0.93]	[0.31]	[0.24]
Constant	-0.469	3.012***	1.268	1.505**	0.172	3.044***	-0.820	-10.07*	-5.006	-5.163	-0.598	-9.171
	[-0.63]	[2.73]	[1.49]	[2.08]	[0.24]	[3.06]	[-0.49]	[-1.75]	[-1.28]	[-1.64]	[-0.36]	[-1.47]
Observations	6290	6290	6256	6158	6290	6125	6290	6290	6256	6158	6290	6125
Adjusted R-Squared	0.008	0.012	0.022	0.022	0.006	0.041	-0.007	-0.001	0.004	0.001	-0.007	0.015

Table 5: Simultaneous Equations (3SLS): R&D, Capital Expenditures and Gamma

Table 5: Simultaneous Equations (3SLS): R&D, Capital Expenditures and Gamma: Simultaneous system estimations for accounting meansure of investment behavior (R&D and CAPEX), Vega (with and without severance), Delta, and Gamma (with and without severance) are presented. The reported estimates represent only the values from the first equation in the system. Other equations in the system match those found in Coles, *et al.* (2006) and Model 1 is a 'calibration' model which matches their construction completely--results are similar differences may result from time periods. In Model 2, Gamma (without severance) is added to the estimation--results seem to indicate that gamma shows stronger investment in R&D and CAPEX than reported under Coles, *et al.* (2006) with vega alone, vega appears to have little effect on investment behavior relative to gamma. Model 3 shows estimates where gamma and vega include the effect of severance compensation. Results seem to indicate that when the incentives of severance are incorporated into the model gamma indicates a reduction in risky-investment behavior (lower R&D, higher CAPEX), but a dramatically reduced incentive to invest overall. The scales between models are the same. Vega (with severance) shows little change in incentive to invest. Model 3 also documents a negative and significant relationship between R&D and severance payments and a positive relationship between CAPEX and severance, though it is insignificant. P-values based on firm-clustered robust standard errors are reported in parenthesis. ***,**, and * represent significance at the 1%, 5% and 10% level repsectively. Construction of control variables can be found in Appendix I of Coles, *et al.* (2006).

	Model 1		Model 2		Model 3	
Dependent Variables of Eq 1.	R&D	CAPEX	R&D	CAPEX	R&D	CAPEX
Regressors of Eq 1.						
Gamma (No. Term)			**19.985 *****	**58.294 *****		
			(0.000)	**(0.000)**		
Full Comp. Gamma					**-0.185 *****	**0.444 *****
					(0.000)	**(0.000)**
Vega (No. Term)	**-1.150 *****	**-7.735 ****	**0.371 *****	**-0.393 *****		
	(0.009)	**(0.019)**	**(0.000)**	**(0.000)**		
Full Comp. Vega					**0.325 *****	**-0.298 *****
					(0.000)	**(0.000)**
Delta	0.418 ***	2.903 ***	-0.024 ***	0.153 ***	-0.010 ***	0.178 ***
	(0.000)	(0.005)	(0.000)	(0.000)	(0.000)	(0.000)
Termination Payment					-0.739 ***	0.502
					0.000	0.159
Tenure	0.000	-0.010 **	-0.001 ***	-0.006 ***	-0.001 ***	-0.010 ***
	(0.507)	(0.013)	(0.000)	(0.000)	(0.000)	(0.000)
Cash Compensation	0.000	0.000 *	0.000 ***	0.000 **	0.000 ***	0.000 ***
	(0.560)	(0.083)	(0.000)	(0.025)	(0.000)	(0.000)
Ln(Sales)	0.008	0.096	-0.023 ***	-0.018 ***	-0.023 ***	-0.030 ***
	(0.453)	(0.160)	(0.000)	(0.000)	(0.000)	(0.000)
Market-to-Book	0.002	0.006	-0.001	-0.002	-0.002 *	-0.007 ***
	(0.560)	(0.782)	(0.203)	(0.361)	(0.065)	(0.004)
Surplus Cash	-0.012	-0.153 *	-0.006	-0.020	-0.020 ***	-0.113 ***
	(0.447)	(0.065)	(0.176)	(0.363)	(0.000)	(0.000)
Sales Growth	0.003	0.017	0.000	0.002	0.000	0.005 ***
	(0.171)	(0.205)	(0.690)	(0.406)	(0.944)	(0.006)
Stock Returns	-0.008	-0.040	0.000	0.002	0.000	-0.007 ***
	(0.119)	(0.162)	(0.538)	(0.600)	(0.346)	(0.006)
Book Leverage	-0.035 ***	-0.174 **	-0.052 ***	-0.153 ***	-0.032 ***	-0.091 ***
	(0.005)	(0.017)	(0.000)	(0.000)	(0.000)	(0.000)
2-Digit SIC Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Constant	0.090 **	0.206	0.181 ***	0.393 ***	0.198 ***	0.509 ***
	(0.035)	(0.420)	(0.000)	(0.000)	(0.000)	(0.000)
Observations	6247	6247	6247	6247	6247	6247

Table 6: Simultaneous Equations (3SLS): Firm Focus and Gamma

Table 6: Simultaneous Equations (3SLS): Firm Focus and Gamma: Simultaneous system estimations for sales concentration of segments and number of segments of firms, Vega (with and without severance), Delta, and Gamma (with and without severance). Reported estimates are for the first equation in the system, estimates of other equations in the system are available upon request. Construction of other equations in the system match those found in Coles, *et al.* (2006) and Model 1 is a 'calibration' model which produces estimates similar to those found in Coles, *et al.* (2006). Model 2 has gamma (without severance) included--results show that the effect of vega switches and is negatively and significantly associated with lower concentration of sales among segments and positively associated with a higher number of segments (*i.e.* a reduction in firm focus overall). Gamma (without severance) has a large, positive and significant relationship with concentration of sales among segments and a large, negative and significant relationship with number of segments (*i.e.* higher firm focus overall). Model 3 reports estimates for vega and gamma where severance's incentives are included. Results indicate that with severance gamma shows a negative and significant relationship with concentration of sales among segments and a positive and significant relationship with number of segments. Vega's relationship remains unchanged from that of Model 2. This indicates that the incentives provided by severance may reduce firm focus--although severance is positively and significantly related to sales concentration among segments. P-values based on firm-clustered robust standard errors are reported in parenthesis. ***,**, and * represent significance at the 1%, 5% and 10% level repsectively. Construction of control variables can be found in Appendix I of Coles, *et al.* (2006).

	Model 1		Model 2		Model 3	
Dependent Variables of Eq 1.	HHI of Segs	Ln(Seg)	HHI of Segs	Ln(Seg)	HHI of Segs	Ln(Seg)
Regressors of Eq 1.						
Gamma (No. Term)			**63.530 *****	**-98.175 *****		
			(0.000)	**(0.001)**		
Full Comp. Gamma					**-0.246 ***	**8.012 *****
					(0.094)	**(0.000)**
Vega (No. Term)	**1.633 ****	**-22.818 ****	**-1.317 *****	**3.939 *****		
	(0.026)	**(0.010)**	**(0.000)**	**(0.000)**		
Full Comp. Vega					**-1.064 *****	**1.376 *****
					(0.000)	**(0.000)**
Delta	0.113	1.521	-0.010	-0.838 ***	-0.032 ***	-0.431 ***
	(0.523)	(0.478)	(0.378)	(0.000)	(0.002)	(0.000)
Termination Payment					2.006 ***	5.014
					(0.001)	(0.218)
Tenure	-0.002 ***	0.032 ***	0.009 ***	0.035 ***	0.007 ***	0.033 ***
	(0.005)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Cash Compensation	0.000 ***	0.000 ***	0.000 ***	0.000	0.000 ***	0.000 ***
	(0.006)	(0.002)	(0.000)	(0.115)	(0.000)	(0.003)
ROA	-0.015 **	0.158 **	0.029 ***	-0.029	0.011 *	-0.015
	(0.036)	(0.048)	(0.000)	(0.447)	(0.090)	(0.674)
Ln(Sales)	-0.056 ***	0.702 ***	0.081 ***	-0.036 ***	0.070 ***	0.026
	(0.002)	(0.002)	(0.000)	(0.009)	(0.000)	(0.222)
Market-to-Book	-0.026 ***	0.282 ***	0.011 ***	-0.024 *	0.008 **	-0.013
	(0.000)	(0.001)	(0.000)	(0.085)	(0.012)	(0.367)
Surplus Cash	-0.111 ***	0.119	0.127 ***	-0.625 ***	0.044 *	-0.684 ***
	(0.000)	(0.723)	(0.000)	(0.000)	(0.092)	(0.000)
Sales Growth	0.015 ***	-0.127 **	-0.010 ***	0.006	-0.003	-0.014
	(0.001)	(0.011)	(0.000)	(0.672)	(0.204)	(0.263)
Stock Returns	-0.040 ***	0.470 ***	0.024 ***	0.105 ***	0.001	0.157 ***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.817)	(0.000)
Book Leverage	0.060 ***	-0.419	-0.060 ***	0.002	-0.021	0.088
	(0.008)	(0.128)	(0.000)	(0.978)	(0.170)	(0.415)
2-Digit SIC Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Constant	0.862 ***	-0.552	-0.355 ***	0.869 ***	-0.263 ***	0.456 ***
	(0.000)	(0.589)	(0.000)	(0.000)	(0.000)	(0.001)
Observations	6247	6247	6247	6247	6247	6247

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APPENDIX 1: VARIABLE DESCRIPTIONS AND CONSTRUCTION

Variable Name	Description
Termination Payment ($ mil)	Obtained from ExecuComp using the TERM_PYMT variable over the sample 2009 to 2015. Winsorized to the 1% level.
Change-In-Control Payment ($ mil)	Obtained from ExecuComp using the CHG_CTRL_PYMT variable over the sample 2009 to 2015. Winsorizied to the 1% level.
Termination Payment (Scaled)	TERM_PMYT/ AT
Change-In-Control Payment (Scaled)	CHG_CTRL_PYMT/AT
Additionaly CEO Compensation Parameters	As listed in the Variable Description section are obtained as listed under ExecuComp. They are winsorized to the 1% level.
CEO Tenure	Estimated as the amount of time a CEO has continuously remaiend in office since they took office, this is not to be confused with a multiple tenure CEO. This mesure more simply begins at 1 at the beginning of each tenure of the CEO. This variable is not winsorized.
CEO Age	The current age for a given CEO in a given year, used to estimate age differentials in risk-taking behavior. This variable is not winsorized.
Delta of the Portfolio	Estimated to be the change in the portfolio value of a CEO given a 1-dollar change in the underlying share price of the firm. The value is reported in thousands of dollars of change and is winsorized as a part of its original construction. The construction of the variable requires use of the Black-Scholes Merton Option pricing model (Black & Scholes (1973); Merton (1973)).
Vega of the Portfolio	Estimated to be the change in the portfolio value of a CEO given a 1% change in the underlying share volatility of the firm. The value is reported in thousands of dollars of change and is winsorized as a part of its original construction. The construction of the variable requires use of the Black-Scholes Merton Option pricing model (Black & Scholes (1973); Merton (1973)).
R&D Intensity	XRD/ AT, as done in Daniel, Coles, Naveen (2006)
Capital Expenditure Intensity	CAPX/ PPENT, as done in Daniel, Coles, Naveen (2006)
Marekt-to-Book Ratio	(AT - Common Equity + PRFF_C *CSHO)/ AT
Financial Leverage	(Long-Term Debt + Debt in Current Liabilities)/ AT
Market Financial Leverage	(Long-Term Debt + Debt in Current Liabilities)/ (AT - Common Equity + PRFF_C*CSHO)
Sales Growth	Log(Sales t /Sales t-1)
Dividend Yield	DIV / PRFF_C
Tax Rate	TXT/EBT
Cash-To-Asset Ratio	Cash and Equivalents / AT
Total Asset Turnover	Sales / AT
Operating Expense Margin	Total Operating Expenses / Sales
Profit Margin	Net Income / Sales
ROA	Net Income / AT
Ln(Segments)	Ln(# Segments Reported under Compustat Segments Database)

APPENDIX 1: VARIABLE DESCRIPTIONS AND CONSTRUCTION (Cont.)

Variable Name	**Description**
ToeHold	1 where percentage ownership is greater than 5% and zero otherwise
Hostile	1 where SDC Platinum's Attitude variable indicates that the deal is hostile or unsolicited, 0 otherwise
Tender	1 where SDC Platinum indicates the deal is a tender offer, private tender offer, or debt tender off, 0 otherwise.
White-Knight	1 where SDC Platnium indicates the deal was taken on by a White-Knight or White Squire, 0 otherwise
Asset-Swap	1 where SDC Platinum indicates the deal was an asset swap, 0 otherwise
Tobin's Q	(PRFF_C * CSHO) / Total Replacement Value of Assets, Total Replacement Value of Assets as reported by COMPUSTAT
Volatiltiy	rolling measure of prior 60-months of daily volatility logged
Tobin's Style Premium (M&A)	Deal Value / Total Value of Assets Acquired reported by SDC Platinum

APPENDIX II: Simultaneous Equations, Correlations and Robustness

System of Simultaneous Equations Model

$$
\begin{aligned}
\mathit{Variable\ of\ Interest}_{i,t} &= \gamma_{1,1}\mathit{Term\ Pay}_{i,t} + \gamma_{2,1}\mathit{Chg.Control\ Pay}_{i,t} + \gamma_{3,1}\mathit{Delta\ Portfolio}_{i,t} + \gamma_{4,1}\mathit{Vega\ Portfolio}_{i,t} + {}_{1}C_{i,t}\mathbf{B_1} + {}_{1}F_{i,t}\mathbf{G_1} + {}_{1}X_{i,t}\mathbf{Z_1} + a_1 + e_{i,t}\\
\mathit{Delta\ of\ Portfolio}_{i,t} &= \gamma_{1,2}\mathit{Term\ Pay}_{i,t} + \gamma_{2,2}\mathit{Chg.Control\ Pay}_{i,t} + \gamma_{4,2}\mathit{Vega\ Portfolio}_{i,t} + {}_{2}C_{i,t}\mathbf{B_2} + {}_{2}F_{i,t}\mathbf{G_2} + {}_{2}X_{i,t}\mathbf{Z_2} + a_2 + e_{i,t}\\
\mathit{Vega\ of\ Portfolio}_{i,t} &= \gamma_{1,3}\mathit{Term\ Pay}_{i,t} + \gamma_{2,3}\mathit{Chg.Control\ Pay}_{i,t} + \gamma_{3,3}\mathit{Delta\ Portfolio}_{i,t} + {}_{3}C_{i,t}\mathbf{B_3} + {}_{3}F_{i,t}\mathbf{G_3} + {}_{3}X_{i,t}\mathbf{Z_3} + a_3 + e_{i,t}\\
\mathit{Term\ Payment}_{i,t} &= \gamma_{2,4}\mathit{Chg.Control\ Pay}_{i,t} + \gamma_{3,4}\mathit{Delta\ Portfolio}_{i,t} + \gamma_{4,4}\mathit{Vega\ Portfolio}_{i,t} + {}_{4}C_{i,t}\mathbf{B_4} + {}_{4}F_{i,t}\mathbf{G_4} + {}_{4}X_{i,t}\mathbf{Z_4} + a_4 + e_{i,t}\\
\mathit{Chg.Control\ Pay}_{i,t} &= \gamma_{1,5}\mathit{Term\ Pay}_{i,t} + \gamma_{3,5}\mathit{Delta\ Portfolio}_{i,t} + \gamma_{4,5}\mathit{Vega\ Portfolio}_{i,t} + {}_{5}C_{i,t}\mathbf{B_5} + {}_{5}F_{i,t}\mathbf{G_5} + {}_{5}X_{i,t}\mathbf{Z_5} + a_5 + e_{i,t}
\end{aligned}
$$

$$
\begin{aligned}
{}_{1}C_{i,t} &= \mathit{Salary}_{i,t} + \mathit{Bonus}_{i,t} + \mathit{Stock\ Awards}_{i,t} + \mathit{Option\ Awards}_{i,t} + \mathit{NonEquity\ Inct}_{i,t} + \mathit{Oth\ Comp.}_{i,t} + \mathit{CEO\ Tenure}_{i,t} + \mathit{CEO\ Age}_{i,t}\\
{}_{2}C_{i,t} &= + \mathit{CEO\ Tenure}_{i,t}\\
{}_{3}C_{i,t} &= \mathit{Salary}_{i,t} + \mathit{Bonus}_{i,t} + \mathit{Stock\ Awards}_{i,t} + \quad + \mathit{NonEquity\ Inct}_{i,t} + \mathit{Oth\ Comp.}_{i,t}\\
{}_{4}C_{i,t} &= \mathit{Salary}_{i,t} + \mathit{Bonus}_{i,t} + \mathit{Stock\ Awards}_{i,t} + \mathit{Option\ Awards}_{i,t} + \mathit{NonEquity\ Inct}_{i,t} + \mathit{Oth\ Comp.}_{i,t} + \mathit{CEO\ Tenure}_{i,t} + \mathit{CEO\ Age}_{i,t}\\
{}_{5}C_{i,t} &= \mathit{Salary}_{i,t} + \mathit{Bonus}_{i,t} + \mathit{Stock\ Awards}_{i,t} + \mathit{Option\ Awards}_{i,t} + \mathit{NonEquity\ Inct}_{i,t} + \mathit{Oth\ Comp.}_{i,t} + \mathit{CEO\ Tenure}_{i,t} + \mathit{CEO\ Age}_{i,t}
\end{aligned}
$$

$$
\begin{aligned}
{}_{1}F_{i,t} &= M/B_{i,t} + Ln(\mathit{Sales}_{i,t}) + \mathit{Sales\ Growth}_{i,t} + \mathit{Tax\ Rate}_{i,t} + \mathit{EBITDA}_{i,t} + \mathit{FinCF}_{i,t} + \mathit{OCF}_{i,t}\\
{}_{2}F_{i,t} &= M/B_{i,t} + Ln(\mathit{Sales}_{i,t}) + \mathit{Sales\ Growth}_{i,t} + \mathit{Tax\ Rate}_{i,t}\\
{}_{3}F_{i,t} &= M/B_{i,t} + Ln(\mathit{Sales}_{i,t}) + \mathit{Sales\ Growth}_{i,t} + \mathit{Tax\ Rate}_{i,t}\\
{}_{4}F_{i,t} &= \mathit{EBITDA}_{i,t} + \mathit{OCF}_{i,t}\\
{}_{5}F_{i,t} &= M/B_{i,t} + Ln(\mathit{Sales}_{i,t}) + \mathit{EBITDA}_{i,t} + \mathit{OCF}_{i,t}.
\end{aligned}
$$

$$
\begin{aligned}
{}_{1}X_{i,t} &= \mathit{R\&D\ Intensity}_{i,t} + \mathit{CAPEX\ Intensity}_{i,t} + \mathit{Volatility}_{i,t} + \mathit{Div.Yield}_{i,t} + \mathit{Financial\ Leverage}_{i,t} + \mathit{Estimation\ Specific}_{i,t}\\
{}_{2}X_{i,t} &= \mathit{R\&D\ Intensity}_{i,t} + \mathit{CAPEX\ Intensity}_{i,t} + \mathit{Volatility}_{i,t} + \mathit{Financial\ Leverage}_{i,t} + \mathit{Estimation\ Specific}_{i,t}\\
{}_{3}X_{i,t} &= \mathit{R\&D\ Intensity}_{i,t} + \mathit{CAPEX\ Intensity}_{i,t} + \mathit{Volatility}_{i,t} + \mathit{Financial\ Leverage}_{i,t} + \mathit{Estimation\ Specific}_{i,t}\\
{}_{4}X_{i,t} &= \mathit{R\&D\ Intensity}_{i,t} + \mathit{CAPEX\ Intensity}_{i,t} + \mathit{Volatility}_{i,t} + \mathit{Div.Yield}_{i,t} + \mathit{Financial\ Leverage}_{i,t} + \mathit{Estimation\ Specific}_{i,t}\\
{}_{5}X_{i,t} &= \mathit{R\&D\ Intensity}_{i,t} + \mathit{CAPEX\ Intensity}_{i,t} + \mathit{Volatility}_{i,t} + \mathit{Div.Yield}_{i,t} + \mathit{Financial\ Leverage}_{i,t} + \mathit{Estimation\ Specific}_{i,t}
\end{aligned}
$$

Correlation Matrices

In *Table AII.1: Pairwise Correlations* I present in Panels A, B and C, separated for legibility; stars indicate that the correlation is statistically significant at the 99% confidence level. A great deal of these correlations are positive and tend in the direction one would readily assume. There appears to be a positive correlation between *Capital Expenditure Intensity* and *R&D Intensity*, additionally *Change-In-Control Payments Scaled* is positively correlated with both *R&D Intensity* and *Capital Expenditure Intensity* and *Termination Payment*. *Termination Payment* itself is positively correlated with *Capital Expenditure Intensity* but not *R&D Intensity*. The portfolio deltas and vegas here appear significantly but negatively and very lowly correlated with *Termination Payment Scaled* and *Change-In-Control Payments Scaled* but are positively and significantly associated with *Termination Payment* and *Change-In-Control Payments* when presented in millions of dollars. This is perhaps unsurprising as maintaining the comparability helps to increase correlation additionally this implies a size effect occurs between the relationship of the Delta, Vega and the *Termination Payments* and *Change-In-Control Payments* which is otherwise removed when scaled by assets. As I note in a later estimation, the loadings of *Delta* and *Vega of the Portfolio* are much stronger when I use dollar value termination and change in control payments than with scaled measurements.

SURE and Mixed-Model Robustness

As can be seen in *Table 1*, *R&D Intensity*—one of my primary measures for managerial risk-taking—is highly right-skewed whose mean lies above the median but the first three quartiles exhibit natural zero values. This is a result of many firms not reporting R&D expenditure for a specific year or at all. Perhaps they do not have R&D expenditure or the data is dirty in its collection; in order to correct for missing values, R&D expenditure is set to zero.

This over-abundance of truncated natural or data specified zeros in the data set causes the seemingly odd distribution found here. Although I performed various transformations—not limited to the common natural logarithm, in which I employed the $ln(x + c)$ adjustment to correct for the zeros, square-root, inverse square-root and inverse transformation—none of these transformations performed particularly brilliantly. In the end I chose to use no transformation on *R&D Expenditure* or *R&D Intensity*, however, I propose in the future for extended investigation the use of mixture models. Such a suggestion may be implemented in the same vein as this essay via a simultaneous 3-Stage Tobit estimation in which each dependent variable is classed on the threshold or let to run as a normal linear estimation (Roncek 1992)) or Box-Cox transformations to better address this non-normality in the assay which may cause a violation of the Gauss-Markov theorem for Least-Squares estimation and cause the expected central tendency of the residuals to not tend towards ‘0’. Although not the focus of this dissertation, I implement these tests here in the Appendix II.

Regardless of this inconvenient reality, the estimations will still produce BLUE of slope parameters, yet the intercept estimates will be biased: a significant problem when using indicator variables to capture effects. Since the intercept estimations are not my main concern in this essay, I move forward noting the apparent limitations and having given suggestions on further robust analysis via mixture models.

Another interesting pattern in the sample that can be seen in the quartiles is that average Sales for these firms is approximately 7-billion USD, with a minimum of 0 and a maximum of 470-billion—which relates to Walmart's revenue net of returns and allowances in 2015. As these numbers are highly skewed I do perform a log transformation which is also shown in the descriptive statistics. Also firms hold on average 17% of their Total Assets in Cash over the period and Total Assets itself is on average 8 billion USD with a maximum of 800 billion. On the whole it appears that most firms are profitable despite significant negative values in some datum resulting likely from residual fallout from the Great Recession; moreover, the average firm in the sample pays an effective tax rate of roughly 23% and 31% on median. Curiously volatility of firm shares is clustered with very little variance over-all and the average firm has 24% of its total capital funded by interest bearing debt.

Seemingly Unrelated Regression Equations (SUREs)

In order to address the foreseeable criticism that the use of 3SLS simultaneous modeling is not parsimonious. I perform a SURE estimation and compare the results to singularly estimated OLS models. If there is a difference in the results, it indicates that the OLS models are miss-specified owing to correlation among the residuals of the component models and that the models are in fact related (Zellner (1962), Srivastava & Giles (1987)). This quick econometric robustness provides foundation to the use of 3SLS simultaneous estimations as perhaps a more efficient and overall parsimonious system for measuring the endogenous effects of severance and change-in-control payments.

As can be seen in *Table AII.2: SURE About Simultaneous Estimations* the values are different in many cases—drastically different in a few. Additionally, the estimated adjusted R^2 helps to conclude that they are different enough that we can tell the system should be estimated using regressions that allow the error terms to correlate. It is a natural transition to move from SURE estimations into the generalized simultaneous equation world, it is for this reason that I implement with a level of surety in their parsimony systems of 3SLS in this essay.

Mixed Model Analysis: Simultaneous TOBITs to treat Natural Zeros

As previously mentioned in section *III.1 Description of Data* there exists a natural occurrence of '0's in several variables within the data set. While it appears that in the literature it is common to either entirely ignore this issue or more generally transform the data set in such a way as to refit the distribution centered around the 0s or to place the 0s within the distribution itself so that there does not exist a spike within a tail—this merely creates a spike within the data itself. While one could make the argument that such a spike would not alter tendency, which would be true if the distribution is assumed normal—a primacy for BLUE estimation under Gauss-Markov assumptions of OLS models—it would alter the normality of the distribution itself simply by the kurtosis and further still if the transformations do not affix the new transformed central tendency around 0, they will ultimately skew the distribution as well.

Owing to the great repeated frequency of null case reports in R&D expenditure and Capital Expenditure, which would cause R&D Intensity and Capital Expenditure Intensity to likewise be cast to null, I raise the immediate and reasonable objection that the estimations may not be unbiased and to test for this potential error I am faced with a quandary—controlling for natural '0's in a system of simultaneous estimation within a 3SLS framework.

While not easy to execute it is possible to implement a multi-stage simultaneously estimated mixed model which allows for the truncated estimation of some equations of the system and continuous GLS (LIML within the simultaneous space) estimation where the equations regressand is not truncated. This allows me to control and regress intermittently the cases where *R&D Intensity* and *Capital Expenditure Intensity* are reported as '0' and the entire remaining distribution where they are not, effectively capturing and controlling for the bias created in the distributions from the natural zeros—due to the simplistic flexibility of TOBIT models, I can more easily implement this assay by constructing the mixed model and allowing for *R&D Intensity* and *Capital Expenditure Intensity* each in their own system to be estimated using a TOBIT style regression[58].

Furthermore, I can allow for *Termination Payment* and *Change-In-Control Payments*—which are also likely to be ridden with natural zeros as some firms do not pay severance or change-in-control to their CEOs and some firms pay them only for certain years—to be estimated in a likewise fashion. In this way, I construct the simultaneous systems allowing for the main equation, *R&D Intensity* or *Capital Expenditure Intensity*, to be estimated with a TOBIT and I do the same for *Termination Payments* and *Change-In-Control Payments*. For *Vega and Delta of the Portfolio* I allow those to remain estimated in the continuous sense, as they can take on both positive and negative values varying with the CEO's level of sensitivity to either the underlying volatility or the share price.

I present the results of the system estimations as specified in *Table AII.3: Mixed Model Robustness and Force-Field Hypothesis*. The results indicate that even after controlling for natural zeros the estimations of the simultaneous equations using 3SLS framework in this essay are econometrically robust. There still appears to be a reduction in worth-while investment in R&D projects, a proxy for risk-taking, and an increased investment in capital projects, typically seen as risk reduction. In order to verify that my conditional result of reduced cash levels for firms which compensate CEOs with severance packages ex-ante is robust I also run the estimation on *Cash-To-Assets*, however, this main equation in it system is made using a continuous estimation like that of Vega and Delta of the Portfolio as previously described, yet the *Termination Payment* and *Change-In-Control Payment* are still estimated using TOBIT models. The results are reported in the third-column of *Table AII.3*. They indicate that I do indeed continue to find reduced levels of cash for firms which compensate CEOs with severance—producing a robust verification of the cofounded theories of Harford *et al.* (2008) and Almazan and Suarez (2003) where a CEO compensated with severance reduces cash, spends it on capital projects—which may be self-serving—and reduces the likelihood of being terminated by her board.

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[58] Implementation of the Mixed Model may be easiest performed in either R or STATA via the use of -cmp- command coded and released by Roodman (2009). I follow Roodman's (2009) paper as a guide for implementing these Mixed Model estimations. Of additional interest to future research is the ability to 'emulate' various types of recursive simultaneous SUR style estimations such as those for biprobits, ivtobits, iterated SUR, Heckman selection models, etc. See Pagan (1979) & Roodman (2009).

Barriers to Internal Governance and Heterogeneity in Firm Size

To investigate how behavior is affecting the CEO with respect to firm size, I stratified the firms into quartile groups based using *Sales* as a proxy for firm size. I chose not to use *Total Assets* because I wanted to capture the effect of size related to a specific firm's overall performance. For example, a firm which has a large amount of assets may simply exist in an industry that requires large physical investment but has relatively low sales. Since CEOs are more than likely to be compensated on their ability to drive sales than they are on their ability to simply acquire assets—I found it appropriate to use *Sales* as my proxy for size.

Stratifying the sample into the four sub-samples I re-run the SSE on each sub-sample and report the most pertinent results: the parameter estimates of the *Termination Payment*, *Change-In-Control Payments*, *Delta of the Portfolio*, and *Vega of the Portfolio*—all other controls omitted for brevity. I perform the estimation using both *R&D Intensity* and *Capital Expenditure Intensity* as a measure of CEO risk-taking. The results of these estimations are reported in *Table AII.4.*

Panel A of *Table AII.4* details the first quartile representing the smallest firms in the full-sample[59]. There are some interesting effects of note here: severance contracts appear to continue to decrease risk-taking behavior via investment in worth-while R&D projects, however, there is a positive, yet insignificant, relationship with investment in capital assets. This might suggest that small firms will see decreased investment in R&D expenditures where they might otherwise prefer such investment given their larger opportunity for growth leading to higher market-adjusted returns (Fama & French 1993). Although not reported, this effect could be due to a lack of available funds for increased R&D expenditure—whereas some CEOs are compensated in such a way that their level of compensation is set based on 'Peer Groups' of firms within the industry which may not readily reflect the diminutive size of the firm. This might force a result of a negative relationship where a more interesting, and complicated, issue of relative size of the firm and CEO total compensation arise (Bizjak, Lemmon, Nguyen 2011; Gong, Li, Shin 2010; Black, Dikolli, & Hofmann 2011).

Another interesting result from this panel is that there seems to be new relationship that forms between the *Vega of the Portfolio* and the severance payments. In both the *R&D Intensity* and *Capital Expenditure Intensity* regressions the vega of the portfolio is now positively related to the severance contract—which is largely the opposite of all prior estimations and the premise behind the use of severance compensation contracts—they reduce the CEOs sensitivity to volatility of the firm, at the very least they should hedge her downside risk and provide appropriate protections reducing the overall sensitivity.

Although the *Vega of the Portfolio* correctly estimates the effects on risky investment, the indirect effect is puzzling. Effectively, while Coles, Daniel, and Naveen (2006) documented the effect of setting the vega and delta of the CEOs compensation portfolio relative to the risk-taking behavior of increasing investment, they did not document the indirect effect of the severance contract upon the vega or when size of the firm is taken into consideration. For small firms it

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[59] A stratification of effective firm size distributions (*Sales*) can be found in the quartile estimates in *Table 1: Descriptive Statistics*.

appears that severance contracts ultimately increase the relative sensitivity of the CEO to the firm's volatility—which would explain why CEOs of small firms shy away from R&D expenditure.

Panel B describes the effect of the second quartile of size of the firms (25% - Median). It appears that the indirect effects of severance and change-in-control payments on vega have reverted to their normal relationship in that severance helps to reduce the sensitivity of the CEO to the firm's volatility. However, for this lower-mid tier group of firms, severance contracts seem to increase intensities for both R&D intensity and capital expenditure intensity—leading to a conclusion of increased investment overall and expansion activities. It is not immediately clear how such a result factors into the traditional frame-work given both results indicate increased investment, but perhaps severance contracts, for these mid-level firms, are a useful means of inducing risk-taking behavior in managers. Indeed, it is likely the case in the mid-tier firms that severance levels are optimal and boards have greater monitoring capabilities owing to the size of the firm. Stronger boards help to reduce the power of a force-field, particularly where the CEO cannot erect one when monitoring costs are low, consistent with the prior analysis in sub-section *V.6.*

Panel C estimates the effects of upper-mid tier group firms (Median – 75%), and shows a stable severance and change-in-control relationship with the determination of vega as was seen in prior estimations. But in this estimation we see that the main results of the prior estimations appear to take hold and severance loads negatively on *R&D Intensity* and positively on *Capital Expenditure Intensity* indicating a net overall shift away from risky investment in worth-while R&D programs to less risky investments in capital assets. Given the skewness implicit in the size distributions from the sample—it is not surprising that my main result should fall within this quartile group and confirms the prior hypotheses.

Panel D estimates the large group firm effect; these firms are unique in that their size is so large, severance could end up having no effect. Indeed, I find that for large firms both the direct and indirect of severance on *R&D Intensity* are insignificant, and that only the effect of *Change-In-Control Payments* is negatively associated with risk-taking. This result is consistent since large firms are relatively guarded from M&A activity and such a compensation scheme has low efficacy due to the reduced likelihood of being the target in an acquisition: resulting in CEOs interpreting the payout as equally unlikely to occur further reducing the effect of the incentive. Lastly, it could be the case that the size of the firm helps to stabilize the overall volatility such that severance's effect is largely negligible, as can be seen with the insignificant results shown for *Termination Payments* here in *Panel D.* Even still for large firms, we see that severance does increase capital expenditure which suggests that CEOs are induced to invest—though it remains to be seen whether those investments are self-serving since there is little evidence that cash is depleted in large firms—at least sufficiently enough that a severance agreement would constitute a burden. If it is true that CEOs erect barrier to governance in the previously examined ways, then CEOs of large firms should be increasing the capital expenditure in MSI projects which allows them to protect themselves and increase the cost of termination enough.

There appears to be a significant and differing discrete size effect relating to severance and change-in-control payments on risk-taking. For small firms, severance could reduce risk and simultaneously make the CEO more sensitive firms to the underlying volatility; which may ultimately result in CEOs finding ways of hedging this sensitivity elsewhere, for example, via reduced investment in risky-projects, for example. For medium size firms, severance results in an increase in risk-taking or the overall result of a total net reduction of investment in worth-while R&D projects but increased expenditure on capital assets, and reduced cash balances. And finally, large firms show little net benefit as a result of severance and this effect is largely significant and continuing monotonically from small firms to large firms. This effect is in of the barrier to governance as firms with higher severance, which correlates with size, are likely to see higher levels of reduced cash-to-asset ratios and ultimately a lower likelihood of terminating the CEO as they deride assets into capital expenditures and acquisitions making it more and more difficult to rationalize termination as the cash balances decline.

TABLE AII.1 : CORRELATION MATRIX PANEL A

	R&D Intensity	Capital Expenditure Intensity	Termination Payments Scaled	Change-In-Control Payments Scaled	Termination Payments (mil $)	Change-In-Control Payments (mil $)	Delta of the Portfolio ($000)	Vega of the Portfolio ($000)	Salary ($000)	Bonus ($000)	Stock Awards ($000)	Option Awards ($000)	Non-Equity Incentives ($000)	Other Compensation ($000)
R&D Intensity	1.000													
Capital Expenditure Intensity	**0.2430***	1.000												
Termination Payments Scaled	0.021	**0.0867***	1.000											
Change-In-Control Payments Scaled	**0.0672***	**0.0836***	**0.5048***	1.000										
Termination Payments (mil $)	**-0.0798***	-0.049	**0.2926***	**0.1138***	1.000									
Change-In-Control Payments (mil $)	**-0.0744***	**-0.0800***	**0.1512***	**0.2263***	**0.7300***	1.000								
Delta of the Portfolio ($000)	0.024	0.022	**-0.0758***	**-0.0527***	**0.2203***	**0.2853***	1.000							
Vega of the Portfolio ($000)	0.027	**-0.0751***	-0.034	-0.010	**0.2889***	**0.3582***	**0.5021***	1.000						
Salary ($000)	**-0.1812***	**-0.1643***	**0.0740***	**0.0701***	**0.4587***	**0.5648***	**0.2716***	**0.4056***	1.000					
Bonus ($000)	-0.030	-0.003	-0.015	-0.038	**0.1511***	**0.1315***	**0.1117***	**0.1581***	**0.1568***	1.000				
Stock Awards ($000)	-0.021	0.019	0.003	-0.004	**0.1495***	**0.2074***	**0.0754***	**0.1148***	**0.2278***	**0.0626***	1.000			
Option Awards ($000)	**0.0716***	-0.004	0.000	0.045	**0.2009***	**0.3378***	**0.4348***	**0.5282***	**0.2617***	**0.0602***	**0.0534***	1.000		
Non-Equity Incentives ($000)	**-0.1145***	**-0.1003***	0.029	0.011	**0.3659***	**0.4145***	**0.2235***	**0.3216***	**0.4528***	-0.023	**0.1356***	**0.1867***	1.000	
Other Compensation ($000)	-0.049	-0.046	0.011	-0.029	**0.1753***	**0.1309***	**0.0640***	**0.1229***	**0.1932***	0.040	**0.0664***	0.049	**0.0855***	1.000
Market to Book Ratio	-0.031	-0.032	-0.012	-0.014	0.004	0.011	0.040	**0.0763***	0.050	-0.003	0.006	0.021	**0.0872***	0.009
Log Sales	**-0.3195***	**-0.2549***	**-0.1169***	**-0.1347***	**0.2732***	**0.3890***	**0.2793***	**0.4741***	**0.5967***	**0.0907***	**0.2441***	**0.2393***	**0.4794***	**0.1267***
Sale (mil $)	**-0.0764***	**-0.0818***	**-0.1159***	**-0.1899***	**0.0930***	**0.1031***	**0.1322***	**0.2731***	**0.3224***	**0.1476***	**0.2091***	**0.1083***	**0.2424***	**0.0573***
Financial Leverage	0.051	-0.048	-0.027	-0.043	0.004	0.003	-0.008	-0.002	-0.001	-0.001	-0.002	-0.004	0.003	0.003
Dividend Yield	-0.029	-0.041	0.007	-0.018	**0.0706***	**0.0717***	-0.003	-0.015	0.052	0.001	0.001	-0.016	0.034	0.016
Tax Rate	**-0.1671***	-0.027	-0.018	-0.008	0.012	0.028	0.043	0.020	0.036	0.007	0.011	0.015	0.023	-0.010
CEO Continuous Tenure	0.012	**-0.0791***	**-0.0718***	-0.035	**0.1115***	**0.1076***	**0.2771***	**0.1850***	**0.1473***	0.044	**0.0560***	**0.0752***	**0.0880***	0.036
Sales Growth	-0.013	-0.020	-0.027	-0.042	-0.003	-0.006	-0.004	0.002	0.004	0.015	0.005	0.003	0.000	-0.002
Cash To Assets Ratio	**0.5002***	**0.2955***	0.025	0.033	**-0.0907***	**-0.1195***	0.004	**-0.0637***	**-0.2379***	-0.034	-0.034	0.019	**-0.1201***	**-0.0630***
CEO Age	**-0.0938***	**-0.1495***	**-0.0930***	**-0.1115***	**0.0822***	**0.0643***	**0.0945***	**0.0608***	**0.1220***	**0.0663***	0.019	-0.011	**0.0783***	**0.0687***
Volatility	0.005	-0.049	-0.010	0.001	-0.045	**-0.0771***	-0.035	0.003	**-0.1131***	0.011	**-0.0547***	-0.022	-0.014	-0.027
EBITDA	-0.038	**-0.0553***	**-0.1421***	**-0.2048***	**0.0883***	**0.1261***	**0.1500***	**0.3153***	**0.3677***	**0.1834***	**0.2716***	**0.1498***	**0.2514***	**0.0676***
Operating Cash Flow	-0.027	-0.039	**-0.1447***	**-0.2068***	**0.0789***	**0.1119***	**0.1396***	**0.2926***	**0.3410***	**0.1832***	**0.2995***	**0.1352***	**0.2268***	**0.0611***
Tobin's Q	-0.020	-0.015	0.019	0.009	0.003	-0.002	-0.001	-0.001	0.014	-0.007	-0.002	-0.007	-0.004	0.000
Return on Assets (ROA)	**-0.1552***	0.041	0.019	**0.0551***	0.033	**0.0555***	**0.0622***	**0.0615***	**0.0813***	0.016	0.034	0.036	**0.0765***	0.007
Profit Margin	**-0.1063***	**-0.0580***	-0.029	-0.023	0.009	0.017	0.017	0.017	0.012	-0.004	0.012	-0.002	0.023	0.006
Total Asset Turnover	**-0.2015***	-0.016	0.034	-0.042	-0.036	**-0.0797***	-0.047	**-0.1009***	0.000	-0.048	-0.045	**-0.0638***	-0.001	-0.032
Operating Expense Margin	**0.1080***	**0.0557***	0.029	0.023	-0.009	-0.017	-0.017	-0.017	-0.010	0.003	-0.011	0.001	-0.023	-0.006
Total Assets (mil $)	-0.046	**-0.0673***	**-0.1279***	**-0.1892***	**0.0634***	**0.0892***	**0.1026***	**0.2412***	**0.3634***	**0.1937***	**0.1615***	**0.1111***	**0.1869***	**0.0659***

Pair-Wise Correlation Matrix with Sidak corrected errors for pairwise matches. Correlations are bolded and stared where significant at the 99% confidence level. Remaining correlation pairs are disclosed in Panel B and Panel C for the total of the variables represented

TABLE AII.1 : CORRELATION MATRIX PANEL B

	Market to Book Ratio	Log Sales	Sale (mil $)	Financial Leverage	Dividend Yield	Tax Rate	CEO Continuous Tenure	Sales Growth	Cash To Assets Ratio
Market to Book Ratio	1								
Log Sales	**0.0840***	1							
Sale (mil $)	0.0356	**0.4914***	1						
Financial Leverage	-0.0063	-0.014	-0.0009	1					
Dividend Yield	**-0.0885***	0.0208	-0.0158	0.0062	1				
Tax Rate	0.0383	**0.1159***	0.0267	-0.0097	0.0182	1			
CEO Continuous Tenure	0.0131	**0.1145***	0.0313	0.033	-0.0287	0.009	1		
Sales Growth	-0.0074	0.008	0.0327	-0.0004	0.0166	0.0019	-0.0203	1	
Cash To Assets Ratio	-0.0382	**-0.3886***	**-0.1028***	-0.0216	**0.0554***	**-0.1191***	-0.0239	-0.008	1
CEO Age	-0.0054	**0.1039***	**0.0749***	0.0083	0.0072	0.0241	**0.4109***	0.0258	**-0.0790***
Volatility	-0.0222	**-0.0649***	-0.0198	-0.006	-0.0418	0.0096	-0.0419	-0.0084	0.0467
EBITDA	**0.0538***	**0.4644***	**0.8292***	0.0005	-0.0059	0.0202	0.0389	0.037	**-0.0651***
Operating Cash Flow	0.0482	**0.4430***	**0.8054***	-0.0011	-0.0054	0.0189	0.0452	0.0343	-0.047
Tobin's Q	0.0378	0.0094	-0.0058	0.001	-0.001	0.0164	0.0221	-0.0011	-0.0321
Return on Assets (ROA)	**0.0564***	**0.1301***	0.0288	**-0.6748***	0.036	0.0503	-0.0062	0.0039	-0.02
Profit Margin	0.0101	**0.0739***	0.0094	-0.0502	0.0101	0.0174	-0.0159	0.001	**-0.0873***
Total Asset Turnover	0.0497	**0.2128***	**0.1347***	-0.0163	-0.0305	**0.0624***	-0.0359	0.0081	**-0.1490***
Operating Expense Margin	-0.0103	**-0.0712***	-0.0091	0.0505	-0.0108	-0.0166	0.0171	-0.001	**0.0860***
Total Assets (mil $)	0.0294	**0.4007***	**0.6967***	0.0048	-0.0121	0.0053	**0.0671***	0.0123	**-0.0676***

Pair-Wise Correlation Matrix with Sidak corrected errors for pairwise matches. Correlations are bolded and stared where significant at the 99% confidence level. Remaining correlation pairs are disclosed in Panel A and Panel C for the total of the variables represented

TABLE AII.1 : CORRELATION MATRIX PANEL C

	CEO Age	Volatility	EBITDA	Operating Cash Flow	Tobin's Q	Return on Assets (ROA)	Profit Margin	Total Asset Turnover	Operating Expense Margin
CEO Age	1								
Volatility	-0.0372	1							
EBITDA	**0.0650***	-0.0271	1						
Operating Cash Flow	**0.0600***	-0.027	**0.9851***	1					
Tobin's Q	0.026	-0.0157	-0.0072	-0.0069	1				
Return on Assets (ROA)	-0.0165	0.0059	0.045	0.041	0.0013	1			
Profit Margin	-0.0444	0.0104	0.012	0.0113	0.0013	**0.1257***	1		
Total Asset Turnover	0.0094	0.0026	**-0.0585***	**-0.0644***	0.0194	0.0129	0.0364	1	
Operating Expense Margin	0.045	-0.0111	-0.0126	-0.0118	-0.0011	**-0.1255***	**-0.9926***	-0.0324	1
Total Assets (mil $)	**0.0695***	-0.0237	**0.8319***	**0.8145***	-0.0066	0.0202	0.009	**-0.0773***	-0.009

Pair-Wise Correlation Matrix with Sidak corrected errors for pairwise matches. Correlations are bolded and stared where significant at the 99% confidence level. Remaining correlation pairs are disclosed in Panel A and Panel B for the total of the variables represented

TABLE AII.2: SURE About Simutaneous Estimation

	PANEL A: Seemingly Unrelated Regression Equations (SUREs)					PANEL B: Independent Estimated OLS Regressions Across System				
	R&D Intensity	**Delta of the Portfolio**	**Vega of The Portfolio**	**Termination Payment**	**Change of Control Payment**	**R&D Intensity**	**Delta of the Portfolio**	**Vega of The Portfolio**	**Termination Payment**	**Change of Control Payment**
Termination Payments (mil $)	-0.00032 ***	-5.90119 ***	0.39944 **		1.09478 ***	-0.00018 ***	-0.77131	0.52086 ***		0.75763 ***
Change of Control Payments (mil $)	0.00021 ***	7.43275 ***	0.42666 ***	0.71754 ***		0.00013 ***	5.57908 ***	0.53896 ***	0.49438 ***	
Delta of The Portfolio ($ 000)	-0.00000 ***		0.11700 ***	-0.00033 **	0.00124 ***	-0.00000		0.06984 ***	0.00002	0.00047 **
Vega of The Portfolio ($ 000)	0.00007 ***	3.52426 ***		0.00279 ***	-0.00169	0.00004 ***	2.06249 ***		0.00312 ***	-0.00136
Salary	-0.00001 ***		0.01922 ***	-0.00345 ***	0.00780 ***	-0.00000 **		0.03563 ***	0.00169 ***	0.01186 ***
Bonus	-0.00000 **		0.01698 ***	0.00087 ***	-0.00054 **	-0.00000		0.02228 ***	0.00139 ***	0.00048 *
Stock Awards	0.00000 ***		-0.00127 ***	-0.00012 ***	0.00021 ***	0.00000 ***		-0.00114 ***	-0.00003	0.00025 ***
Option Awards	0.00000 **			-0.00071 ***	0.00104 ***	0.00000 ***			-0.00043 ***	0.00115 ***
Non-Equity Incentive	-0.00000		0.00207	0.00014	0.00024 **	-0.00000		0.00411 ***	0.00069 ***	0.00083 ***
Other Compensation	-0.00000		0.00679 ***	0.00118 ***	-0.00124 ***	-0.00000		0.00827 ***	0.00127 ***	-0.00072 ***
Market to Book Ratio	-0.00075	-13.51815	7.37208 ***		-0.11206	-0.00044	3.66513	7.05857 ***		-0.19588
Log Sales	-0.00837 ***	-60.18720 ***	40.02575 ***		0.37871 ***	-0.00664 ***	27.04752 ***	40.85565 ***		0.99065 ***
Financial Levearge	0.00167 ***	-4.59945	-0.78500	0.01983	-0.00783	0.00169 ***	-5.67196	-0.33242	0.02567	0.01621
Sales Growth	-0.00000	-0.00968	0.00900			-0.00000	0.00782	0.00532		
Dividend Yield	-0.00049 ***			0.01221	0.03333	-0.00052 ***			0.06267 **	0.09267 **
Tax Rate	-0.01192 ***					-0.01259 ***				
CEO Continuous Tenure	0.00026 *	31.90857 ***		0.06887 **	-0.13308 ***	0.00044 ***	42.96467 ***		0.05668 *	-0.05413
CEO Age	-0.00032 ***			0.03350 *	-0.03444	-0.00035 ***			0.03269 *	-0.03111
R&D Intensity		-516.43609 **	914.09884 ***	-7.29947 ***	14.11765 ***		236.05930	578.60773 ***	-3.57471	11.77851 ***
Capital Expenditure Intensity		492.02701 ***	-50.08714 ***	3.15759 ***	-3.46298 ***		543.59132 ***	-12.85122	2.94563 ***	-0.99695
Volatility		-611.90547 ***	200.73391 ***	6.84431 **	-9.52590 ***		-299.91361	221.41869 ***	4.81209 *	-8.25723 **
EBITDA				-0.00034 *	0.00016				-0.00043	0.00022
Operating Cash Flows				0.00044 *	-0.00049 *				0.00045 *	-0.00032
Constant	0.08670 ***	426.00325 ***	-363.33620 ***	-5.72718 ***	2.89855	0.07482 ***	-290.77738 **	-369.88162 ***	-6.94751 ***	-4.63816 **
Observations	6584	6584	6584	6584	6584	6586	6603	6603	6603	6584
Adj. R-Squared	0.3089	0.3622	0.2432	0.5017	0.5917	0.3193	0.3043	0.4192	0.5546	0.6374

Table AII.2: SURE About Simultaneous Estimations Panel A contains parameter estimates for results of a Seemingly Unrelated Regression Equations estimation system. Panel B contains parameter estimates for individually estimated equations containing the same independent and dependent estimators as in the SUREs but regressed individually and reported. Observations are identitical across the SURE using the lowest common observations and dropping estimations which are missing in the independent variable across the sample. The Adjusted R-Squareds reported below show differences in the estimation across the samples, additionally in many cases the parameter estimates are quite different, for example the factor loadings of *Termination Payments* on *Delta of Portfolio* are insignificant and different by an order of magnitude under the independent OLS estimations and the SUREs. The difference in the parameter estimations suggests that the system is related and that OLS may not be as efficient, although it is consistent, as using SURE estimations or even more generalized simultaneous systems. For a detailed description of SUREs see Takeshi's *Advanced Econometrics* (1985) or Baltagi's *Econometric Analysis of Panel Data (1995). * indicates significance at the 10% level, ** indicates signifiance at the 5% level, *** indicates signifiance at the 1% level*

TABLE AII.3: Mixed Model Robustness and Force-Field Hypothesis

PANEL A: Mixed Model Simultaneous Estimation

Type of Primary Regression in 3SLS Mixed Model for Equation Specifying Regressand of Interest	**TOBIT**	**TOBIT**	**GLS (LIML)**
Regressand of Interest	**R&D Intensity**	**Capital Expenditure Intensity**	**Cash-To-Assets**
Termination Payments (mil $)	-0.00042 ***	0.00034 ***	-0.00694 ***
Change of Control Payments (mil $)	0.00027 ***	-0.00013	-0.00049
Delta of The Portfolio ($ 000)	0.00000 **	0.00001 ***	0.00001 ***
Vega of The Portfolio ($ 000)	0.00008 ***	-0.00002	0.00001
Salary	0.00000	-0.00001 **	-0.00001 **
Bonus	0.00000	0.00000	0.00000
Stock Awards	0.00000 ***	0.00000 ***	0.00000 **
Option Awards	0.00000 **	0.00000	0.00000 ***
Non-Equity Incentive	0.00000	0.00000	0.00001 ***
Other Compensation	0.00000	0.00000	0.00000
Market to Book Ratio	0.00058	-0.00328 *	0.00027
Log Sales	-0.01058 ***	-0.01533 ***	-0.03481 ***
Financial Levearge	0.00290 ***	-0.07238 ***	-0.00150 *
Sales Growth	0.00000	-0.00002	-0.00002
Dividend Yield	-0.00120 ***	-0.00156 ***	0.00248 ***
Tax Rate	-0.02027 ***	0.00647	-0.00791 **
CEO Continuous Tenure	0.00029	-0.00166 ***	0.00079 *
Cash-To-Assets	0.20251 ***	0.20237 ***	
CEO Age	-0.00056 ***	-0.00206 ***	-0.00094 ***
Constant	0.07327 ***	0.45749 ***	0.64382 ***
Observations	6578	6578	6578

TABLE AII.3: Mixed Model Robustness and Force-Field Hypothesis. Three independently performed estimations using a mixed-model simultaneous 3SLS estimation with the parameter construction which follows the original 3SLS analysis performed in *Tables 3 & 4.* Parameter estimates for the first--main--equation in each system are reported here, all other equations in the system are omitted for brevity. The first estimation uses a TOBIT model to estimate R&D Intensity where the system is specified truncated for natural 0s in the equations for R&D Intensity, Termination Payment, and Change-In-Control. The second system also uses a TOBIT model to estimate Capital Expenditure Intensity where the system is specified truncated for natural 0s in the equations for Capital Expenditure Intensity, Termination Payment, and Change-In-Control. The final and third estimation uses a GLS (LIML in the simultaneous space) model to estimate Cash-To-Asset ratio dependent upon TOBIT style estimations for Termination Payment and Change-In-Control to control for natural 0s. The intent of these robustness regressions are to control for naturally occuring 0s in the data-sets which create spikes and non-normal distributions with extreme excess kurtosis focused around 0. Using mixed models with truncated models where natural 0s are known to occur, I am able to separate the estimation procedure to account for this bias and more accurately estimate the model. It warrants noting that the estimations are consistent with prior analysis providing robust support for the Force-Field hypothesis. ** indicates significance at the 10% level, ** indicates signifiance at the 5% level, *** indicates signifiance at the 1% level*

Table AII.4: Size Effect of Severance, Change-In-Control, Delta and Vega on Risk-Taking

PANEL A: 1st Quartile of Size (Small)

Variables	R&D Intensity	Delta of the Portfolio	Vega of The Portfolio	Termination Payment	Change of Control Payment
Termination Payments	-0.05179 ***	-37.88540	25.11943 ***		0.82532 ***
Change of Control Payments	0.07142 ***	-151.12219 ***	-10.98965 **	0.88441 ***	
Delta of The Portfolio	0.00001		0.08812 ***	-0.00008	-0.00020 ***
Vega of The Portfolio	0.00082 ***	5.83672 ***		0.00195 ***	-0.00167 **

	Capital Expenditure Intensity	Delta of the Portfolio	Vega of The Portfolio	Termination Payment	Change of Control Payment
Termination Payments	0.01530	-52.59231	17.25514 ***		0.81463 ***
Change of Control Payments	0.04761 ***	-202.36661 ***	6.96540	0.86641 ***	
Delta of The Portfolio	0.00033 ***		0.08854 ***	-0.00013 **	-0.00016 ***
Vega of The Portfolio	-0.00064 ***	5.80481 ***		0.00170 **	-0.00016
Obs	1630				

PANEL B: 2nd Quartile of Size (25% - 50%)

Variables	R&D Intensity	Delta of the Portfolio	Vega of The Portfolio	Termination Payment	Change of Control Payment
Termination Payments	0.02024 ***	347.00647 ***	-47.79241 ***		0.68310 ***
Change of Control Payments	-0.03172 ***	-875.53360 ***	123.20675 ***	1.00070 ***	
Delta of The Portfolio	-0.00003 ***		0.14320 ***	0.00025 ***	-0.00038 ***
Vega of The Portfolio	0.00028 ***	6.38033 ***		-0.00076 ***	0.00181 ***

	Capital Expenditure Intensity	Delta of the Portfolio	Vega of The Portfolio	Termination Payment	Change of Control Payment
Termination Payments	0.02396 *	298.47264 ***	-40.47104 ***		0.67609 ***
Change of Control Payments	0.05870 ***	-870.69184 ***	119.16431 ***	0.99212 ***	
Delta of The Portfolio	0.00010 ***		0.14778 ***	0.00022 ***	-0.00036 ***
Vega of The Portfolio	-0.00054 ***	6.42372 ***		-0.00052 **	0.00161 ***
Obs	1656				

TABLE AII.4:Size Effects of Severance, Change-In-Control, Delta and Vega on Risk-Taking. Panels A and B. Separating the full sample into quartiles based on size I rerun the 3SLS estimations across the four sub-sample size groups. Panel A: 1st Quartile of Size (Small), contains the parameter estimates for the smallest size of firms. Only Termination Payments, Change-In-Control Payments, Delta and Vega of the Portfolio are enumerated for brevity. Panel B: 2nd Quartile of Size (25% - 50%) indicates the lower middle group of firms by size. Observations within the size groups are indicated below each panel. ** indicates significance at the 10% level, ** indicates signifiance at the 5% level, *** indicates signifiance at the 1% level*

Table AII.4: Size Effect of Severance, Change-In-Control, Delta and Vega on Risk-Taking (cont.)

PANEL C: 3rd Quartile of Size (50% - 75%)

Variables	R&D Intensity	Delta of the Portfolio	Vega of The Portfolio	Termination Payment	Change of Control Payment
Termination Payments	-0.01209 ***	258.48098 ***	-34.12792 ***		0.43126 ***
Change of Control Payments	-0.00403	1358.42279 ***	214.58953 ***	0.92438 ***	
Delta of The Portfolio	-0.00001 ***		0.13815 ***	0.00008 ***	-0.00021 ***
Vega of The Portfolio	0.00012 ***	5.78789 ***		-0.00010	0.00101 ***

	Capital Expenditure Intensity	Delta of the Portfolio	Vega of The Portfolio	Termination Payment	Change of Control Payment
Termination Payments	0.07095 ***	234.81874 ***	-46.68772 ***		0.45296 ***
Change of Control Payments	-0.07513 ***	1251.70462 ***	210.73646 ***	0.96452 ***	
Delta of The Portfolio	0.00003 ***		0.14462 ***	0.00007 ***	-0.00018 ***
Vega of The Portfolio	-0.00012 ***	5.80184 ***		-0.00026	0.00094 ***
Obs	1652				

PANEL D: 4th Quartile of Size (Large)

Variables	R&D Intensity	Delta of the Portfolio	Vega of The Portfolio	Termination Payment	Change of Control Payment
Termination Payments	-0.00309	-615.29005 ***	24.68907		0.31934 ***
Change of Control Payments	-0.02188 ***	646.39655 ***	199.68591 ***	0.74593 ***	
Delta of The Portfolio	-0.00001 ***		0.15624 ***	-0.00005 ***	0.00002 ***
Vega of The Portfolio	0.00010 ***	3.66245 ***		0.00004	0.00024 ***

	Capital Expenditure Intensity	Delta of the Portfolio	Vega of The Portfolio	Termination Payment	Change of Control Payment
Termination Payments	0.11534 ***	-584.36491 ***	17.54061		0.35732 ***
Change of Control Payments	-0.14883 ***	659.71395 ***	158.20114 ***	0.79690 ***	
Delta of The Portfolio	0.00001 ***		0.16133 ***	-0.00006 ***	0.00003 ***
Vega of The Portfolio	-0.00004 ***	3.77391 ***		0.00007	0.00016 ***
Obs	1638				

TABLE AII.4:Size Effects of Severance, Change-In-Control, Delta and Vega on Risk-Taking. Panels C and D. Separating the full sample into quartiles based on size I rerun the 3SLS estimations across the four sub-sample size groups. Panel C: 3rd Quartile of Size (50%-75%), contains the parameter estimates for the upper middle quartile group of firm size. Only Termination Payments, Change-In-Control Payments, Delta and Vega of the Portfolio are enumerated for brevity. Panel D: 4th Quartile of Size (Large) indicates the grup of the largest firms by size. Observations within the size groups are indicated below each panel. * *indicates significance at the 10% level, ** indicates signifiance at the 5% level, *** indicates signifiance at the 1% level*

APPENDIX III: CEO DEATH TABLES ADDITIONAL TABLES

Average Tenure Expectancy

$$E(Years\ CEO) = tenure_x + e_x$$

Year Became	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Tenure Year													
1999	16.600	15.595											
2000	16.600	15.595	15.870										
2001	16.600	15.595	15.870	14.939									
2002	16.600	15.595	15.870	14.939	13.594								
2003	16.600	15.595	15.870	14.939	13.594	12.564							
2004	16.600	15.595	15.870	14.939	13.594	12.564	11.740						
2005	16.600	15.595	15.870	14.939	13.594	12.564	11.740	11.021					
2006	16.600	15.595	15.870	14.939	13.594	12.564	11.740	11.021	9.763				
2007	16.600	15.595	15.870	14.939	13.594	12.564	11.740	11.021	9.763	9.032			
2008	16.600	15.595	15.870	14.939	13.594	12.564	11.740	11.021	9.763	9.032	8.014		
2009	16.921	15.595	15.870	15.293	13.594	12.564	11.740	11.116	9.856	9.123	8.014	6.888	
2010	17.222	15.783	16.432	15.293	13.992	12.564	12.063	11.377	10.292	9.289	8.090	6.888	6.378
2011	17.500	16.528	16.803	15.583	14.241	12.961	12.588	11.619	10.627	9.758	8.363	7.324	6.378
2012	17.750	17.133	16.803	15.850	14.351	13.556	12.893	11.763	10.780	9.904	8.612	7.600	6.496
2013	17.967	17.536	16.942	16.092	14.539	13.846	13.076	11.887	10.981	10.164	9.018	7.660	6.646
2014	18.143	17.715	16.942	16.092	14.779	13.927	13.076	12.040	11.152	10.275	9.068	7.961	6.768
2015	18.269	18.010	17.110	16.244	15.125	14.052	13.248	12.295	11.242	10.361	9.265	8.084	6.926

Standarized Remaining Tenure

$$Sd.e_x = \mathrm{E}\left(\text{Years CEO}\middle|\text{Became CEO}_\mathrm{j}\right) - \Delta \mathrm{e}_{(\mathrm{x,x-1})}$$

$$\mathrm{E}\left(\text{Years CEO}\middle|\text{Became CEO}_\mathrm{j}\right) = \sum_{i=1}^{MaxTenure} \left\{ \prod\nolimits_{j=1}^{i} \left(1 - M_j\right) + 0.5\left(\prod\nolimits_{j=1}^{i-1} \left(1 - M_j\right)\right) M_i \right\}$$

$$M_i = \frac{n_0(1 - l_i)}{L_x}$$

Year Became	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Tenure Year													
1999	14.761	14.463											
2000	13.761	13.463	21.442										
2001	12.761	12.463	20.442	21.879									
2002	11.761	11.463	19.442	20.879	15.470								
2003	10.761	10.463	18.442	19.879	14.470	15.002							
2004	9.761	9.463	17.442	18.879	13.470	14.002	16.507						
2005	8.761	8.463	16.442	17.879	12.470	13.002	15.507	16.416					
2006	7.761	7.463	15.442	16.879	11.470	12.002	14.507	15.416	14.422				
2007	6.761	6.463	14.442	15.879	10.470	11.002	13.507	14.416	13.422	15.894			
2008	5.761	5.463	13.442	14.879	9.470	10.002	12.507	13.416	12.422	14.894	13.468		
2009	5.082	4.463	12.442	14.233	8.470	9.002	11.507	12.511	11.515	13.985	12.468	10.952	
2010	4.384	3.652	12.004	13.233	7.867	8.002	10.830	11.772	10.951	13.151	11.543	9.952	13.092
2011	3.661	3.397	11.374	12.523	7.117	7.399	10.355	11.014	10.286	12.620	10.816	9.389	12.092
2012	2.911	3.001	10.374	11.790	6.227	6.994	9.660	10.158	9.440	11.766	10.065	8.665	11.209
2013	2.128	2.404	9.513	11.032	5.415	6.284	8.843	9.281	8.640	11.026	9.471	7.724	10.359
2014	1.304	1.583	8.513	10.032	4.655	5.366	7.843	8.435	7.811	10.137	8.521	7.025	9.482
2015	0.431	0.878	7.682	9.184	4.001	4.490	7.015	7.689	10.242	9.223	7.719	6.148	8.639

Standardized Average Tenure Expectancy

$$Sd.E(Years\ CEO) = tenure_x + Sd.e_x$$

Year Became	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Tenure Year													
1999	15.761	14.463											
2000	15.761	14.463	21.442										
2001	15.761	14.463	21.442	21.879									
2002	15.761	14.463	21.442	21.879	15.470								
2003	15.761	14.463	21.442	21.879	15.470	15.002							
2004	15.761	14.463	21.442	21.879	15.470	15.002	16.507						
2005	15.761	14.463	21.442	21.879	15.470	15.002	16.507	16.416					
2006	15.761	14.463	21.442	21.879	15.470	15.002	16.507	16.416	14.422				
2007	15.761	14.463	21.442	21.879	15.470	15.002	16.507	16.416	14.422	15.894			
2008	15.761	14.463	21.442	21.879	15.470	15.002	16.507	16.416	14.422	15.894	13.468		
2009	16.082	14.463	21.442	22.233	15.470	15.002	16.507	16.511	14.515	15.985	13.468	10.952	
2010	16.384	14.652	22.004	22.233	15.867	15.002	16.830	16.772	14.951	16.151	13.543	10.952	13.092
2011	16.661	15.397	22.374	22.523	16.117	15.399	17.355	17.014	15.286	16.620	13.816	11.389	13.092
2012	16.911	16.001	22.374	22.790	16.227	15.994	17.660	17.158	15.440	16.766	14.065	11.665	13.209
2013	17.128	16.404	22.513	23.032	16.415	16.284	17.843	17.281	15.640	17.026	14.471	11.724	13.359
2014	17.304	16.583	22.513	23.032	16.655	16.366	17.843	17.435	15.811	17.137	14.521	12.025	13.482
2015	17.431	16.878	22.682	23.184	17.001	16.490	18.015	17.689	19.242	17.223	14.719	12.148	13.639

APPENDIX IV: VALUATION OF DIGITAL AND DYNAMIC BARRIER OPTIONS AND SELECTED FIRST AND SECOND ORDER GREEKS DERIVATIONS

In order to motivate the construction of the digital barrier, I need to borrow the frame-work of Black and Scholes (1973) and Merton (1973, 1976) and most importantly to follow closely the seminal work of Rubinstein and Reiner (1991, 1995) in developing these simple, yet, elegant models. These models are well known to the realm of quantitative and option pricing in finance, and perhaps are used most extensively by exotic option's trading desks and individuals and actuaries of the insurance industry who may find them useful for quantifying risk. I do not extend the literature here in these summarizations and derivations, but only provide a simplified and pertinent to the topic of these papers explanation in order to motivate the arguments contained within. The scholarship for these derivations can, in large part, be attributed to Rubinstein and Reiner and in the case of some more complicated barrier-style options, Merton for his initial derivations. In short, this appendix is meant to serve as an immediate primer for individuals operating in corporate financial research who do not regularly use options or exotic options in their work and may be unfamiliar with their pricing methods.

Pricing of Digital, or Binary, Options

Digital options, also called Binary options, are so called because their payout takes on either 0 or 1 in value. Although their name may suggest a likeness with computing, their use is actually one of the very first options ever constructed, the pure gamble, that a value will be below or above a stated amount. If the gamble should finish 'in the money' then the payout is 1 dollar, or however many multiples of 1 dollar in the number of contracts purchased. If the contract or gamble should finish 'out of the money' or is a 'bad bet' then the gambler would face 0 earnings, and the house (the underwriter or call or put writer in this case) of the option would keep the premium paid for the bet. Naturally such bets have an attractive payout ratio relative to the cost, as to all options: and can be easily interpreted in reality as an incremental bet on each square in the game of roulette.

In a financial setting digital options are most often used to trade, or more functionally gamble, upon whether or not a stock's price, or other asset—such as forex pairs—will exist above a certain price or below a certain price on or before expiration, and the payout for being correct is 1 dollar or you lose your entire investment in the bet. Owing to the fact that digital calls and puts take on their value of 1 or 0 depending on where the price is in relation to the strike and the payout does not continue to increase in value once the option is 'in the money': there is no need to determine the risk-adjusted probability difference of the price ending 'in the money' for a given share price and strike. For digital options there is simply the need to determine the present value risk-adjusted probability that the option will execute 'in the money' which is given simply by:

$$\boldsymbol{V_{Q_C} = Qe^{-r\tau}\Phi(d_2)} \qquad (AIV.1)$$

for a standard digital call option, where Q is value of the payout (1 dollar in the prior discussion), and for a standard digital put option it is:

$$\boldsymbol{V_{Q_P} = Qe^{-r\tau}\Phi(-d_2)} \qquad (AIV.2)$$

These pricing kernels are much simpler than the previous pricing kernels of the of the vanilla call and put options. Coincidentally their derivatives can be easily solved as well. Here I provide the simplified derivation of digital options delta, gamma, vega and rho.

Delta of Digital Call and Put Option

Taking equation *AIV.17* and partially differentiating with respect to the share price we have:

$$\frac{\partial V_{Q_s}}{\partial S_t} = \Delta_{Q_c} = Qe^{-r\tau}\Phi'(d_2)\left(\frac{\partial d_2}{\partial S_t}\right) \tag{$AIV.3$}$$

Substituting equations *AIV.5 and AIV.6* into *AIV.19* the Δ_{Q_c}:

$$\boldsymbol{\Delta_{Q_c}} = \frac{\boldsymbol{Qe^{-r\tau}\phi(d_2)}}{\boldsymbol{S_t\sigma\sqrt{\tau}}} \tag{$AIV.4$}$$

With respect to the digital put option, the computations are nearly identical with the exception of a negative,

$$\frac{\partial V_{Q_P}}{\partial S_t} = \Delta_{Q_P} = Qe^{-r\tau}\Phi'(-d_2)\left(-\frac{\partial d_2}{\partial S_t}\right) = \frac{\boldsymbol{-Qe^{-r\tau}\phi(-d_2)}}{\boldsymbol{S_t\sigma\sqrt{\tau}}} \tag{$AIV.5$}$$

Gamma of Digital Call and Put Option

Taking equation *AIV.4 and AIV.5* and differentiating a second time with respect to S_t we obtain the option gamma.

$$\frac{\partial \Delta_{Q_c}}{\partial S_t} = \frac{\partial\left(\frac{\partial V_{Q_c}}{\partial S_t}\right)}{\partial S_t} = \frac{\partial^2 V_{Q_c}}{\partial S_t^2} = \Gamma_{Q_c} = \frac{\partial}{\partial S_t}\left(\frac{Qe^{-r\tau}\phi(d_2)}{S_t\sigma\sqrt{\tau}}\right) = \frac{Qe^{-r\tau}}{\sigma\sqrt{\tau}}\cdot\frac{\partial[\phi(d_2)S_t^{-1}]}{\partial S_t}$$

for simplification define a constant $A = \frac{Qe^{-r\tau}}{\sigma\sqrt{\tau}}$ and differentiate with product rule:

$$\begin{aligned}\frac{\partial \Delta_{Q_c}}{\partial S_t} = A\frac{\partial[\phi(d_2)S_t^{-1}]}{\partial S_t} &= A[\phi'(d_2)\left(\frac{\partial d_2}{\partial S_t}\right)S_t^{-1} - 1S_t^{-2}\phi(d_2)] \\ &= A\left[\frac{\phi'(d_2)}{S_t^2\sigma\sqrt{\tau}} - \frac{\phi(d_2)}{S_t^2}\right] \\ &= \frac{-Qe^{-r\tau}d_2\phi(d_2)}{S_t^2\sigma^2\tau} - \frac{Qe^{-r\tau}\phi(d_2)}{S_t^2\sigma\sqrt{\tau}}\end{aligned}$$

factor out the common terms and simplify, we have:

$$\boldsymbol{\Gamma_{Q_c}} = \frac{\boldsymbol{-Qe^{-r\tau}\phi(d_2)d_1}}{\boldsymbol{S_t^2\sigma^2\tau}} \tag{$AIV.6$}$$

For the put option the calculations are similar:

$$\frac{\partial \Delta_{Q_P}}{\partial S_t} = \frac{\partial\left(\frac{\partial V_{Q_P}}{\partial S_t}\right)}{\partial S_t} = \frac{\partial^2 V_{Q_P}}{\partial S_t^2} = \Gamma_{Q_P} = \frac{\partial\left\{\frac{-Qe^{-r\tau}\phi(-d_2)}{S_t\sigma\sqrt{\tau}}\right\}}{\partial S_t} = \frac{-Qe^{-r\tau}}{\sigma\sqrt{\tau}}\cdot\frac{\partial[\phi(-d_2)S_t^{-1}]}{\partial S_t}$$

Again, let A be a constant here defined as $A = -\frac{Qe^{-r\tau}}{\sigma\sqrt{\tau}}$ and using the product rule:

$$= A\frac{\partial[\phi(-d_2)S_t^{-1}]}{\partial S_t} = A[\phi'(-d_2)\left(-\frac{\partial d_2}{\partial S_t}\right)S_t^{-1} - 1S_t^{-2}\phi(-d_2)]$$

$$= A\left[\frac{-\phi'(-d_2)}{S_t^2\sigma\sqrt{\tau}} + \frac{-\phi(-d_2)}{S_t^2}\right]$$

$$= \frac{Qe^{-r\tau}d_2\phi(-d_2)}{S_t^2\sigma^2\tau} + \frac{Qe^{-r\tau}\phi(-d_2)}{S_t^2\sigma\sqrt{\tau}}$$

$$= \frac{Qe^{-r\tau}d_2\phi(-d_2)}{S_t^2\sigma^2\tau} + \frac{Qe^{-r\tau}\phi(-d_2)}{S_t^2\sigma\sqrt{\tau}} * \frac{\sigma\sqrt{\tau}}{\sigma\sqrt{\tau}} \qquad \left(multiply\ by\ 1 = \frac{\sigma\sqrt{\tau}}{\sigma\sqrt{\tau}}\right)$$

finally, factor like terms and simplify*:*

$$\boldsymbol{\Gamma_{Q_P}} = \boldsymbol{\frac{Qe^{-r\tau}\phi(-d_2)d_1}{S_t^2\sigma^2\tau}} \qquad (AIV.7)$$

Vega of Digital Call and Put Option

To compute the vega of the digital call and put options we take the partial derivative with respect to σ:

$$\frac{\partial V_{Q_s}}{\partial\ \sigma} = v_{Q_c} = Qe^{-r\tau}\Phi'(d_2)\frac{\partial d_2}{\partial\sigma}$$

$$\frac{\partial d_2}{\partial\sigma} = \frac{\partial}{\partial\sigma}\left\{\frac{\ln\left(\frac{S_t}{K}\right) + \left(r - q - \frac{\sigma^2}{2}\right)\tau}{\sigma\sqrt{\tau}}\right\} = \frac{-\ln\left(\frac{S_t}{K}\right)}{\sigma^2\sqrt{\tau}} + \frac{-(r-q)\sqrt{\tau}}{\sigma^2} - \frac{1}{2} * \sqrt{\tau}$$

$$= -\left(\frac{\ln\left(\frac{S_t}{K}\right)}{\sigma^2\sqrt{\tau}} + \frac{(r-q)\tau}{\sigma^2\sqrt{\tau}} + \frac{\frac{1}{2}\sigma^2\tau}{\sigma^2\sqrt{\tau}}\right)$$

factored through by -1 and by unity $1 = \frac{\sqrt{\tau}}{\sqrt{\tau}} = \frac{\sigma^2\sqrt{\tau}}{\sigma^2\sqrt{\tau}}$:

$$\frac{\partial d_2}{\partial\sigma} = -\left(\frac{\ln\left(\frac{S_t}{K}\right) + \left(r - q + \frac{\sigma^2}{2}\right)\tau}{\sigma^2\sqrt{\tau}}\right)$$

$$\frac{\partial d_2}{\partial\sigma} = -\frac{d_1}{\sigma}$$

using the partial of d_2, we can now solve the vega of the digital call option:

$$\boldsymbol{\nu_{Q_c}} = -\frac{\boldsymbol{Qe^{-r\tau}\phi(d_2)d_1}}{\boldsymbol{\sigma}} \qquad (AIV.8)$$

Following the same derivation, the vega of the digital put option is given similarly by:

$$\boldsymbol{\nu_{Q_P}} = \frac{\boldsymbol{Qe^{-r\tau}\phi(-d_2)d_1}}{\boldsymbol{\sigma}} \qquad (AIV.9)$$

Rho of Digital Call and Put Option

The rho of the digital call and put options indicates how the options value changes with respect to changes in the discounted risk-free rate for valuation and is particularly important for many applications.

$$\frac{\partial V_{Q_c}}{\partial r} = \rho_{Q_c} = \frac{\partial}{\partial r} Qe^{-r\tau}\Phi(d_2)$$

$$= -\tau Qe^{-r\tau}\Phi'(d_2)\frac{\partial d_2}{\partial r}$$

$$\frac{\partial d_2}{\partial r} = \left\{\frac{ln\left(\frac{S_t}{K}\right) + \left(r - q - \frac{\sigma^2}{2}\right)\tau}{\sigma\sqrt{\tau}}\right\} = \frac{\sqrt{\tau}}{\sigma} \qquad (AIV.10)$$

$$\boldsymbol{\rho_{Q_c}} = \boldsymbol{-\tau Qe^{-r\tau}\phi(d_2)\frac{\sqrt{\tau}}{\sigma}} \qquad (AIV.11)$$

similarly, for a digital put:

$$\boldsymbol{\rho_{Q_P}} = \boldsymbol{\tau Qe^{-r\tau}\phi(-d_2)\frac{\sqrt{\tau}}{\sigma}} \qquad (AIV.12)$$