Does Debt Concentration Depend on the Risk-Taking Incentives in CEO Compensation?

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Abstract

Coordination problems amongst creditors are reduced when a firm's debt structure is concentrated in fewer debt types. Using a sample of US non-financial firms, we show that an increase in risk-taking incentives in CEO pay is associated with a greater debt concentration by debt type. This result holds in various settings that account for endogeneity and is primarily driven by pay incentives embedded in vested options that are expected to favor business choices with more immediate negative effects on debtholders' wealth. Further, our findings are stronger for firms with a higher default risk where coordinated efforts amongst creditors become more pressing. A final test documents that a more concentrated debt structure reduces the negative influence of CEO risk-taking incentives on debtholder wealth thus highlighting the advantages of lower coordination problems amongst creditors.

JEL classification: G30, G32 J33, M12

Keywords: Debt Concentration; Executive Compensation; Asset Substitution; Corporate Governance.

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* We thank Helen Bollaert, Tim King, Pedro Martínez Solano, Myriam García Olalla, Eleuterio Vallelado González, Ephraim Clark and seminar participants at the 2015 International and Finance Doctoral Symposium (IAFDS) in Ljubljana for their helpful comments. We also thank participants at the 2015 Finance Forum in Madrid, at the I Workshop in Section of Finance (2016) and at the 3rd Young Finance Scholars Conference and Corporate Debt Workshop (2016) for their helpful suggestions on a preliminary version of the paper circulated with the title "The Incentives of Creditors to Monitor Via Debt Concentration: The Impact of CEO Compensation Structure and Horizon".

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1. Introduction

It is a widely accepted view that the presence of equity-based incentives in executive pay, by linking the value of compensation to stock return volatility and to stock price, contributes to aligning the interests of managers with those of shareholders (Brockman et al., 2010; Coles et al., 2006; Dow and Raposo, 2005; Lo, 2003). Another effect produced by these incentives is, however, the increase in the agency costs of debt related to asset substitution problems (Brockman et al., 2010; Cassell et al., 2012), commonly defined as risk-shifting (Eisdorfer, 2008; Leland, 1998). In fact, when equity-based compensation incentives favor risk-taking, managers might be tempted to replace safe activities with riskier ones, thus transferring wealth from debtholders to shareholders.

Nevertheless, debtholders understand the risk-taking incentives in executive pay and the related potential negative effects for their wealth (John and John, 1993; Kabir et al., 2013; Liu and Mauer, 2011; Ortiz-Molina 2007). Furthermore, Brockman et al. (2010) demonstrate this understanding generates constraints on a firm's financing policy by documenting that larger risk-taking incentives in CEO pay lead to an increase in the share of short-term debt in a firm's debt structure. Essentially, we observe an increase in the importance of those debt types that engender creditor monitoring (Barclays and Smith, 1995; Rajan and Winton, 1995; Stulz, 2000).

In this paper, we show that the relationship between executive compensation and a firm's debt structure goes beyond the established nexus between debt maturity and the structure of executive pay to influence the diversity of financing choices within a corporation. In doing so, we focus on the relationship between risk-taking incentives in executive compensation and the degree of debt concentration by debt type measured as in Colla et al. (2013), Li et al. (2016), Lou and Otto (2017) and Platikanova and Soonawalla (2014).

Our analysis is motivated by a growing set of studies suggesting that a high degree of concentration of the debt structure across different types of debts, and the consequent lower complexity of the debt structure, reduces coordination problems among creditors and the related costs of financial distress priced in debt financing (Colla et al., 2013; Li et al., 2016; Lou and Otto, 2017; Platikanova and Soonawalla, 2014). In fact, when creditors have similar cash flow rights, investment horizons, and relationships to the borrower, it is more likely that they share the same objectives, thus becoming more effective in coordinating their actions (Lou and Otto, 2017). In contrast, coordination problems amongst lenders are amplified by the diversification of their claims over the assets of a borrower with a consequent higher risk that creditors suffer from expropriation by shareholders (Bernardo and Talley, 1996; Bris and Welch, 2005; Gertner and Scharfstein, 1991) and from costly debt renegotiation and liquidations in the case of default (Bris and Welch, 2005; Platikanova and Soonawalla, 2014).

Several, as yet unexplored, testable implications emerge from the theoretical setting described above in terms of the relationship between executive compensation and debt structure. First, the concentration of debt claims should increase when managerial actions are more likely to shift risk to debtholders, as is the case of when managers receive greater risk-taking incentives in their compensation package (see Coles et al., 2006; Dong et al., 2010; Gormley et al., 2013; Guay, 1999; Park and Vrettos, 2015). This is because coordination problems among creditors are relevant in a risky setting for lenders, being instead unimportant if the debt is risk-free.

Second, the need for a more concentrated debt structure should be more pronounced when the executive compensation incentives lack any vesting restrictions, thus giving managers the opportunity to realize immediately wealth benefits at the expense of creditors. In fact, the lack of restrictions should favor a shorter-term perspective in firm risk-taking (Burns and Kedia, 2006; Devers et al., 2008; Efendi et al. 2007; Erkens, 2011; Kolasinsky and Yang, 2017).

Third, the impact of risk-taking incentives in executive pay on debt concentration should be stronger when firms are closer to a default condition. Riskier firms are more prone to risk-shifting (Black and Scholes, 1973; Leland, 1998) and a diversified group of debtolders would be inefficient in organizing and coordinating negotiation efforts in the case of bankruptcy (Bolton and

Scharfstein, 1996; Hart and Moore, 1995; Hubert and Schfer, 2002; Ivashina and Scharfstein, 2010; Lou and Otto, 2017). Along these lines, Lou and Otto (2017) show that the bankruptcy filings of firms with more heterogeneous debt structures are less likely to report prearranged resolution plans.

We build our analysis and test the validity of the three arguments proposed above on a sample of publicly traded US non-financial firms for the period 2001-2012. Following previous studies (see, for instance, Armstrong et al., 2013; Low, 2009; Rego and Wilson, 2012) we rely on the sensitivity of compensation to stock return volatility, commonly known as Vega, as our primary measure of the risk-taking incentives embedded in executive pay. We compute Vega for each CEO in the sample.[1] A higher Vega has usually been linked to higher risk-taking as it signals the possibility to gain in compensation in the presence of a more volatile business (Coles et al., 2006; Dong et al., 2010; Gormley et al., 2013; Guay, 1999; Park and Vrettos, 2015).

We start our analysis by finding consistently an increase in debt concentration when the CEO compensation sensitivity to stock return volatility increases. This finding highlights that the need to reduce coordination problems among creditors becomes more pressing when compensation packages can exacerbate risk-shifting strategies by corporate executives. Our conclusion is robust to changes in the way we measure debt concentration, to the addition of controls that have been shown to explain debt concentration, and to changes in the econometric method. Furthermore, it remains valid when we control for the potential endogeneity of Vega under an instrumental variable setting and, more importantly, when we exploit the adoption of FAS 123R in 2005 as a source of exogenous variation in Vega as in Hayes et al. (2012). Essentially, the implementation of FAS 123R removed the accounting advantages related to option compensation, thus producing large changes in Vega that are generally unrelated to other firm characteristics (Hayes et al., 2012).

[1] The focus on CEOs is a common choice in the literature on executive compensation (see, among others, Brockman et al., 2010; Coles et al., 2006; Fich et al., 2014; Liu and Mauer, 2011) given the centrality of this executive role in driving business choices at the firm level.

Next, we examine how our results are influenced by the vesting period of equity incentive following several papers that have highlighted how only incentives from vested options give the CEO the opportunity to realize immediate wealth benefits while other incentives imply a longer term managerial approach (Burns and Kedia, 2006; Devers et al., 2008; Efendi et al., 2007; Erkens, 2011; Kolasinsky and Yang, 2017). To this end, we quantify two components of Vega based on the vesting periods of the option holdings. Specifically, we compute a proxy for the shorter-term compensation benefits for the CEO produced by an increase in volatility by using only vested options and a proxy for the longer-term benefits by focusing on unvested options. Our analysis offers support for the conjecture that the vesting period of risk-taking incentives is critical in shaping the relationship between debt concentration and CEO pay. We show that our result of a positive impact of CEO risk-taking incentives on debt concentration is driven by those incentives related to stock options that can be immediately exercised by the CEO. In other words, we demonstrate that only increases in the component of Vega linked to vested options lead to a rise in the degree of debt concentration in a firm's debt structure.

We then proceed by evaluating our prior that creditors concerns over risk-shifting policies by managers are expected to be larger in firms that are more likely to default with the consequence of amplifying the impact of Vega on debt concentration as firms becomes riskier. By using different proxies for firm default risk based on market data, we indeed find that an increase in Vega raises the degree of debt concentration significantly more in riskier firms. Furthermore, we also document that the effect of Vega is generally driven by its component linked to vested options, suggesting that debtholders of riskier firms are especially concerned with the presence of risk-taking incentives that might impact on CEO wealth in the short-run. All in all, these additional tests highlight the role of the interplay between CEO pay and firm default risk in amplifying the importance of coordination problems among creditors.

While the analyses summarized above indicate a higher degree of debt concentration is potentially beneficial when the agency costs of debt are expected to be higher, they say, however, little as to what extent these costs are reduced when the debt structure becomes more concentrated by debt type. To quantify the potential benefits we rely on a similar empirical setting as in Eisdorfer (2008). Controlling for the level of corporate investments, we examine how the percentage change of the market value of debt is influenced by Vega and its components. In effect, the above approach implies that, for a given level of corporate investment, asset substitution problems would lead to a reduction in the percentage change of the market value of debt when Vega increases.

By comparing the impact of Vega on the percentage change of the market value of debt in firms with low and high degrees of debt concentration, we find that the negative influence of equity-based incentives on debtholder wealth is limited to the group of firms with less concentrated debt structures, especially in the presence of larger vested incentives. This result implies, therefore, that debt concentration is effective in curtailing asset substitution.

Our analysis offers a number of contributions to the extant literature. First, our study extends the growing literature that examines the drivers and implications of debt concentration by debt type. Existing studies have primarily focused on the importance of firm characteristics related to the information environment, access to credit and accounting quality (see Colla et al., 2013; Li et al. 2016; Platikanova and Soonawalla, 2014) and have documented the importance of the existing debt concentration in reducing the demand for covenants when raising new debt (Lou and Otto, 2017). Our analysis documents the importance of accounting for the agency costs of debt that are associated with the design of compensation packages when modelling the determinants of debt concentration and confirms the importance of this concentration in mitigating coordination problems among creditors.

Second, our focus on compensation relates our study to the existing evidence on the role of executive pay in influencing a firm's financing policy. While several analyses have generally linked executive incentives to firm leverage (Berger et al. 1997; Coles et al., 2006), to the types of debt (straight debt versus convertible debt) (Ortiz-Molina, 2007) and to the maturity of the debt contracts (Brockman et al., 2010), our analysis places emphasis of the composition of debt structure by type of claims.

Finally, our study is also related to the literature focusing on the reaction of debtholders to pay incentives in executive compensation. Previous studies have observed a negative bond price reaction in the presence of an increase in Vega (Billett et al., 2010), a higher cost of debt (Brockman et al., 2010; Daniel et al., 2004), a shorter debt maturity (Brockman et al., 2010), and a more concentrated syndicate lending structure (Chen, 2014) when compensation risk is higher. None of these studies, however, examine the implications of CEO incentive structures on the degree of concentration of the debt structure at the firm level.

The rest of the paper is organized as follows. Section 2 conducts a review of the related literature and develops testable hypotheses. In Section 3 we describe our data, the measurement of the key variables and our econometric method. Section 4 presents the empirical results, while Section 5 concludes the paper.

2. Theoretical Background and Hypotheses

2.1. Debt Concentration and Executive Compensation

The design of executive compensation contracts in the borrowing firms affects managerial incentives to engage in asset substitution (risk-shifting) that might favor shareholders and damage creditors (Brockman et al., 2010). In particular, the sensitivity of executive compensation to stock return volatility (Vega) should favor riskier business choices by managers as it implies that executives gain in compensation when the business becomes more volatile (Coles et al., 2006; Dong et al., 2010; Gormley et al., 2013; Guay 1999; Park and Vrettos 2015). For instance, the literature has associated a higher Vega with more R&D expenditures and fewer investments in fixed assets (Coles et al., 2006), higher leverage (Coles et al., 2006; Dong et al., 2010), less cash reserves (Gormley et al., 2013), and less hedging with derivative securities (Knopf et al., 2002).

However, managers' risk-taking pay incentives are thought to be understood and rationally priced by creditors and this might have implications for corporate financing decisions (see for instance, Billett et al., 2010; Daniel et al., 2004; Liu and Mauer, 2011). In fact an increase in Vega has been linked to a shorter maturity of the debt structure (Brockman et al., 2010); namely, to firms being forced to use debt contracts that limit managerial incentives to increase risk and reduce or even eliminate the agency costs associated with asset substitution by facilitating creditor monitoring (Barnea et al., 1980; Leland and Toft, 1996; Rajan and Winton, 1995; Stulz, 2000). In fact, with short-term contracts lenders can frequently review whether to continue providing credit and to restrict borrowers from increasing the riskiness of the underlying assets (Barnea et al., 1980).

Numerous theoretical studies argue, however, that other features of the debt structure influences coordination among creditors and the costs of financial distress (Allen, 1990; Diamond, 1984), and as such they are potentially associated with executive pay incentives.

For instance, earlier studies focus on the implications related to the number of a firm's creditors, highlighting that creditors have incentives to effectively monitor corporate borrowers provided they have a sufficient claim in the firm (Diamond, 1991; Holmström, 1982; Park, 2000). A larger number of creditors might then lead to free-riding problems and exacerbate conflicts in the case of a firm's liquidation.

More recent analyses focus instead on how the coordination problems between creditors vary when debt structures differ in the degree of concentration by debt type. The key argument proposed by these analyses is that a less concentrated debt structure amplifies coordination problems and the related financial distress costs, as it increases potential conflicts between debtholders (Lou and Otto, 2017). In fact, different types of creditors are less likely to agree on common objectives (Lou and Otto, 2017). This will result in larger coordination problems and would then favor expropriation by shareholders (Bernardo and Talley, 1996; Bris and Welch, 2005; Gertner and Scharfstein, 1991) and an increase in the risk that creditors suffer from costly debt renegotiation and liquidations in the presence of a distress (Bris and Welch, 2005; Hoshi et al., 1990; Platikanova and Soonawalla, 2014). More generally, the large costs of financial distress in the presence of disagreement between different types of lenders are priced in financing costs, thus making debts more expensive for the borrowing firm (Hoshi et al., 1990; Giammarino, 1989; Li et al., 2016).

In line with the view above, Colla et al. (2013) and Platikanova and Soonawalla (2014) show that when there is greater information asymmetry, borrowing firms rely on a more limited number of types of debt, while Li et al. (2016) achieve a similar conclusion for firms with weak internal control systems. In essence, the existing studies show that firms use less diverse sources of financing when they show characteristics signaling more dangers for creditor interests. It is not surprising, therefore, that new debt contracts include more covenants when a borrowing firm has a more heterogeneous existing debt structure (Lou and Otto, 2017).

Overall, a key implication offered by the existing studies on debt concentration is that when CEO compensation is designed in a way that amplifies the agency costs of debt linked to asset substitution problems, firms have to rely on more concentrated debt structures in terms of type of claims. In other words, the presence of risk-taking incentives in executive pay amplifies the importance of coordinated efforts among creditors thus favoring a less dispersed debt structure. The statement above can then be summarized in the following first hypothesis:

H1: An increase in the sensitivity of a CEO's compensation to stock return volatility increases the degree of debt concentration by debt type in a firm's debt structure.

2.2. Debt Concentration, CEO Incentive and Vesting Period

Several studies have highlighted the importance of distinguishing the risk-taking incentives from vested options from those attached to unvested options. In fact, only the former give the CEO the opportunity to realize immediate wealth benefits while the latter imply a longer-term managerial approach (Erkens, 2011). Along these lines, Devers et al. (2008) show that when CEOs hold larger values of exercisable options corporate risk-taking increases, while Burns and Kedia (2006) and Efendi et al. (2007) find that managers with large holdings of vested options are more likely to engage in misreporting. Furthermore, Kolasinsky and Yang (2017) show that financial firms with CEOs that were contractually allowed to sell or exercise more of the their stock and options holdings sooner had more subprime exposure, a higher probability of financial distress, and lower risk-adjusted stock returns during the 2007-2009 financial crisis.

A related line of research suggests that the time horizon of pay incentives, and not simply their structure, significantly influences managerial behavior (see, for instance, Cadman and Sunder, 2014; Edmans et al., 2015; Gopalan et al., 2014).

More generally, the presence of incentives offering potentially larger shorter term benefits makes it attractive for managers to choose riskier projects that boost short-term performance and enhance manager reputation (Gopalan et al., 2014; Thakor, 1990), without particular attention being given to their long-term effects.

In the context of our analysis, the discussion above implies that the impact of risk-taking incentives on debt concentration should be more pronounced when these incentives are supposed to be detrimental to creditor interests in the shorter-run. Accordingly, we expect that more concentrated debt structures materialize especially in firms whose CEOs have larger risk-taking incentives due to vested options. In accordance with this argument, we formalize our second hypothesis as follows:

H2: An increase in the risk-taking incentives due to the CEO's vested options has a stronger effect on the degree of debt concentration in a firm's debt structure than an increase in the incentives due to unvested options.

2.3. Debt Concentration, CEO Incentive and Firm Default Risk

The relationships between debt concentration and risk-taking incentives in executive pay postulated above are unlikely to be independent from firm default risk. In fact, there are at least two reasons that lead to a higher firm default risk amplifying the increase in the concentration of the debt structure in fewer sources of financing when risk-taking incentives in executive compensation are larger.

First, coordination problems among creditors become evident when a firm is in distress as a dispersed debt structure is inefficient in organizing and coordinating negotiation efforts (Hart and Moore, 1995; Hubert and Schafer, 2002; Ivashina and Scharfstein, 2010). This conclusion finds support in the theoretical models proposed by Bolton and Scharfstein (1996) and by Bris and Welch (2005) and in the empirical analysis of Lou and Otto (2017). This latter study documents that the bankruptcy filings of firms characterized by more heterogeneous debt structures are less likely to include a prearranged resolution plan.

Second, firms that are closer to financial distress are more likely to engage in risk-shifting (Black and Scholes, 1973; Leland, 1998). This is because shareholders benefit from risky investments if the investments go well, while debtholders will bear the costs in the case of a negative outcome. In line with this view, Eisdorfer (2008) shows that an increase in investment intensity increases asset volatility in distressed firms while it reduces asset volatility in healthier firms.

Overall the two aspects mentioned above should be particularly relevant in riskier firms where executive pay is characterized by high risk-taking incentives that might accelerate the actual default of the organization. In these firms, therefore, we should observe a further decline in the use of heterogeneous sources of financing. Accordingly, we formulate the following third hypothesis:

H3: An increase in the sensitivity of a CEO's compensation to stock return volatility increases the degree of debt concentration in a firm's debt structure especially in riskier firms.

3. Data Overview and Variable Measurement

3.1 Data Sources and Sample Selection

The analysis presented in this paper is based on four data sources: Capital IQ, ExecuComp, Compustat, and CRSP. We begin our sampling process by obtaining data on the debt structure of firms (needed to compute the degree of debt concentration as detailed in section 3.2) from Capital IQ for the period from 2001 to 2012. Following previous studies on debt concentration (see, for instance, Colla et al., 2013; Lou and Otto, 2017), we remove financial firms (SIC codes from 6000 to 6999) from the list of selected firms given their specificities in terms of capital structure and debt composition.

Next, by using the CIK identifier, we match the initial sample with firm level characteristics extracted from Compustat and market data from CRSP. From this sample we exclude observations with missing or zero values for total assets or total debt, firm-years with market or book leverage outside the unit interval, and observations where the difference between total debt, as reported in Compustat, and the sum of the different debt types reported in Capital IQ exceeds 10% of total debt (as in Colla et al., 2013). Furthermore, we remove the few observations where the debt maturity ratio (defined by the ratio between debts with maturity lower than three years over total debts) is less than 0 or greater than 1, since they are potentially erroneous (Brockman et al., 2010).

We finally match the remaining sample (by using the GVKEY identifier) with the firms included in Standard and Poor´s ExecuComp database that we employ to collect CEO compensation data.

[Insert Table 1 here]

In Panel A of Table 1, we report the sample distribution by year. Our final sample contains 6,300 firm-year observations for 1,006 unique firms. The number of firms ranges from a minimum of 279 in year 2001 to a maximum of 644 in year 2011. In Panel B of the same Table we report the sample distribution by industry breakdown based on the Fama and French industry classification. Overall, we observe that none of the industries has a share of the sample in terms of total observations larger than 8.1%.

3.2 Measures of Debt Concentration By Debt Type

Following Colla et al. (2013), Li et al. (2016), Platikanova and Soonawalla (2014) we construct measures of debt concentration based on debt types by using yearly balance sheet data from Capital IQ.

Our preferred proxy of debt concentration is the normalized Herfindahl-Hirschman Index (**HHI**) of the usage of different debt types. To compute this index, we first calculate the total sum of the squares of the share of the seven mutually exclusive debt types reported in Capital IQ over the total volume of debt for firm *i* in year *t* as shown below:

$$SS_{it} = \left(\frac{CP_{it}}{TD_{it}}\right)^2 + \left(\frac{DC_{it}}{TD_{it}}\right)^2 + \left(\frac{TL_{it}}{TD_{it}}\right)^2 + \left(\frac{SBN_{it}}{TD_{it}}\right)^2 + \left(\frac{SUB_{it}}{TD_{it}}\right)^2 + \left(\frac{CL_{it}}{TD_{it}}\right)^2 + \left(\frac{Other_{it}}{TD_{it}}\right)^2 \quad (1)$$

Where TD refers to total debt, CP refers to commercial paper, DC to drawn credit lines, TL to term loans, SBN to senior bonds and notes, SUB to subordinated bonds and notes, CL to capital leases, and Other to the remaining debt in a firm's capital structure (including securities sold under an agreement to repurchase, securities debt, total trust-preferred stock and other unclassified borrowing). The normalized Herfindahl-Hirschman Index (HHI) of debt types is then computed as follows:

$$HHI_{it} = \frac{SS_{it} - 1/7}{1 - 1/7} \quad (2)$$

This index ranges from zero to one. HHI equals one when a firm employs exclusively one single debt type, whereas if a firm simultaneously employs all seven types of debt in equal proportion, HHI equals zero. Therefore, higher HHI values indicate a firm's tendency to specialize in fewer debt types (that is, a lower borrowing diversity), while lower values of HHI indicate a lower debt concentration (namely, a higher borrowing variety).

Following Colla et al. (2013), we also employ an alternative measure of debt concentration defined for firm *i* in year *t* by the dummy variable **Excl90** as follows:

$\textbf{Excl90}_{it}$= 1 if a firm obtains at least 90% of its debt from one debt type, = 0 otherwise.

Table 2 presents summary statistics of the share of each debt type and for the two related measures of debt concentration. The majority of the debt is in the form of senior bonds and notes (with a sample mean of 55.9% of total debt) followed by drawn credit lines (14.1%) and term loans (11.9%). The shares for the remaining types of debt are quite low, ranging from 7.3% for subordinated bonds and notes, to 2.2% for commercial paper.[2] The measure of debt concentration has a mean value of 0.697 for HHI and 0.440 for Excl90, which are similar to the reported means over time (0.676-0.718 in HHI and 0.424-0.487 in Excl90) in Table II of Colla et al. (2013).

[Insert Table 2 here]

In the Online Appendix we report the sample distribution of debt concentration by industry. There is a considerable variation in the degree of debt concentration across the industrial categories.[3] All estimated specifications, therefore, contain industry dummies to limit the risk that our results are driven by omitted industry controls.

3.3 Measuring Risk-Taking Incentives in CEO Pay and Incentive Horizons

Vega is a conventional measure of risk-taking incentives in executive pay widely employed in the literature (see Brockman et al., 2010; Coles et al., 2006; Core and Guay, 2002, among others). Vega captures the change in the value of a CEO's stock and option portfolio due to a 1% increase in the standard deviation of the firm's stock returns. In essence, Vega expresses the incentives for CEOs to undertake investments that increase firm risk.

[2] Total adjustment is the difference between total debt obtained from Compustat and the sum of seven debt types from Capital IQ. We show that the mean and median of the total adjustment to total debt are nearly zero.

[3] For instance, companies in the "Fabricated products" sector show an average degree of debt concentration of approximately 43.9%, while for companies in the "Computer Software" sector the average increases to above 86.7%.

Another widely employed measure of equity-based incentives is Delta; namely, the sensitivity of a CEO's portfolio to stock price. Delta is defined as the change in the value of a CEO's stock and option portfolio in response to a 1% increase in the price of a firm's common stock. Delta is a measure of the incentives for CEOs to undertake value-enhancing investments but the impact of Delta on the decision of a risk-averse manager to undertake a risky project is controversial and difficult to predict. On the one hand, by linking compensation to changes in equity prices, a higher Delta should increase the propensity of a risk-averse manager to realize the project as Delta implies an increase in value for the manager's wealth (a reward effect according to Armstrong et al., 2013). On the other hand, a higher Delta might induce a risk-averse manager to opt for more prudent behavior as Delta magnifies the impact of changes in price on manager wealth (a risk-effect according to Armstrong et al., 2013). Nevertheless, Armstrong et al. (2013) argue that the risk-taking incentives Vega provides to managers should materialize empirically so long as the regression controls for differences in the manager risk premium that, at least in part, is determined by Delta. Therefore, we employ Vega as our key measure of risk-taking incentives in executive pay and include Delta as a control.

Two CEOs with an identical Vega may, however, have significantly different short-term benefits from an increase in firm volatility depending on when their options might be exercised. In this respect, Vega does not allow us to clearly identify the potential short-term effect that a change in firm volatility of stock price might have on CEO pay. To account for this, similarly to Burns and Kedia (2006), Devers et al. (2008) and Efendi et al. (2007), we rely on the information on the vesting periods of the portfolio of options held by each CEO. Accordingly, we decompose Vega into vested and unvested components.

Vested Vega measures the sensitivity to changes in stock return volatility of the portfolio consisting of all exercisable options. As such, a larger vested Vega should indicate more pronounced short-term benefits for CEO pay from increases in stock return volatility. Unvested

Vega is instead the sensitivity of the value of the portfolio of all unexercisable options (including those of newly granted options and existing Unvested options) to changes in stock return volatility.

The computation of Vega, its components, and Delta is based on the Black and Scholes (1973) option-pricing model adjusted for dividends by Merton (1973) and on the methodology proposed by Core and Guay (2002). To ease exposition, we discuss details of the methodology employed to compute the different measures of risk-taking incentives in the Online Appendix.

[Insert Table 3 here]

In Panel A of Table 3 we present the summary statistics for the measures of equity based incentives employed in our analysis. It is worth noting that to reduce the skewness of the distribution of the measures of equity pay-incentives, we follow Brockman et al. (2010) and Kim et al. (2011) and employ the log transformation of Vega (LNVEGA), Unvested Vega (LNVEGA_UNVEST), Vested Vega (LNVEGA_VEST) and Delta (LNDELTA) instead of the raw measures in the empirical tests. Finally, it is worthwhile noting that high values of LNVEGA_UNVEST are not necessarily associated with high values of LNVEGA_VEST, the correlation between the two variables being equal to 0.62. Along these lines, we find that about 1181 yearly CEO observations (equivalent to about 19% of the full sample) have a LNVEGA_UNVEST equal to zero. In more than 60% of these observations (723), however, LNVEGA_VEST is larger than zero.

3.4 Estimation Method and Control Variables

To estimate how risk-taking incentives in executive compensation impact on the degree of debt concentration, we follow Colla et al. (2013) and initially employ an econometric approach that is appropriate to deal with the censored nature of our preferred measure of debt concentration (HHI). We estimate, therefore, a pooled Tobit regression model with standard errors clustered at the industry-year level. More precisely, the Tobit model is specified as follows:

$$HHI_{it} = \beta_0 + \beta_1 LNVEGA_{it} + \beta_2 LNDELTA_{it} + \beta_3 X_{it} + \beta_4 Z_{it} + \sum_{k=1}^{49} S_k + \sum_{t=2001}^{2012} Y_t + \varepsilon_{it} \quad (3)$$

Where HHI_{it} is the degree of debt concentration of firm i in year t, $LNVEGA_{it}$ and $LNDELTA_{it}$ are the measures of equity incentives, X_{it} is a vector of firms' financial characteristics, Z_{it} is a vector of CEO control variables, β_0 is the constant term and β are the coefficients of the explanatory variables, S_k is the set of industries dummies, Y_t is a set of time dummy variables and ε_{it} is the error term. All variables are winsorized at 1% and 99% in order to remove possible bias due to the presence of outliers. When we employ Excl90 as the dependent variable, we estimate a similar equation via a Probit model as in Colla et al. (2013).

The control variables are divided into two different categories: firm characteristics and CEO controls. Details on how all the variables are constructed are presented in Panel B of Table 3. The vector of firm characteristics *(X)* that, based on Colla et al. (2013), are considered determinants of debt concentration, includes book leverage (**LEVERAGE**), size (**SIZE**), the market to book ratio (**MARKET_BOOK**), firm profitability (**PROFITABILITY**), the degree of asset tangibility (**TANGIBILITY**), a dummy equal to one if a firm is a dividend payer (**DIVIDEND_PAYER**), cash flow volatility (**CF_VOL**), the value of R&D expenses divided by total assets (**R&D**)[4], and a dummy equal to one if a firm is not rated by S&P (**UNRATED**). Essentially, these controls aim to capture the role of bankruptcy costs, incentives to monitor and access to capital markets as potential determinants of the degree of debt concentration (Colla et al. 2013; Platikanova and Soonawalla, 2014).

We add to this set of controls a dummy equal to one if a firm is from a regulated industry (**REG_DUM**) and firm age as the number of years since it appears in the COMPUSTAT database (**FIRM_AGE**). In particular, older firms are expected to show a wider access to capital markets with the consequence of exhibiting a lower degree of debt concentration. The vector of CEO control variables (Z) includes CEO ownership, defined as the percentage of a company´s shares

[4]Following Edmans et al. (2015) and Himmelberg et al. (1999) we replace missing R&D values by zero.

owned by the CEO (**CEO_SHARES**), and a pay slice variable that, as in Bebchuk et al. (2011), is defined as the percentage of the total compensation to the top five executives that goes to the CEO (**PAYSLICE**). These controls might influence the risk-taking attitude of the CEO. For instance, greater ownership should mitigate CEO risk-taking incentives (Armstrong et al., 2013; Guay, 1999) while PAYSLICE is typically a proxy for the relative power of a CEO within the organization. As such, the omission of these variables may bias the potential effect of risk-taking incentives on the debt structure

The summary statistics for our control variables, reported in Panel B of Table 3, are in general, consistent with those reported in Billett et al. (2007), Colla et al. (2013), and Li et al. (2016), among others. The correlation matrix for all the explanatory variables (including Vega and Delta), reported in the Online Appendix in the interest of brevity, indicates that the selected variables are in general far from being highly correlated.

4. Empirical Results

4.1 The Impact of CEO Risk-Taking Incentives on Debt Concentration

In the first four columns of Table 4 we report the empirical results from the Tobit regression model where the degree of debt concentration, measured via HHI, is modeled as a function of CEO pay incentives. Our empirical analysis starts with a parsimonious specification that includes only a limited number of control variables and progresses with additional models that differ in the number of controls.

In all specifications, the coefficient assigned to our proxy for risk-taking incentives in CEO pay is in line with our first hypothesis. We find that the presence of higher risk-taking incentives in the forms of a higher sensitivity of CEO pay to stock return volatility (higher values of LNVEGA) increases the degree of debt concentration in a firm's debt structure. This result confirms the view that a higher degree of debt concentration is required when CEO incentives amplify the risk of asset substitution. In terms of economic impact, we observe that, using the results for the model reported in column 4, an increase from the 25th to the 75th percentile of the sample distribution in LNVEGA increases the degree of debt concentration in the debt structure by about 2 percentage points. It is also worth noting that LNDELTA enters all models with a negative coefficient, significant at customary levels; that is, an increase in the value incentives in CEO pay reduces the need for a more specialized debt structure.

[Insert Table 4 here]

In columns (5) and (6) of Table 4 we assess whether our results depend on the estimation methods or the way we measure the degree of debt concentration. In column (5) we re-estimate the model reported in column (4) using OLS, while in column (6) we estimate a Probit model where Excl90 is the dependent variable.[5] Again, our results on the effects of LNVEGA on the degree of debt concentration remain qualitatively unchanged. In unreported tests, we also repeat our analysis excluding utilities from our sample as in Colla et al. (2013); our findings remain qualitatively the same. Furthermore, we evaluate whether our results are driven by the financial crisis of 2007-2009 by interacting LNVEGA (and LNDELTA) with a dummy equal to one during the crisis period. Under this empirical setting, we do not find that the financial crisis explains our findings.

In terms of control variables, most of our results confirm the evidence provided by previous empirical studies on debt concentration (Colla et al. 2013; Li et al., 2016; Platikanova and Soonawalla, 2014). The estimated coefficients on LEVERAGE and SIZE are negative and statistically significant at customary levels, while increases in MARKET_BOOK, CF_VOL, and R&D increase the degree of debt concentration. Furthermore, the degree of debt concentration is

[5] As additional robustness tests we also repeat the analysis by using two alternative measures of debt concentration that we compute as in Li et al. (2016). The two measures are motivated by the idea that coordination costs amongst creditors might differ depending on the debt type. Accordingly, we initially combine private debt types (term loans and credit lines) into one debt category and, consequently, estimate HHI across six debt categories. Next, we also combine all public bonds (senior bonds and notes and subordinated bonds and notes) into one category and re-estimate HHI across five debt categories. When we use these alternative measures, we still find a positive and significant relationship between Vega and debt concentration.

greater in more regulated industries as shown by the positive coefficient for REG_DUM, and in younger firms as shown by the negative and significant coefficient for FIRM_AGE.

To recap, the results discussed in this section support our first hypothesis that debt concentration increases in the presence of larger incentives (generated by the compensation structure) for CEOs to engage in asset substitution. In other words, when the potential conflicts between debtholders and shareholders are increased by the design of CEO pay incentives, the need to reduce coordination problems amongst creditors is reflected in a more concentrated debt structure.

4.2 Alternative Specifications

4.2.1 Omitted Variables: Additional controls

Our analysis might be biased because of omitted variables that simultaneously affect both debt concentration and LNVEGA. In this section we estimate a set of alternative specifications that attempt to account for this problem. In the interest of brevity we only report the key coefficients in Panel A of Table 5.

In particular, our initial analysis does not account for the governance structure of the firm that has the potential to affect both creditors and managers as it might influence the shareholder orientation of a corporation. Therefore, in the first two columns of Panel A, we account for this potential omitted variable bias by including in the most comprehensive specification of the Tobit and Probit models (shown in the previous section) a set of governance characteristics. Accordingly, we include in the models the log transformation of board size, the degree of board independence (both taken from BoardEx) and a measure of co-opted boards (taken from Coles at al. (2014) and defined as the ratio between directors appointed after the appointment of the CEO and the total number of board members).[6] We further account for the external governance via the log transformation of the number of analysts. Although the inclusion of these controls reduces the

[6] Data on co-opted boards are available here: https://sites.temple.edu/lnaveen/data/.

sample size of approximately 25%, we still find that LNVEGA shows a positive and highly significant coefficient.

In the next column, we further rule out the potential effects of omitted variables by adding to our baseline Tobit model industry x year fixed effects (column (3)). With this specification, therefore, we assess how LNVEGA impacts on the cross-sectional variation in debt concentration in a given year within an industry. We still find that our results remain unchanged. In the final two columns we account for unobserved firm heterogeneity. We start in column (4) by estimating a fixed effect panel that in addition to industry x year fixed effects includes firm fixed effects. Finally, in the last column we account for unobserved heterogeneity using a panel Random Effect Tobit model (with industry x year fixed effects). In all settings, we still find that our key result of a positive impact of LNVEGA on debt concentration is confirmed.

4.2.2 Controlling for the Endogeneity of Risk-Taking Incentives in CEO Pay

Another possible concern over the validity of the results reported in section 4.1 refers to the potential endogeneity of our measures of CEO pay incentives due to reverse causality. For instance, numerous studies suggest that corporate policy might affect the way the compensation packages offered to executives are designed (see for instance Coles et al., 2006; Guay, 1999). One obvious source of endogeneity is, therefore, the potential reverse causality between debt concentration and pay incentives. It might be the case that a higher concentration of debt structure, and the related effect in terms of managerial discipline, might induce boards to increase incentives to CEOs so as to safeguard the interests of shareholders at the expense of debtholders.

We proceed in several ways to rule out the possibility that our results are biased due to the presence of reverse causality. The results of these tests are reported in Panel B of Table 5. In the interest of brevity, we only show the estimated coefficients for the key variables in our analysis.

[Insert Table 5 here]

Initially, we follow Boone et al. (2007), Faleye et al., (2014) and Faleye (2015) among others that deal with reverse causality by regressing the dependent variable on lagged values of the potentially endogenous explanatory variables. This choice is based on the intuition that such historical values are largely predetermined (Faleye, 2015). Therefore, in the first two columns of Table 5 we re-estimate the most comprehensive specification of the Tobit model reported in the previous section, with one and two period lags, respectively, of all explanatory variables. Our results remain qualitatively similar; we again find evidence that an increase in LNVEGA increases the degree of concentration in a firm's debt structure. Notably, also the impact of LNDELTA remains qualitatively unchanged.

In the next column, we address reverse causality by estimating instrumental variable Tobit models that resemble the more conventional use of 2SLS in Bhagat and Bolton (2008) and Coles et al. (2006). We identify potential instruments for our measures of equity-pay incentives by following Armstrong and Vashishtha (2012), Brockman et al. (2010) and Chen et al. (2015). Accordingly, we use cash from assets-in-place scaled by total assets (CASH), sales growth (SGRTH) and the firm's marginal tax rate (TAX_DUM) as instruments.

Two motivations can justify an impact of CASH on equity incentives, though the two motivations imply opposite signs in the relationship between CASH and LNVEGA. First, cash-constrained firms employ equity incentives as substitutes for cash compensation (Core and Guay, 1999). Alternatively, agency problems tend to be higher in firms with greater cash balances (Jensen, 1986; Stulz, 1990), and these problems can be mitigated by larger equity incentives (Armstrong and Vashishtha, 2012). Although the sign of the relationship of this instrument with equity incentives is a priori uncertain, there is no obvious reason to postulate a different debt structure for cash-constrained firms as compared to other firms.

The second instrument ((SGRTH) is normally associated with lower values of Vega (Chen et al., 2015). In terms of this latter result, as suggested by Datta et al. (2001) sales growth might be seen as a proxy for growth opportunities and this might reduce the need to provide risk-taking incentives in executive pay. The third instrument (TAX_DUM) is calculated as a dummy variable equal to one if a firm has a tax-loss carry-forward in any of the last three years. The tax-loss carry forward should have a negative relationship with equity incentives since the future tax deduction from deferred compensation will be higher than the immediate tax deduction related to cash compensation when expected corporate tax rates are higher (Core and Guay 1999).

The results of the first-stage regressions (where the instruments for the Vega regression are significant and CASH enters with a positive sign) are reported in the first two columns of Table A.V in the Online Appendix while the second stage results are reported in column (3) of Table 5. In this Table we also show the Hansen J-statistic of over-identifying restriction to test the validity of the selected instruments. In this respect, the insignificant values of the Hansen test (under the null hypothesis that the instruments are valid; namely that the instruments are uncorrelated with the error term) confirm the model is well identified and that our instruments satisfy the required exogeneity conditions. More importantly, under this new empirical setting we generally confirm the results of the previous tests: we still find that an increase in LNVEGA increases the degree of debt concentration. [7,8]

We finally address endogeneity by exploiting the adoption of FAS 123R in 2005 as a source of exogenous variation in Vega as in Hayes et al. (2012). Essentially, the implementation of FAS 123R removed the accounting advantages related to option compensation thus producing large changes in Vega that are generally unrelated to other firm characteristics (Hayes et al., 2012). To capture this source of exogenous variation in CEO incentives, we implement the empirical setting adopted in Hayes et al. (2012) and estimate a difference equation where all variables are expressed as the

[7] In Table A.V in the Appendix we show the results of the endogeneity tests for the Probit specification using Excl90 as an alternative dependent variable. The results are qualitatively similar to those shown in Table 5 and confirm an increase in debt concentration when Vega increases.

[8] As a further robustness test (available upon request) we implement an instrumental variable setting based on Kini and Williams (2012) using industry benchmarks as instruments. We employ the mean values of LNVEGA (LNDELTA) by industry and year as instruments for LNVEGA (LNDELTA) at the firm level. Kini and Williams (2012) suggest that industry benchmarks in terms of compensation are likely to be reflected in CEO pay at the firm level, whereas they are unlikely to influence business policies. Similarly to Brockman et al. (2010) we also employ the log transformation of (one plus) the total cash compensation received by the CEO as an additional instrument, as CEOs that receive larger cash compensation are also more likely to benefit from larger LNVEGA (LNDELTA). While the first stage regressions and statistical tests validate our instruments selection, we still observe in the second stage regression a positive relationship between debt concentration and CEO Vega.

difference between their mean values computed for the post- (from 2005 to 2008) and the pre-FAS 123R period (from 2002 to 2004). We use all available firm-years to calculate the mean values and require all observations per firm in both periods. Furthermore, as in Hayes et al. (2012) we employ the dollar value of Vega and Delta (and not their log transformation) in our tests. Under this setting we estimate the difference equation using both an OLS specification and a quantile (median) regression, with this latter approach accounting for the potential influence of extreme values in the changes in Vega and Delta. The results, reported in columns (4) and (5) confirm a positive impact of risk-taking incentives on debt concentration.

Taken together, the tests discussed in this section confirm the presence of a strong positive relationship between debt concentration and risk-taking incentives in CEO pay as measured by LNVEGA.

4.2.3 Controlling for the Simultaneity of Debt Concentration and Debt Maturity

The degree of debt concentration might be jointly determined with other characteristics of a firm's financing policy. For instance, Brockman et al. (2010) show that when CEOs are rewarded with pay incentives that amplify the risk of asset substitution, the debt maturity in a firm's capital structure tends to decline. In the context of our analysis, therefore, the use of shorter-term debt contracts might act as a potential substitute or as a possible complement to debt concentration.

To examine the effects of managers' incentives on different aspects of a firm's financial policy and to control for a possible interrelationship between debt concentration and debt maturity, we estimate a system of three equations. The three dependent variables are debt concentration, debt maturity and leverage with the inclusion of this latter equation being justified by the possible endogeneity between different aspects of financial policy and the degree of corporate leverage as suggested by Brockman et al. (2010). Furthermore, following Brockman et al. (2010), we measure debt maturity as the ratio between debt with a maturity lower than 3 years and total debt, and leverage as the ratio of long term debt over total assets. As detailed in the Online Appendix, the selection of the set of controls is also broadly based on Brockman et al. (2010).

The results reported in the Table A.VI of the Online Appendix show that LNVEGA (LNDELTA) remains significant even after we control for the possible simultaneity between debt concentration and debt maturity. Furthermore, we observe that LNVEGA influences debt maturity and leverage in a similar manner as to how it affects the degree of debt concentration, while our measure of debt concentration enters with a negative and highly significant coefficient in the maturity equation. This shows that debt concentration can be seen as an alternative tool of debt policy to contain the risk of asset substitution generated by CEO pay.

4.3 Debt Concentration and Incentive Vesting Period

In this section we focus on our second hypothesis and explore how the impact of CEO pay incentives on debt concentration depends on the vesting period of the incentives. As explained in Section 3.3, LNVEGA does not allow us to infer indications on the possible differential effects of shorter-term and longer-term risk-taking incentives within the pay contract. To this end, we extend our baseline model by replacing LNVEGA with its vested and unvested components (LNVEGA_VEST, and LNVEGA_UNVEST), computed as explained in Section 3.3.

More precisely, when we decompose LNVEGA, we maintain LNDELTA in the specification as an explanatory variable (in addition to the full set of control variables defined in the previous section).[9] Furthermore, we conduct the analysis by initially using a Tobit specification with HHI as the dependent variable; we then consider a Probit model with Excl90 as the dependent variable.

[Insert Table 6 here]

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[9] In unreported tests we also re-estimate the models by decomposing total Delta into Vested and Unvested components. However, we design our empirical setting by taking into account that there is a high degree of correlation between Unvested Vega and Unvested Delta (r= 0.9672). Accordingly, we do not simultaneously decompose Vega and Delta in the same specification to avoid including both Unvested Vega and Unvested Delta in the same model. These additional tests show that the impact of Delta on debt concentration does not depend on the vesting period of the incentives.

The results reported in columns (1), (2), (4) and (5) of Table 6 refer to regression models where the components of Vega are introduced separately. In columns (3) and (6) we re-estimate the models by jointly controlling for LNVEGA_VEST, and LNVEGA_UNVEST. We find positive and significant coefficients for vested Vega (LNVEGA_VEST) for both the Tobit and Probit models. In contrast, the results for unvested Vega (LNVEGA_UNVEST) are not significant at customary levels. In essence, we find that the positive influence of Vega on debt concentration is driven by the risk-taking incentives with the potential to generate gains from more aggressive risk-taking in the short-term. This result supports, therefore, our second hypothesis. In terms of economic impact, we observe that, using the results for the model reported in column 4, an increase from the 25th to the 75th percentile of the sample distribution in LNVEGA_VEST (equivalent to an increase of about 190,000 US $ in Vega) increases the degree of debt concentration in the debt structure by approximately 2.2 percentage points. This increase is similar to the one obtained by Brockman et al. (2010) for the share of short-term debt for a similar change in risk-taking incentives.

Finally, in the last two columns of Table 6 we address endogeneity concerns by exploiting the adoption of FAS 123R in 2005 as a source of exogenous variation as in section 4.2.2. We report the result of this test in the last two columns of Table 6 (where all the controls are computed as differences between the post- and pre- FAS 123R as defined earlier). The results for the OLS specification (column (7)) and for the Quantile regression ((column (8)) confirm the positive relationship between LNVEGA_VEST and debt concentration.

Overall, the findings reported in this section suggest that pay-incentives linked to stock return volatility matter in influencing the debt structure especially when they have the potential to generate immediate wealth gains for the CEO due to the lack of vesting restrictions, thus amplifying the risk of asset substitution problems over the shorter-term.

4.4 Debt Concentration, Corporate Default Risk and CEO Risk-Taking Incentives

To test our third hypothesis (that the impact of risk-taking incentives in CEO pay on debt concentration is amplified in riskier firms) we initially extend our baseline Tobit and Probit specifications with interaction terms between LNVEGA and two alternative market-based proxies of firm distress risk. In addition, to control for possible variation in the importance of value incentives related to distress risk, we also interact LNDELTA with our two proxies of distress risk.

Our first proxy of distress risk is the distance to default measure (DD) based on Merton (1974) and is computed according to the formula reported below:

$$DD = \frac{\ln(V / F) + (\mu - 0.5\sigma^2_V)T}{\sigma_V \sqrt{T}} \tag{4}$$

where V is the total market value of the firm, F is the value of total liabilities, μ is an estimate of the expected annual return of the firm's assets, and σ_v is the annualized volatility of the firm's asset return. The derivation of DD requires the estimation of two unknowns, the market value of assets and the volatility of asset returns, that we obtain by employing the interactive numerical approach based on option pricing used by, among others, Hillegeist et al. (2004), Vallascas and Hagendorff (2013) and Vassalou and Xing (2004).

The second measure is the naïve distance to default (NAÏVE_DD) proposed by Bharath and Shumway (2008). Differently from DD, the calculation of NAÏVE_DD is less computationally intensive as it does not require an interactive numerical method. Specifically, following Bharath and Shumway (2008), we employ the formula reported below:

$$NAÏVEDD = \frac{\ln\left[(\mathrm{E} + \mathrm{F}/F)\right] + (\mathrm{r}_{it-1} - 0.5 * naïve\sigma^2_V)T}{naïve\sigma_V \sqrt{T}} \tag{5}$$

where E is the market value of equity, r_{it-1} is the firm's stock return over the previous year, and naïve σ_v is the approximation of asset volatility that is obtained by multiplying the volatility of equity returns by the equity to asset ratio.

For both risk measures, smaller values signal a higher likelihood that a default will occur; to conduct the empirical tests we multiply each measure by minus one. As a result, in all specifications, larger values of the risk variables will consistently indicate higher firm default risk.

[Insert Table 7 here]

The results of the extended Tobit regression models with interaction terms between LNVEGA (LNDELTA) and firm default risk are reported in the first two columns of Table 7 whereas the results for the extended Probit regression are reported in columns (3) and (4). Notably, to reduce multicollineary between the interaction terms and the constituent terms, we employ a de-mean approach as in Vallascas and Hagendorff (2013). Thus, for each variable involved in the computation of the interaction terms, its sample mean is subtracted before computing the interaction term. As a result, in Table 7 the coefficients of LNVEGA (LNDELTA) have to be interpreted as referring to a company with average default risk; namely, when the interaction term with one of the measures of default risk is equal to zero.

Furthermore, as suggested by Norton et al. (2004), in non-linear models it is not possible to infer the role and the degree of significance of the interaction term simply through the estimated coefficient and the related standard error. Following Berger and Bouwman (2013), therefore, we report in Panel B the coefficients and standard errors of the marginal effects of equity-based incentives computed for low (default risk proxy equal to the 25th percentile of the sample distribution) and high risk firms (default risk proxy equal to the 75th percentile of the sample distribution). [10]

In general, the regression results of Table 7 show that CEO risk incentives linked to stock return volatility are seen as being more dangerous in more risky firms and this conclusion is independent from the way we measure default risk. Specifically, while the interaction terms

[10] More specifically, for the Tobit model we compute the marginal effects of the censored expected value. These marginal effects describe how the observed variable (Debt Concentration) changes with respect to the variations in the incentives variables (Vega and Delta) for different levels of distress risk.

between LNVEGA and default risk are positive and significant, more importantly the marginal effects reported in Panel B are significant only when firms are characterized by higher default risk. It is worth noting, that the results for LNDELTA (not reported in the interest of brevity) are less consistent, with the marginal effects being significant in both low and high risk firms.[11] This is not surprising given the more controversial relationship between risk-taking incentives and LNDELTA.

We next repeat the analysis by separating LNVEGA into the vested (LNVEGA_VEST) and the unvested (LNVEGA_UNVEST) components. The results of the extended Tobit regression models with interaction terms between LNVEGA_VEST, LNVEGA_UNVEST and firm default risk are reported in columns (5) and (6) of Table 7 and the results for the extended Probit regressions are reported in columns (7) and (8). In line with the findings discussed in the previous section our results indicate that the positive influence of CEO risk-taking incentives on debt concentration is amplified in riskier firms when these incentives are related to vested options. More precisely, the marginal effects, computed for different values of firm default risk (and reported in panel B), are significant only in the case of LNVEGA_VEST. Furthermore, the marginal effect referring to LNVEGA_VEST computed for a riskier firm is significantly higher than the marginal effect computed for a safer firm (at least when the dependent variable is the HHI index).

In summary, in line with our third hypothesis, when firm risk increases there is greater concern about the presence of risk-incentives linked to stock return volatility. In effect, these risk-incentives are likely to be especially detrimental to the survival of firms that are characterized by a higher degree of riskiness. Furthermore, in line with this view, when we take into account for the vesting period of risk-taking incentives, we observe that the impact of firm default risk materializes especially in the presence of incentives linked to vested options.

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[11] This is especially the case when the analysis is based on HHI. Furthermore, in unreported tests we find that the magnitude of the marginal effects of LNDELTA is not statistically different between low and high risk firms.

Overall, our findings document that debt concentration is sought in the presence of CEO risk-taking incentives especially when borrowing firms are closer to a default condition.

4.5 Debt Concentration, CEO Risk-Taking Incentives and Asset Substitution

Our analysis says little as to the extent to which debt concentration is indeed helpful in curtailing the agency costs of debt produced by executive compensation in the form of asset substitution.

In this section we assess, therefore, the benefits to debtholders stemming from debt concentration. To this end we take as a point of departure the view that the presence of the agency costs of debt materializes via a decrease in the market value of debt when managers engage in asset substitution via riskier projects as in the framework employed by Eisdorfer, (2008). In accordance with this framework, we expect, controlling for the level of corporate investments, that an increase in LNVEGA should lower the growth rate of the market value of debt. Nevertheless, if it is effective in curtailing the agency cost of debt, a higher degree of debt concentration should mitigate the negative impact of LNVEGA on the growth rate in the market value of debt.

We design our empirical setting by initially estimating for the full sample of firms the sensitivity of the yearly percentage change of the market value of debt to risk-taking incentives in executive pay, via an OLS regression model specified as follows:

$$\%\Delta V_{Dit} = \beta_0 + \beta_1 LNVEGA_{it} + \beta_2 LNDELTA_{it} + \beta_3 INVESTMENT_{it} + \beta_4 X_{it} + \beta_5 Z_{it} + \sum_{k=1}^{49} S_k + \sum_{t=2001}^{2012} Y_t + \varepsilon_{it} \quad (6)$$

Similarly to Eisdorfer (2008), the dependent variable is the yearly percentage change in the market value of debt (V_D), that we measure in continuous time ($Ln(V_{D_t}) - Ln(V_{D_{t-1}})$) to reduce skewness in the dependent variable. The dependent variable is expected to capture the value effect for debtholders produced by a firm's business policies. More precisely, the market value of debt is the difference between the market value of firm assets (estimated via option pricing as described in the previous section) and the market value of equity.

Our key explanatory variable in equation (6) is LNVEGA, while a critical control is INVESTMENTS, as it measures the investment intensity and it is expected to increase the market value of debt. Following Eisdorfer (2008), we compute investment intensity as capital expenditures scaled by property, plant and equipment. In addition, we include the vector of firm characteristics (X) and the vector of CEO control variables (Z), both described in section 3.4.

[Insert Table 8 here]

The results for model (6) are reported in column (1) of Table 8 and, in line with our prediction, show that an increase in LNVEGA reduces the percentage change in the market value of debt. Our results also show that larger value incentives (as indicated by higher value of LNDELTA) are associated with an increase in the yearly percentage change of the market value of debt.

To assess the role of debt concentration in safeguarding the interests of debtholders, we next repeat the analysis by splitting our sample into firms with low and high degrees of debt concentration. We group the firms in our sample by adopting two alternative criteria. First, we classify as having a highly specialized debt structure firms with a value of HHI above the sample median. Second, we employ the dummy variable Excl90 and define as highly specialized those firms with a value of Excl90 equal to one.

The results of the regression models for the sub-samples, reported in columns (2) to (5) of Table 8, show that when debt concentration is low, LNVEGA has a negative effect on the percentage change of the market value of debt. In contrast, LNVEGA does not have any impact on the percentage change of the market value of debt in firms with a higher degree of debt concentration. To recap, we find that the negative effect of increases in LNVEGA on the percentage change of the market value of debt is confined to firms with a less concentrated debt structure.

Next we extend the analysis by decomposing LNVEGA into LNVEGA_VEST and LNVEGA_UNVEST to test whether our findings vary with the vesting period of the pay incentives. The results reported in columns (6) to (10) show that risk-taking incentives due to unvested equity do not exercise any effect on debtholders' wealth and this result is independent from which measure of debt concentration we employ to split the sample. In contrast, we observe a significant influence of LNVEGA_VEST that materializes primarily in firms with a low degree of debt concentration. In short, when debt concentration is measured by the HHI index, LNVEGA_VEST has a significantly stronger (at the 1% level) negative effect on the percentage change of the market value of debt in the sub-sample of firms with a degree of debt concentration below the sample median[12]. Similarly, when we measure debt concentration via Excl90, we observe a negative and significant coefficient for LNVEGA_VEST only in the group of firms with a low degree of debt concentration (Excl90 equal to zero).

Overall, the analysis reported in this section indicates that a high degree of debt concentration mitigates risk shifting by firms where the risk-taking incentives of the CEO have the potential to produce wealth gains for the executive in the shorter term.

5. Conclusions

Previous studies identify the shortening of the maturity of debt as a way to reduce the risk for creditors to suffer from asset substitution that arises when the design of compensation packages amplifies risk-taking incentives by the CEO (Brockman et al., 2010). Our analysis highlights how another characteristic of firm debt policy (the degree of debt concentration by debt type) that has been shown to reflect coordination problems among creditors is influenced by CEO pay incentives.

More precisely, in line with the view proposed by recent studies that a more concentrated debt structure tends to decrease coordination problems among creditors, and the related costs of financial distress priced in debt financing (Colla et al., 2013; Li et al., 2016; Lou and Otto, 2017;

[12] We observe a negative and significant coefficient of Vested Vega on the change in debt value for firms with HHI above the median (Column (8)). However, this coefficient is lower and less significant than for firms with HHI below the median. Furthermore, the difference between the two coefficients is statistically significant according to the Chow and Chi-squared tests.

Platikanova and Soonawalla, 2014), we find a strong positive relationship between debt concentration and risk-taking incentives in executive compensation (measured by CEO Vega). In other words, we find that firms have to rely on fewer debt types when CEO pay is designed in a way that potentially amplifies risk-shifting against creditors. This result is robust to a number of changes in our empirical setting, including when we account for the potential endogeneity of CEO risk-taking incentives using a similar setting as in Hayes et al. (2012).

In a set of further tests we provide additional evidence in favor of our results capturing creditors' concerns over risk-shifting that affect a firm's financing policy via a coordination problem channel. In fact, we demonstrate that the effect of risk-taking incentives on debt concentration is stronger when creditor interests are more at risk. In this respect we find that our results are stronger when borrowing firms show higher incentives to engage in risk-shifting in the interest of shareholders in the short-term (see Devers et al., 2008; Kolasinsky and Yang, 2017), and when this risk-shifting is more likely to lead to the default of the company in the short-run (see Eisdorfer, 2008).

Finally, we show that after controlling for the level of investments, an increase in Vega and its vested component only reduces the percentage change of the market value of debt in firms characterized by a low degree of debt concentration. This latter result, therefore, highlights the benefits of a more concentrated debt structure for creditors when CEO pay incentives might favor risk-shifting.

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Table 1: Sample Distribution by Year and by Industry

Table 1 shows the sample distribution by year for the period ranging from 2001 to 2012. The final sample contains 6,300 observations from 49 industry sectors.

Panel A: Sample Distribution by Year

Year	Observations	
	N.	%
2001	279	4.43
2002	401	6.37
2003	446	7.08
2004	474	7.52
2005	480	7.62
2006	533	8.46
2007	589	9.35
2008	606	9.62
2009	593	9.41
2010	620	9.84
2011	644	10.22
2012	635	10.08
Total	6300	100.00

Panel B: Sample Distribution by Industry

Industries	Fama-French 49 sectors	N	%
Agriculture	1	23	0.37
Food Products	2	162	2.57
Candy & Soda	3	23	0.37
Beer & Liquor	4	15	0.24
Tobacco Products	5	22	0.35
Toys Recreation	6	35	0.56
Fun Entertainment	7	68	1.08
Books Printing and Publishing	8	60	0.95
Consumer Goods	9	139	2.21
Clothes Apparel	10	79	1.25
Healthcare	11	116	1.84
Medical Equipment	12	183	2.91
Drugs Pharmaceutical Products	13	206	3.27
Chemicals	14	273	4.33
Rubber and Plastic Products	15	44	0.70
Textiles	16	34	0.54
Construction Materials	17	167	2.65
Construction	18	116	1.84
Steel Works, etc.	19	146	2.32
Fabricated Products	20	6	0.10
Machinery	21	363	5.76
Electrical Equipment	22	104	1.65
Automobiles and Trucks	23	128	2.03
Aircraft	24	72	1.14
Ships Shipbuilding, Railroad Equipment	25	16	0.25
Guns Defence	26	26	0.41
Precious Metals	27	14	0.22
Mines Non-Metallic and Industrial Metal Mining	28	43	0.68
Coal	29	33	0.52
Oil Petroleum and Natural Gas	30	354	5.62
Utilities	31	512	8.13
Communication	32	168	2.67
Personal Service	33	96	1.52
Business Service	34	292	4.64
Computer Hardware	35	119	1.89
Computer Software	36	233	3.70
Electronic Equipment	37	368	5.84
Measuring and Control Equipment	38	159	2.52
Paper Business Supplies	39	172	2.73
Shipping Containers	40	78	1.24
Transportation	41	252	4.00
Wholesale	42	249	3.95
Retail	43	304	4.86
Meals Restaurants, Hotels, Motels	44	129	2.05
Others	49	99	1.57
Total		6300	100.00

Table 2: Summary Statistics of Debt Types and Debt Concentration

This table shows summary statistics for the ratios of different debt types to total debt, as well as for the two measures of debt concentration HHI and Excl90.

Variable	Definition	Obs.	Mean	5th perc.	25th perc.	Median	75th perc.	95th perc.	Std. Dev.
CP	Commercial paper/Total Debt	6300	0.022	0.000	0.000	0.000	0.000	0.157	0.078
DC	Drawn credit line/Total Debt	6300	0.141	0.000	0.000	0.000	0.134	0.923	0.269
TL	Term loans/Total Debt	6300	0.119	0.000	0.000	0.000	0.085	0.819	0.250
SBN	Senior bonds and notes/Total Debt	6300	0.559	0.000	0.067	0.681	0.917	1.000	0.386
SUB	Subordinated bonds and notes/Total Debt	6300	0.073	0.000	0.000	0.000	0.000	0.681	0.220
CL	Capital leases/Total Debt	6300	0.034	0.000	0.000	0.000	0.005	0.118	0.146
OTHER	Other debt plus total trust-preferred stock/Total Debt	6300	0.052	0.000	0.000	0.000	0.024	0.273	0.157
Total Adjustment	Total debt − (CP + DC + TL + SBN + SUB + CL + Other)	6300	-0.001	-0.025	-0.000	0.000	0.000	0.019	0.018
HHI	$\{[[CP/(Total\ debt)]^2 + [DC/(Total\ debt)]^2 + [TL/(Total\ debt)]^2 + [SBN/(Total\ debt)]^2 + SUB/(Total\ debt)]^2 + [CL/(Total\ debt)]^2 + [(Other)/(Total\ debt)]^2] - (1/7)\}/(1 - (1/7))$	6300	0.697	0.281	0.463	0.719	0.966	1.000	0.254
Excl90	Dummy equal to 1 if a firm has more than 90% of its total debt in one debt type (CP, DC,TL, SBN, SUB, CL, or OTHER), and 0 otherwise	6300	0.440	0.000	0.000	0.000	1.000	1.000	0.496

Table 3: Summary Statistics of Explanatory Variables

This table presents descriptive statistics for the variables used in the debt concentration model. The sample contains 6,300 observations and covers the 2001 to 2012 period.

Variable	Definition	Mean	Std. Dev.	Min.	25th perc.	Median	75th perc.	Max.
Panel A: Pay Variables								
LNVEGA	Natural log of one plus the change in the value of a CEO's option portfolio due to a 1% change in the annualized standard deviation of stock returns plus one. Ln (1+Vega)	4.085	1.812	0.000	3.175	4.375	5.368	7.293
LNDELTA	Natural log of one plus the change in the value of a CEO's stock and option portfolio due to a 1% increase in the value of the firm's common stock price plus one. Ln (1+Delta)	5.546	1.371	2.048	4.656	5.551	6.448	9.184
LNVEGA_UNVEST	Natural log of one plus the change in the value of a CEO's option portfolio of Unvested stocks and options due to a 1% change in the annualized standard deviation of stock returns plus one. Ln (1+Vega Unvested)	3.088	1.922	0.000	1.749	3.490	4.555	6.487
LNVEGA_VEST	Natural log of one plus the change in the value of a CEO's option portfolio of Vested stocks and options due to a 1% change in the annualized standard deviation of stock returns plus one. Ln (1+Vega Vested)	3.366	1.828	0.000	2.228	3.631	4.710	6.868
Panel B: Additional Controls								
LEVERAGE	Total debt over total assets. Total debt is defined as debt in current liabilities plus long-term debt	0.260	0.156	0.001	0.150	0.250	0.353	0.722
SIZE	Logarithm of total assets measured in millions US$	8.030	1.485	4.912	6.936	7.913	9.019	11.835
MARKET_BOOK	MV of equity plus total debt plus preferred stock liquidating value minus deferred taxes and investment tax credit over total assets	1.119	0.945	-0.106	0.491	0.901	1.468	5.054
PROFITABILITY	Operating income before depreciation over total assets	0.139	0.076	-0.113	0.094	0.133	0.179	0.389
TANGIBILITY	Net property, plant, and equipment over total assets	0.314	0.236	0.019	0.126	0.238	0.472	0.892
DIVIDEND_PAYER	Equals one if common stock dividends are positive	0.608	0.488	0.000	0.000	1.000	1.000	1.000
CF_VOL	Standard deviation of operating cash flows from operations calculated over the 3 year period before the observation year over total assets	0.032	0.029	0.002	0.013	0.023	0.041	0.159
R&D	Research and development expenses over total assets	0.021	0.038	0.000	0.000	0.000	0.025	0.199
UNRATED	Equals one if a firm does not have a S&P rating on long-term debt, and zero otherwise	0.332	0.471	0.000	0.000	0.000	1.000	1.000
REG_DUM	Equals one if the firm's SIC code is between 4,900 and 4,939 (firms from regulated industries) and zero otherwise	0.078	0.269	0.000	0.000	0.000	0.000	1.000
FIRM_AGE	Natural log of one plus the number of years since the firm was added to the database Compustat.	3.320	0.638	1.792	2.773	3.434	3.932	4.143
CEO_SHARES	Number of shares owned by the CEO scaled by total shares outstanding	0.014	0.038	0.000	0.001	0.003	0.008	0.250
PAYSLICE	The percentage of the total compensation to the top five executives that goes to the CEO	0.400	0.100	0.124	0.340	0.406	0.462	0.671

Table 4: Debt Concentration and CEO Risk-Taking Incentives

This table presents regression results to examine the relation between the degree of debt concentration and the sensitivity of CEOs' compensation to stock return volatility (**LNVEGA**) controlling for the sensitivity of CEO compensation to changes (in percent) to stock prices (**LNDELTA**) and for firm and CEO characteristics, industry dummies (based on Fama-French 49) and year dummies. In the first five columns the dependent variable is a Herfindahl index of concentration of debt structure by type of debt (**HHI**), while in the last column it is a dummy equal to one if more than 90% of the debt structure is concentrated in only one type of debt (**Excl90**). The set of controls include **LEVERAGE** (Total debt over total assets), **SIZE** (Logarithm of total assets measured in millions US$), **MARKET_BOOK** (market value of equity plus total debt plus preferred stock liquidating value minus deferred taxes and investment tax credit over total assets), **PROFITABILITY** (operating income before depreciation over total assets), **TANGIBILITY** (net property, plant, and equipment over total assets), **DIVIDEND_PAYER** (a dummy equal to one if a firm pays common stock dividends), **CF_VOL** (the standard deviation of operating cash flows from operations calculated over the 3 year period before the observation year over total assets), **R&D** (research and development expenses over total assets), **UNRATED** (a dummy equal to one if a firm does not have a S&P rating on long-term debt, and zero otherwise), **REG_DUM** (a dummy equal to one for regulated firms defined as firms with a SIC code between 4,900 and 4,939), **FIRM_AGE** (the log transformation of one plus the number of years since the firm was added to the Compustat database), **CEO_SHARES** (number of shares owned by the CEO scaled by total shares outstanding) and **PAYSLICE** (the percentage of the total compensation to the top five executives that goes to the CEO). Statistical significance is based on industry-year clustered standard errors. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

	Dependent Variable					
	HHI					Excl90
	Tobit				OLS	Probit
	(1)	(2)	(3)	(4)	(5)	(6)
LNVEGA	**0.008*** **	**0.008*** **	**0.008*** **	**0.009*** **	**0.006** **	**0.034** **
	[0.003]	**[0.003]**	**[0.00263]**	**[0.003]**	**[0.003]**	**[0.015]**
LNDELTA	**-0.0139*** **	**-0.011*** **	**-0.0109*** **	**-0.012** **	**-0.009** **	**-0.046* **
	[0.004]	**[0.004]**	**[0.004]**	**[0.005]**	**[0.004]**	**[0.025]**
LEVERAGE	-0.556***	-0.557***	-0.565***	-0.570***	-0.466***	-2.259***
	[0.027]	[0.027]	[0.027]	[0.027]	[0.023]	[0.137]
SIZE	-0.025***	-0.022***	-0.025***	-0.021***	-0.016***	-0.077***
	[0.004]	[0.00397]	[0.004]	[0.004]	[0.004]	[0.022]
MARKET_BOOK	0.049***	0.041***	0.042***	0.039***	0.028***	0.126***
	[0.006]	[0.007]	[0.007]	[0.008]	[0.005]	[0.033]
PROFITABILITY		-0.036	-0.046	-0.044	-0.019	0.051
		[0.061]	[0.061]	[0.061]	[0.050]	[0.317]
TANGIBILITY		0.021	0.026	0.018	0.007	-0.148
		[0.029]	[0.029]	[0.029]	[0.026]	[0.141]
DIVIDEND_PAYER		0.004	0.004	0.016	0.017**	0.060
		[0.010]	[0.010]	[0.010]	[0.008]	[0.046]
CF_VOL		0.662***	0.640***	0.663***	0.492***	2.867***
		[0.134]	[0.135]	[0.135]	[0.110]	[0.671]
R&D		1.362***	1.368***	1.359***	0.935***	4.787***
		[0.182]	[0.183]	[0.183]	[0.122]	[0.791]
UNRATED			-0.012	-0.015	-0.021***	-0.106**
			[0.010]	[0.009]	[0.008]	[0.047]
REG_DUM			0.159***	0.164***	0.144***	1.216***
			[0.050]	[0.050]	[0.049]	[0.466]
FIRM_AGE				-0.0333***	-0.0238***	-0.131***
				[0.007]	[0.006]	[0.035]
CEO_SHARES				-0.0101	-0.0105	-0.223
				[0.129]	[0.107]	[0.650]
PAYSLICE				0.0153	0.0216	0.0521
				[0.035]	[0.0291]	[0.178]
Constant	1.079***	1.019***	1.047***	1.115***	0.780***	1.493***
	[0.034]	[0.040]	[0.040]	[0.044]	[0.038]	[0.224]
Industry dummies	YES	YES	YES	YES	YES	YES
Time dummies	YES	YES	YES	YES	YES	YES
Observations	6,300	6,300	6,300	6,300	6,300	6,294
Pseudo R2	0.395	0.430	0.432	0.438	.	0.136
R2 adj.	.	.	.	.	0.209	.

Table 5: Additional Tests

This table presents the regression results on the relation between the degree of debt concentration and the sensitivities of CEOs' compensation to stock return volatility (**LNVEGA**) controlling for the sensitivity of CEO compensation to changes (in percent) to stock prices (**LNDELTA**), for firm and CEO characteristics, industry dummies (based on Fama-French 49) and year dummies and for the potential endogenetiy of equity-based incentives. The dependent variable is a Herfindahl index of concentration of debt structure by type of debt (HHI). In Panel A we address potential problems due to omitted variables by adding governance controls (columns (1) and (2)), and by controlling for industry*year fixed effects (column (3)), for industry*year fixed effects and firm fixed effect (column (4) and by estimating a Random Effect Tobit model. Panel B addresses endogeneity due to reverse causality by estimating the model with all right-hand side variables lagged one year (column 1), all right-hand side variables lagged two years (column 2) and an instrumental variable regression for HHI in columns 3i and an exogenous shock setting in the last two columns. The set of controls include **LEVERAGE** (total debt over total assets), **SIZE** (logarithm of total assets measured in millions US$), **MARKET_BOOK** (market value of equity plus total debt plus preferred stock liquidating value minus deferred taxes and investment tax credit over total assets), **PROFITABILITY** (operating income before depreciation over total assets), **TANGIBILITY** (net property, plant, and equipment over total assets), **DIVIDEND_PAYER** (a dummy equal to one if a firm pays common stock dividends), **CF_VOL** (the standard deviation of operating cash flows from operations calculated over the 3 year period before the observation year over total assets), **R&D** (research and development expenses over total assets), **UNRATED** (a dummy equal to one if a firm does not have a S&P rating on long-term debt, and zero otherwise), **REG_DUM** (a dummy equal to one for regulated firms defined as firms with a SIC code between 4,900 and 4,939), **FIRM_AGE** (the log transformation of one plus the number of years since the firm was added to the Compustat database), **CEO_SHARES** (number of shares owned by the CEO scaled by total shares outstanding) and **PAYSLICE** (the percentage of the total compensation to the top five executives that goes to the CEO). Statistical significance is based on industry-year clustered standard errors. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

Panel A: Omitted Variables					
	Tobit	Probit	Tobit	Fixed Effect	Random Effect Tobit
	+Governance	+Governance			
	HHI	**Excl90**	**HHI**	**HHI**	**HHI**
	(1)	(2)	(3)	(4)	(5)
LNVEGA	**0.012*** **	**0.038** **	**0.008*** **	**0.007** **	**0.010*** **
	[0.003]	**[0.0179]**	**[0.003]**	**[0.003]**	**[0.003]**
LNDELTA	-0.016**	-0.056*	-0.014***	-0.009*	-0.014***
	[0.006]	[0.032]	[0.005]	[0.005]	[0.005]
Constant	1.076***	1.286***	1.064***	1.903***	1.268***
	[0.069]	[0.340]	[0.042]	[0.139]	[0.097]
Observations	4,500	4,487	6,300	6,300	6,300
Control variables	YES	YES	YES	YES	YES
Industry dummies	YES	YES	YES	YES	YES
Time dummies	YES	YES	YES	YES	YES
Industry*Time dummies	NO	NO	YES	YES	YES
Firm Fixed Effects	NO	NO	NO	YES	NO
Pseudo R2	0.425	0.125	0.538	0.185	

Panel B: Reverse Causality					
	1-Lag	2-Lag	IV	Exogenous Shock	
	HHI	**HHI**	**HHI**	**ΔHHI**	
				OLS	Quantile Regression
	(1)	(2)	(3)	(4)	(5)
LNVEGA	**0.012*** **	**0.010** **	**0.262*** **		
	[0.004]	**[0.004]**	**[0.099]**		
LNDELTA	**-0.018*** **	**-0.023*** **	**0.0434**		
	[0.006]	**[0.006]**	**[0.090]**		
ΔVEGA				**0.092** **	**0.062** **
				[0.040]	**[0.030]**
ΔDELTA				**0.005**	**0.001**
				[0.013]	**[0.003]**
Constant	1.008***	0.968***	1.613***	-0.007	-0.006
	[0.049]	[0.054]	[0.254]	[0.016]	[0.015]
Observations	4,524	3,814	6,245	542	542
Control Variables	YES	YES	YES	YES	YES
Industry dummies	YES	YES	YES	NO	NO
Time dummies	YES	YES	YES	NO	NO
Pseudo R2	0.418	0.402	.	.	.
R2	.	.		0.06	0.022
Hansen test	.	.	0.1413	.	.

Table 6: CEO Vesting Period and Debt Concentration

This table reports the empirical results on the relation between debt concentration and the component of CEO Vega. Specifically, we distinguish the component based on Vested options (**LNVEGA_VEST**), from the component based on Unvested options (**LNVEGA_UNVEST**). The All specifications control for the sensitivity of CEO compensation to changes (in percent) to stock prices (**LNDELTA**), firm and CEO characteristics. The models from column (1) to column (6) include industry dummies (based on Fama-French 49) and year dummies, while the models reported in columns (7) and (8) are estimated using the difference approach described in section 4.2.2. with the dependent variable and all the controls are expressed as the difference between the average value over the period 2005-2008 and the average value from 2002 to 2004. Columns from (1) to (3) present the regression results using the Tobit methodology, the dependent variable being a Herfindahl index of concentration of debt structure by type of debt (HHI), while in the last three columns we use Probit methodology since the dependent variable is a dummy equal to one if more than 90% of the debt structure is concentrated in only one type of debt (Excl90). In columns (1) and (3) we include Unvested and Vested Vega CEO. In columns (2) and (4) we employ the ratio between Unvested Vega and total Vega. The set of controls include **LEVERAGE** (total debt over total assets), **SIZE** (logarithm of total assets measured in millions US$), **MARKET_BOOK** (market value of equity plus total debt plus preferred stock liquidating value minus deferred taxes and investment tax credit over total assets), **PROFITABILITY** (operating income before depreciation over total assets), **TANGIBILITY** (net property, plant, and equipment over total assets), **DIVIDEND_PAYER** (a dummy equal to one if a firm pays common stock dividends), **CF_VOL** (the standard deviation of operating cash flows from operations calculated over the 3 year period before the observation year over total assets), **R&D** (research and development expenses over total assets), **UNRATED** (a dummy equal to one if a firm does not have a S&P rating on long-term debt, and zero otherwise), **REG_DUM** (a dummy equal to one for regulated firms defined as firms with a SIC code between 4,900 and 4,939), **FIRM_AGE** (the log transformation of one plus the number of years since the firm was added to the Compustat database), **CEO_SHARES** (number of shares owned by the CEO scaled by total shares outstanding) and **PAYSLICE** (the percentage of the total compensation to the top five executives that goes to the CEO). Statistical significance is based on industry-year clustered standard errors from column (1) to column (6) and on robust standard errors in the last two columns. ***, **, and * denote significance at the 1%, 5%, and 10% levels respectively.

		HHI			**Excl90**		**ΔHHI**	
		Tobit			**Probit**		**OLS**	**Quantile**
							Exogenous shock	
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**
LNVEGA_VEST	**0.010***** **[0.002]**		**0.010***** **[0.002]**	**0.033**** **[0.013]**		**0.033**** **[0.014]**		
LNVEGA_UNVEST		**0.002** **[0.002]**	**-0.001** **[0.003]**		**0.009** **[0.0127]**	**-0.002** **[0.014]**		
LNDELTA	**-0.013***** **[0.005]**	**-0.006** **[0.004]**	**-0.013***** **[0.005]**	**-0.046*** **[0.025]**	**-0.022** **[0.023]**	**-0.045*** **[0.025]**		
ΔVEGA_VEST							**0.119*** **[0.061]**	**0.060**** **[0.029]**
ΔVEGA_UNVEST							**0.018** **[0.090]**	**0.045** **[0.083]**
ΔDELTA							**0.006** **[0.013]**	**0.009** **[0.003]**
LEVERAGE	-0.572*** [0.027]	-0.569*** [0.027]	-0.573*** [0.027]	-2.266*** [0.138]	-2.250*** [0.137]	-2.266*** [0.138]	-0.350*** [0.106]	-0.236*** [0.086]
SIZE	-0.021*** [0.004]	-0.021*** [0.004]	-0.021*** [0.004]	-0.075*** [0.022]	-0.075*** [0.022]	-0.075*** [0.022]	-0.075*** [0.026]	-0.056** [0.025]
MARKET_BOOK	0.041*** [0.008]	0.037*** [0.008]	0.041*** [0.008]	0.130*** [0.033]	0.118*** [0.033]	0.130*** [0.033]	0.001 [0.024]	-0.001 [0.015]
PROFITABILITY	-0.039 [0.061]	-0.047 [0.061]	-0.038 [0.061]	0.066 [0.317]	0.038 [0.318]	0.068 [0.318]	0.211 [0.131]	-0.0055 [0.153]
TANGIBILITY	0.0189 [0.029]	0.012 [0.029]	0.0186 [0.029]	-0.149 [0.141]	-0.171 [0.140]	-0.15 [0.141]	-0.037 [0.174]	-0.096 [0.137]
DIVIDEND_PAYER	0.016 [0.010]	0.017* [0.010]	0.016 [0.010]	0.06 [0.046]	0.064 [0.046]	0.061 [0.046]		
CF_VOL	0.662*** [0.135]	0.672*** [0.136]	0.661*** [0.135]	2.868*** [0.671]	2.905*** [0.673]	2.866*** [0.671]	0.178 [0.322]	0.084 [0.214]
R&D	1.341*** [0.183]	1.371*** [0.184]	1.341*** [0.183]	4.735*** [0.789]	4.825*** [0.793]	4.735*** [0.788]	-0.842 [0.756]	-0.631 [0.624]
UNRATED	-0.015* [0.009]	-0.015* [0.009]	-0.015* [0.009]	-0.107** [0.047]	-0.106** [0.047]	-0.107** [0.047]		
REG_DUM	0.162*** [0.051]	0.158*** [0.059]	0.161*** [0.050]	1.208*** [0.466]	1.196*** [0.461]	1.207*** [0.466]		
FIRM_AGE	-0.034*** [0.007]	-0.032*** [0.007]	-0.034*** [0.007]	-0.133*** [0.035]	-0.126*** [0.035]	-0.133*** [0.035]	0.098 [0.086]	0.105 [0.078]
CEO_SHARES	0.00331 [0.124]	-0.138 [0.125]	-0.007 [0.127]	-0.258 [0.630]	-0.705 [0.634]	-0.277 [0.649]	-0.502* [0.298]	-0.323 [0.298]
PAYSLICE	0.022 [0.035]	0.017 [0.036]	0.024 [0.036]	0.078 [0.178]	0.059 [0.180]	0.082 [0.180]	-0.018 [0.097]	0.002 [0.088]
Constant	1.116*** [0.044]	1.105*** [0.044]	1.114*** [0.045]	1.489*** [0.223]	1.456*** [0.227]	1.484*** [0.228]	-0.009 [0.016]	-0.007 [0.015]
Observations	6,300	6,300	6,300	6,294	6,294	6,294	542	542
Industry dummies	YES	YES	YES	YES	YES	YES	NO	NO
Time dummies	YES	YES	YES	YES	YES	YES	NO	NO
Pseudo R2	0.439	0.435	0.439	0.136	0.135	0.136	0.061	0.022

Table 7: Debt Concentration, CEO Risk-Taking Incentives and Corporate Risk

Panel A presents the regression results to examine whether the relations between the degree of debt concentration and the sensitivities of CEOs' compensation to stock return volatility (**LNVEGA**) vary with firm risk. In all specifications we control for the sensitivity of CEO compensation to changes (in percent) to stock prices (**LNDELTA**), for firm and CEO characteristics, industry dummies (based on Fama-French 49) and year dummies. In columns (1), (2). (5) and (6) the dependent variable is a Herfindahl index of concentration of debt structure by type of debt (**HHI**), in the other columns it is a dummy equal to one if more than 90% of the debt structure is concentrated in only one type of debt (**Excl90**). Accordingly, (1), (2), (5) and (6) columns present the regression results using the Tobit methodology, whereas the remaining specifications are estimated via a Probit model. In the first four columns we study Delta and Vega, whereas in the remaining columns we separate Vega into Vested (**LNVEGA_VEST**) and Unvested (**LNVEGA_UNVEST**) components. Firm risk is defined through two alternative proxies: the distance to default (**DD**) based on Merton (1974) and the naïve distance to default (**NAÏVEDD**) proposed by Bharath and Shumway (2008). The set of controls include **LEVERAGE** (total debt over total assets), **SIZE** (logarithm of total assets measured in millions US$), **MARKET_BOOK** (market value of equity plus total debt plus preferred stock liquidating value minus deferred taxes and investment tax credit over total assets), **PROFITABILITY** (operating income before depreciation over total assets), **TANGIBILITY** (net property, plant, and equipment over total assets), **DIVIDEND_PAYER** (a dummy equal to one if a firm pays common stock dividends), **CF_VOL** (the standard deviation of operating cash flows from operations calculated over the 3 year period before the observation year over total assets), **R&D** (research and development expenses over total assets), **UNRATED** (a dummy equal to one if a firm does not have a S&P rating on long-term debt, and zero otherwise), **REG_DUM** (a dummy equal to one for regulated firms defined as firms with a SIC code between 4,900 and 4,939), **FIRM_AGE** (the log transformation of one plus the number of years since the firm was added to the Compustat database), **CEO_SHARES** (number of shares owned by the CEO scaled by total shares outstanding) and **PAYSLICE** (the percentage of the total compensation to the top five executives that goes to the CEO). **Panel B** reports the marginal effects of LNVEGA and LNDELTA for the Tobit and Probit models computed for low and high risk firms. Statistical significance is based on industry-year clustered standard errors. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

	Tobit HHI	Tobit HHI	Probit Excl90	Probit Excl90	Tobit HHI	Tobit HHI	Probit Excl90	Probit Excl90
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A: Regression analysis								
LNVEGA	0.010***	0.010***	0.038***	0.039***				
	[0.003]	[0.003]	[0.015]	[0.015]				
LNVEGA_VEST					0.011***	0.011***	0.036**	0.037**
					[0.003]	[0.003]	[0.014]	[0.015]
LNVEGA_UNVEST					-0.000	-0.001	0.002	0.001
					[0.003]	[0.003]	[0.014]	[0.014]
LNDELTA	-0.013***	-0.014***	-0.049**	-0.056**	-0.015***	-0.016***	-0.050**	-0.057**
	[0.00474]	[0.00476]	[0.025]	[0.025]	[0.004]	[0.00476]	[0.025]	[0.025]
DD	0.001		0.000		0.001		0.001	
	[0.002]		[0.008]		[0.002]		[0.008]	
DD*LNVEGA	0.003***		0.012***					
	[0.001]		[0.003]					
DD*LNDELTA	-0.001		-0.005		-0.001		-0.005	
	[0.001]		[0.004]		[0.001]		[0.004]	
NAÏVEDD		0.001		0.003		0.001		0.002
		[0.001]		[0.008]		[0.001]		[0.008]
NAÏVEDD*LNVEGA		0.003***		0.013***				
		[0.001]		[0.003]				
NAÏVEDD*LNDELTA		-0.000		-0.003		-0.000		-0.004
		[0.001]		[0.004]		[0.001]		[0.005]
DD*LNVEGA_VEST					0.001**		0.005	
					[0.001]		[0.004]	
DD*LNVEGA_UNVEST					0.002**		0.010***	
					[0.001]		[0.003]	
NAÏVEDD*LNVEGA_VEST						0.001**		0.005
						[0.001]		[0.003]
NAÏVEDD*LNVEGA_UNVEST						0.001**		0.009***
						[0.001]		[0.003]
Control variables	YES	YES	YES	YES	YES	YES	YES	YES
Constant	1.065***	1.042***	1.340***	1.266***	1.055***	1.033***	1.307***	1.235***
	[0.0518]	[0.0525]	[0.263]	[0.268]	[0.0520]	[0.0528]	[0.265]	[0.270]
Observations	6,280	6,233	6,274	6,227	6,280	6,233	6,274	6,227
Industry dummies	YES	YES	YES	YES	YES	YES	YES	YES
Time dummies	YES	YES	YES	YES	YES	YES	YES	YES
Pseudo R2	0.442	0.443	0.137	0.137	0.443	0.444	0.137	0.138
Panel B: Marginal Effects								
Vega (low risk firms)	0.003	0.003	0.005	0.005	.	.	.	.
Vega (high risk firms)	0.014***	0.014***	0.024***	0.025***	.	.	.	.
Vega (high vs low risk firms)	0.011**	0.011***	0.019***	0.020***	.	.	.	.
Vega Vested (low risk firms)	.	.	.	.	0.007***	0.006***	0.009*	0.009*
Vega Vested (high risk firms)	.	.	.	.	0.012***	0.013***	0.016***	0.017***
Vega Vested (high vs low risk firms)	.	.	.	.	0.006**	0.006**	0.007	0.008
Vega Unvested (low risk firms)	.	.	.	.	-0.003	-0.003	-0.006	-0.006
Vega Unvested (high risk firms)	.	.	.	.	0.003	0.003	0.009*	0.008

Table 8: Effect of CEO Risk-Taking Incentives on the Percentage Change in the Market Value of Debt

This Table shows the regression results on the effects of CEO risk-taking incentives on the percentage change in the market value of debt. The models are estimated via OLS. Debt concentration is measured by a Herfindahl index of concentration of debt structure by type of debt (**HHI**) and by a dummy equal to one if more than 90% of the debt structure is concentrated in only one type of debt (**Excl90**). **LNVEGA** is the sensitivities of CEOs' compensation to stock return volatility while **LNVEGA_VEST** and **LNVEGA_UNVEST** are the sensitivities computed for Vested and Unvested stock options, respectively. Columns (1) and (6) report the results for the full sample. Columns (2) and (7) refer to subsamples of firms with values of HHI below the sample median, while Columns (3) and (8) refer to subsamples of firms with values of HHI above the sample median. Columns (4) and (9) refer to subsamples of firms with values of Excl90 equal to zero and Columns (5) and (10) refer to subsamples of firms with values of Excl90 equal to one. The set of controls include **LNDELTA** (the sensitivity of CEO compensation to changes (in percent) to stock prices), **INVESTMENTS** (capital expenditures scaled by property, plant and equipment), **LEVERAGE** (total debt over total assets), **SIZE** (logarithm of total assets measured in millions US$), **MARKET_BOOK** (market value of equity plus total debt plus preferred stock liquidating value minus deferred taxes and investment tax credit over total assets), **PROFITABILITY** (operating income before depreciation over total assets), **TANGIBILITY** (net property, plant, and equipment over total assets), **DIVIDEND_PAYER** (a dummy equal to one if a firm pays common stock dividends), **CF_VOL** (the standard deviation of operating cash flows from operations calculated over the 3 year period before the observation year over total assets), **R&D** (research and development expenses over total assets), **UNRATED** (a dummy equal to one if a firm does not have a S&P rating on long-term debt, and zero otherwise), **REG_DUM** (a dummy equal to one for regulated firms defined as firms with a SIC code between 4,900 and 4,939), **FIRM_AGE** (the log transformation of one plus the number of years since the firm was added to the Compustat database), **CEO_SHARES** (number of shares owned by the CEO scaled by total shares outstanding) and **PAYSLICE** (the percentage of the total compensation to the top five executives that goes to the CEO) All specifications include industry (Fama-French 49) dummies and year dummies. Statistical significance is based on industry-year clustered standard errors. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

	Full sample	HHI Below Median	HHI Above Median	Excl90=0	Exc90=1	Full sample	HHI Below Median	HHI Above Median	Excl90=0	Exc90=1
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
LNVEGA	**-0.009*** **	**-0.012*** **	-0.005	**-0.012*** **	-0.003					
	[0.003]	**[0.004]**	[0.00364]	**[0.004]**	[0.004]					
LNVEGA_VEST						**-0.013*** **	**-0.017*** **	**-0.007***	**-0.019*** **	-0.004
						[0.003]	**[0.004]**	**[0.004]**	**[0.004]**	[0.004]
LNVEGA_UNVEST						0.002	0.004	0.001	**0.005***	-0.001
						[0.002]	[0.003]	[0.004]	**[0.003]**	[0.004]
LNDELTA	0.019***	0.027***	0.010	0.025***	0.009	0.021***	0.029***	0.012	0.026***	0.012
	[0.005]	[0.007]	[0.007]	[0.007]	[0.007]	[0.005]	[0.007]	[0.007]	[0.007]	[0.007]
INVESTMENTS	0.163***	0.204***	0.138**	0.233***	0.107*	0.162***	0.202***	0.137**	0.232***	0.106*
	[0.044]	[0.065]	[0.059]	[0.063]	[0.062]	[0.044]	[0.064]	[0.059]	[0.062]	[0.062]
LEVERAGE	0.179***	0.188***	0.164***	0.190***	0.145***	0.183***	0.193***	0.167***	0.195***	0.147***
	[0.030]	[0.043]	[0.044]	[0.040]	[0.048]	[0.031]	[0.043]	[0.04]	[0.040]	[0.048]
SIZE	0.0095**	0.003	0.012**	0.006	0.010	0.009**	0.003	0.011*	0.006	0.010
	[0.004]	[0.006]	[0.006]	[0.006]	[0.006]	[0.004]	[0.006]	[0.006]	[0.006]	[0.006]
MARKET_BOOK	0.017**	0.003	0.026***	0.005	0.027***	0.014**	-0.001	0.025***	0.001	0.026***
	[0.007]	[0.012]	[0.009]	[0.011]	[0.009]	[0.007]	[0.012]	[0.009]	[0.011]	[0.009]
PROFITABILITY	-0.188**	-0.314**	-0.111	-0.299**	-0.107	-0.195**	-0.323**	-0.115	-0.305**	-0.108
	[0.078]	[0.127]	[0.100]	[0.122]	[0.106]	[0.078]	[0.125]	[0.101]	[0.120]	[0.107]
TANGIBILITY	-0.004	-0.0375	0.041	-0.030	0.040	-0.006	-0.042	0.039	-0.034	0.037
	[0.025]	[0.033]	[0.037]	[0.031]	[0.042]	[0.025]	[0.033]	[0.037]	[0.031]	[0.042]
DIVIDEND_PAYER	-0.003	0.013	-0.018	0.012	-0.018	-0.003	0.011	-0.017	0.010	-0.018
	[0.010]	[0.012]	[0.014]	[0.012]	[0.015]	[0.010]	[0.012]	[0.014]	[0.012]	[0.015]
CF_VOL	-0.966***	-0.914***	-0.991***	-0.895***	-1.016***	-0.957***	-0.890***	-0.988***	-0.868***	-1.014***
	[0.131]	[0.237]	[0.166]	[0.220]	[0.172]	[0.131]	[0.234]	[0.165]	[0.217]	[0.172]
R&D	-0.669***	-0.175	-0.836***	-0.305	-0.839***	-0.653***	-0.140	-0.828***	-0.265	-0.828***
	[0.179]	[0.323]	[0.208]	[0.307]	[0.221]	[0.180]	[0.324]	[0.209]	[0.306]	[0.222]
UNRATED	0.049***	0.034**	0.056***	0.040***	0.054***	0.050***	0.035**	0.057***	0.040***	0.054***
	[0.010]	[0.014]	[0.015]	[0.013]	[0.015]	[0.010]	[0.014]	[0.015]	[0.013]	[0.016]
REG_DUM	0.003	0.019	-0.029	0.007	-0.110	0.004	0.012	-0.025	0.007	-0.111
	[0.015]	[0.020]	[0.032]	[0.017]	[0.231]	[0.014]	[0.020]	[0.033]	[0.015]	[0.232]
FIRM_AGE	-0.020***	-0.026***	-0.013	-0.026***	-0.011	-0.018***	-0.023**	-0.012	-0.024***	-0.010
	[0.007]	[0.010]	[0.010]	[0.009]	[0.010]	[0.007]	[0.010]	[0.010]	[0.009]	[0.010]
CEO_SHARES	-0.218	-0.478**	0.046	-0.426**	0.046	-0.244*	-0.492**	0.010	-0.437**	0.001
	[0.141]	[0.216]	[0.201]	[0.207]	[0.206]	[0.141]	[0.215]	[0.200]	[0.206]	[0.204]
PAYSLICE	0.0138	0.077	-0.042	0.072	-0.048	0.003	0.065	-0.0483	0.057	-0.049
	[0.041]	[0.061]	[0.052]	[0.058]	[0.054]	[0.041]	[0.062]	[0.0534]	[0.059]	[0.055]
Constant	-0.038	-0.073	0.056	0.322	0.067	-0.037	-0.084	0.0526	0.327	0.061
	[0.135]	[0.056]	[0.240]	[0.393]	[0.241]	[0.137]	[0.057]	[0.241]	[0.387]	[0.242]
Observations	4,517	2,330	2,187	2,592	1,925	4,517	2,330	2,187	2,592	1,925
Industry dummies	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Time dummies	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Adj R-squared.	0.103	0.117	0.0860	0.115	0.088	0.105	0.121	0.087	0.121	0.088

Online Appendix

Does Debt Concentration Depend on the Risk-Taking Incentives in CEO Compensation?

A.1. Estimation of Vega and Delta

We define the volatility sensitivity or Vega as the change in the value of a CEO's option portfolio due to a 1% increase in the standard deviation of the stock return. The CEO's portfolio price sensitivity or Delta is similarly defined as the change in the value of the CEO's stock and option portfolio in response to a 1% increase in the price of the firm's common stock. The sensitivity of an option (ϒ and Δ) might be observed as partial derivatives that are based on the Black and Scholes (1973) option pricing model adjusted for dividends by Merton (1973). We follow the same procedure as Coles et al. (2006) and Core and Guay (2002).

$$\Delta = e^{-dT} N(Z)$$

$$\Upsilon = e^{-dT} N'(Z) S\sqrt{T}$$

$$Z = \frac{\ln\left[\frac{S}{X}\right] + T\left[r - d + \frac{\sigma^2}{2}\right]}{\sigma\sqrt{T}}$$

where d is the natural logarithm of the expected dividend yield over the life of the option, T is the time to maturity of the option in years, N is the cumulative normal probability function, and N' is the density function for the normal distribution; S is the price of the underlying stock; X is the exercise price of the option; r is the natural logarithm of the risk-free interest rate and σ is the expected stock return volatility over the life of the option.

The six variables necessary to compute the Vega and Delta of an option are the exercise price, time to maturity, volatility, the risk-free rate, the dividend yield, and the stock price. All of these input variables are either directly observable or can be accurately estimated; however, because the FAS 123R issued by the FASB in 2004 specifies a change in format for accounting for equity-based compensation, following Coles et al. (2013) we use different calculations for the fiscal years 2001–2006 and for the fiscal years 2007 and later in some variables.

Variable	Pre 2006	Post 2006
Volatility	BS_VOLATILITY in ExecuComp	We use the annualized standard deviation of stock returns estimated over the 60 months prior to the beginning of the fiscal period, winsorized at the 5th and 95th levels.
Dividend yield	BS_YIELD	We use the average of DIVYIELD provided by ExecuComp over the current year and the two prior years and winsorize the values at the 5th and 95th levels.
Risk free rate	Risk-free rate corresponding to the (rounded) maturity of the options as of the fiscal year end. The risk-free rate is obtained from historical data provided by the Federal Reserve.	
Exercise price	Exercise price in ExecuComp.	
Time to maturity	Expiration date of an option - needed to compute the maturity of the options as of the fiscal year end.	
Stock price	Stock price at the end of the fiscal year.	

- Pre 2006

For the pre-2006 data, we use the approximation method detailed in Core and Guay (2002) to calculate the Vega and Delta of the option portfolio.

We consider three option portfolios: current year's option grants, portfolio of Unvested options from previously granted awards, and the portfolio of Vested options. The executive's incentives are given by the summation of the incentives from these three portfolios.

For the current year's option grants, we obtain the number of options granted during that year, the stated exercise price, and maturity.

For the portfolio of previously granted unvested options, we estimate the exercise price in three steps. First, we estimate the total number of options in the portfolio and the average exercise price of each option in the portfolio. Later, we estimate the intrinsic value of the portfolio of previously granted unvested options by subtracting the intrinsic value of the current year's grants from the reported intrinsic value of all unvested options. Lastly, the average exercise price of each previously granted unvested option is obtained by subtracting the average intrinsic value of each option in the portfolio from the stock price.

For vested options, we calculate the average exercise price based on the realizable value and the number of vested options.

Finally, we estimate Vega and Delta options. Vega is the sum of the Vega of the current year options as well as previously-granted options (both Vested and Unvested).

The Delta is the sum of the Delta of current year options, the Delta of the portfolio of previously granted options (both Vested and Unvested), and the Delta from the shares owned by manager.

- Post 2006

For the period post 2006, in calculating Vega and Delta, we utilize only the Vested and Unvested shares and options, using a separate record for each outstanding option tranche. We underestimate the true Vega and Delta ignoring the unearned awards. These unearned shares or options will be classified as either shares or options when they are earned, and, if these grants are still held by the executive as of the end of the year, they will be included in the Vega and Delta calculation at that point.

We use the values of the variables defined in the previous table and formulate Vega and Delta values according to the methodology provided in Coles et al. (2006) and Core and Guay (2002), which in turn is the Black and Scholes (1973) option valuation model as modified by Merton (1973) to account for dividends.

The Vega and Delta of all Vested and Unvested tranches of options are summed up for each executive-year to give the Vega and Delta of the option portfolio.

Finally, we obtain the Vega and Delta of the equity portfolio. For Vega of the equity portfolio, we use only the Vega of the option portfolio calculated previously. We assume, as in Coles et al. (2006) and Guay (1999), that Vega of the share portfolio is zero. To compute the overall Delta, we add the Delta of the portfolio of options and the Delta of the portfolio of shares.

For pre and post 2006 we have calculated the two components of Vega and Delta separated into vested and unvested.

Vega is split into two parts, unvested Vega calculated as the value sensitivity of a CEO's portfolio to stock return volatility of all unexercisable options including that of newly granted option and existing Unvested option (LNVEGA_UNVEST), and Vested Vega defined as the value sensitivity of a CEO's portfolio to stock return volatility of all exercisable options (LNVEGA_VEST).

A.2. Debt Concentration by Industry

Table A.I. Debt Concentration by Industry.

Table B.I reports the industrial distribution of the degree of debt concentration (HHI and Excl90). The final sample contains 6,300 observations from the 2001 to 2012 period.

Industries	Fama-French 49 sectors	Obs	HHI	Excl90
Agriculture	1	23	0.692	0.478
Food Products	2	162	0.660	0.321
Candy & Soda	3	23	0.646	0.435
Beer & Liquor	4	15	0.778	0.600
Tobacco Products	5	22	0.867	0.682
Toys Recreation	6	35	0.875	0.800
Fun Entertainment	7	68	0.507	0.191
Books Printing and Publishing	8	60	0.535	0.167
Consumer Goods	9	139	0.672	0.388
Clothes Apparel	10	79	0.793	0.595
Healthcare	11	116	0.665	0.397
Medical Equipment	12	183	0.751	0.541
Drugs Pharmaceutical Products	13	206	0.773	0.553
Chemicals	14	273	0.657	0.348
Rubber and Plastic Products	15	44	0.602	0.364
Textiles	16	34	0.518	0.235
Construction Materials	17	167	0.719	0.509
Construction	18	116	0.785	0.578
Steel Works, etc.	19	146	0.777	0.575
Fabricated Products	20	6	0.439	0.000
Machinery	21	363	0.665	0.421
Electrical Equipment	22	104	0.703	0.423
Automobiles and Trucks	23	128	0.560	0.219
Aircraft	24	72	0.695	0.458
Ships Shipbuilding, Railroad Equipment	25	16	0.373	0.063
Guns Defence	26	26	0.723	0.385
Precious Metals	27	14	0.749	0.429
Mines Non-Metallic and Industrial Metal Mining	28	43	0.750	0.488
Coal	29	33	0.599	0.273
Oil Petroleum and Natural Gas	30	354	0.710	0.449
Utilities	31	512	0.663	0.311
Communication	32	168	0.692	0.458
Personal Service	33	96	0.674	0.302
Business Service	34	292	0.716	0.497
Computer Hardware	35	119	0.823	0.697
Computer Software	36	233	0.867	0.764
Electronic Equipment	37	368	0.811	0.649
Measuring and Control Equipment	38	159	0.697	0.447
Paper Business Supplies	39	172	0.661	0.384
Shipping Containers	40	78	0.516	0.128
Transportation	41	252	0.623	0.317
Wholesale	42	249	0.656	0.349
Retail	43	304	0.708	0.454
Meals Restaurants, Hotels, Motels	44	129	0.666	0.426
Others	49	99	0.589	0.313
Total		6300	0.697	0.440

A.3. Correlation Analysis

Table A.II. Correlation Matrix

	LNVEGA	LNDELTA	LEVERAGE	SIZE	MARKET_BOOK	PROFITABILITY	TANGIBILITY	DIVIDEND_PAYER	CF_VOL	R&D	UNRATED	REG_DUM	FIRM_AGE	CEO_SHARES	PAYSLICE
LNVEGA	1														
LNDELTA	0.567	1													
LEVERAGE	-0.034	-0.106	1												
SIZE	0.432	0.421	0.189	1											
MARKET_BOOK	0.192	0.359	-0.239	-0.190	1										
PROFITABILITY	0.123	0.274	-0.172	-0.001	0.487	1									
TANGIBILITY	-0.146	-0.109	0.228	0.185	-0.431	0.036	1								
DIVIDEND_PAYER	0.161	0.107	-0.013	0.339	-0.073	0.155	0.147	1							
CF_VOL	-0.130	-0.141	-0.101	-0.292	0.093	-0.073	-0.076	-0.206	1						
R&D	0.109	0.036	-0.168	-0.143	0.359	-0.106	-0.336	-0.220	0.176	1					
UNRATED	-0.243	-0.185	-0.345	-0.614	0.224	0.032	-0.197	-0.242	0.17	0.178	1				
REG_DUM	-0.128	-0.176	0.167	0.200	-0.276	-0.152	0.383	0.208	-0.121	-0.160	-0.147	1			
FIRM_AGE	0.157	0.024	0.049	0.403	-0.218	-0.048	0.119	0.447	-0.130	-0.141	-0.316	0.288	1		
CEO_SHARES	-0.163	0.354	-0.069	-0.208	0.037	-0.003	-0.036	-0.103	0.089	-0.024	0.168	-0.094	-0.166	1	
PAYSLICE	0.186	0.112	0.036	0.139	0.008	0.082	-0.020	0.157	-0.074	-0.034	-0.139	0.017	0.141	-0.166	1

A.4. Governance Controls: Full Specifications

Table A.III: CEO Incentives, Debt Concentration and Governance Characteristics

This table reports the empirical results on the relation between debt concentration and CEO Incentives considering the Governance characteristics. The sensitivities of CEOs' compensation to stock return volatility (**LNVEGA**) is the variable under study controlling for the sensitivity of CEO compensation to changes (in percent) to stock prices (**LNDELTA**). All specifications control for firm and CEO characteristics, industry dummies (based on Fama-French 49) and year dummies. Columns 1, 3 and 5 present the regression results using the Tobit methodologies respectively and the dependent variables are a Herfindahl index of concentration of debt structure by type of debt (HHI), meanwhile in Columns 2, 4 and 6 we use Probit methodology since the dependent variable is a dummy equal to one if more than 90% of the debt structure is concentrated in only one type of debt (Excl90). In all columns we consider Governance characteristics: **BOARD_SIZE** (logarithm of the total number of directors on the board), **BOARD_INDEPENDENCE** (the proportion of the board that consists of independent directors), **CO_OPTED_DIR** (the ratio between directors appointed after the appointment of the CEO and the total number of board members) **and ANALYSTS_COV** (logarithm of one plus the total number of stock analysts following the firm). To address endogeneity we estimate the model including year and industry interactions (year*industry fixed effects) in Columns 3 and 4, and including year and industry interactions (year*state fixed effects in Columns 5 and 6. The set of controls include **LEVERAGE** (total debt over total assets), **SIZE** (logarithm of total assets measured in millions US$), **MARKET_BOOK** (market value of equity plus total debt plus preferred stock liquidating value minus deferred taxes and investment tax credit over total assets), **PROFITABILITY** (operating income before depreciation over total assets), **TANGIBILITY** (net property, plant, and equipment over total assets), **DIVIDEND_PAYER** (a dummy equal to one if a firm pays common stock dividends), **CF_VOL** (the standard deviation of operating cash flows from operations calculated over the 3 year period before the observation year over total assets), **R&D** (research and development expenses over total assets), **UNRATED** (a dummy equal to one if a firm does not have a S&P rating on long-term debt, and zero otherwise), **REG_DUM** (a dummy equal to one for regulated firms defined as firms with a SIC code between 4,900 and 4,939), **FIRM_AGE** (the log transformation of one plus the number of years since the firm was added to the Compustat database), **CEO_SHARES** (number of shares owned by the CEO scaled by total shares outstanding) and **PAYSLICE** (the percentage of the total compensation to the top five executives that goes to the CEO). Statistical significance is based on industry-year clustered standard errors. ***, **, and * denote significance at the 1%, 5%, and 10% levels respectively.

	HHI	**Excl90**
	Tobit	**Probit**
	1	2
LNVEGA	0.012***	0.038**
	[0.004]	[0.018]
LNDELTA	-0.016**	-0.056*
	[0.006]	[0.032]
LEVERAGE	-0.514***	-1.998***
	[0.037]	[0.179]
SIZE	-0.018***	-0.066**
	[0.006]	[0.029]
MARKET_BOOK	0.044***	0.153***
	[0.009]	[0.041]
PROFITABILITY	-0.030	-0.015
	[0.084]	[0.425]
TANGIBILITY	0.041	-0.049
	[0.035]	[0.171]
DIVIDEND_PAYER	0.008	-0.004
	[0.012]	[0.054]
CF_VOL	0.777***	3.074***
	[0.170]	[0.807]
R&D	1.503***	4.779***
	[0.240]	[1.020]
UNRATED	-0.024**	-0.127**
	[0.011]	[0.055]
REG_DUM	0.186***	1.287***
	[0.050]	[0.463]
FIRM_AGE	-0.033***	-0.087*
	[0.009]	[0.047]
CEO_SHARES	0.310*	0.313
	[0.173]	[0.838]
PAYSLICE	0.024	0.060
	[0.045]	[0.221]
BOARD_SIZE	-0.064***	-0.267**
	[0.025]	[0.127]
BOARD_INDEPENDENCE	0.131***	0.568**
	[0.044]	[0.224]
CO_OPTED_DIR	-0.019	-0.064
	[0.016]	[0.083]
ANALYSTS_COV	0.004	0.016
	[0.005]	[0.025]
Constant	1.076***	1.286***
	[0.069]	[0.340]
Observations	4,500	4,487
Industry dummies	YES	YES
Time dummies	YES	YES
Pseudo R2	0.425	0.125

A.5. Endogeneity Analysis: First Stage Regression

Table A.IV: First Stage Regression

This table reports the first stage regression of the instrumental variables estimation based on the Tobit methodology on the relation between the sensitivities of CEOs' compensation (**LNVEGA** and **LNDELTA**) and the instrumental variables controlling for firm and CEO characteristics, industry dummies (based on Fama-French 49) and year dummies and for the potential endogenetiy of equity-based incentives. In columns (1) and (3) the dependent variable is the sensitivities of CEOs' compensation to stock return volatility (**LNVEGA**), while in columns (2) and (4) it is the sensitivity of CEO compensation to changes (in percent) to stock prices (**LNDELTA**). In columns (1) and (2) we use as instruments: **CASH** (cash from assets-in-place scaled by total assets), **SGRTH** (the annual growth rate of sales) and **TAX_DUM** (dummy variable equal to one if a firm has a tax-loss carry-forward in any of the last three years). The set of controls include **LEVERAGE** (total debt over total assets), **SIZE** (logarithm of total assets measured in millions US$), **MARKET_BOOK** (market value of equity plus total debt plus preferred stock liquidating value minus deferred taxes and investment tax credit over total assets), **PROFITABILITY** (operating income before depreciation over total assets), **TANGIBILITY** (net property, plant, and equipment over total assets), **DIVIDEND_PAYER** (a dummy equal to one if a firm pays common stock dividends), **CF_VOL** (the standard deviation of operating cash flows from operations calculated over the 3 year period before the observation year over total assets), **R&D** (research and development expenses over total assets), **UNRATED** (a dummy equal to one if a firm has not a S&P rating on long-term debt, and zero otherwise), **REG_DUM** (a dummy equal to one for regulated firms defined as firms with a SIC code between 4,900 and 4,939), **FIRM_AGE** (the log transformation of one plus the number of years since the firm was added to the Compustat database), **CEO_SHARES** (number of shares owned by the CEO scaled by total shares outstanding) and **PAYSLICE** (the percentage of the total compensation to the top five executives that goes to the CEO). R Statistical significance is based on industry-year clustered standard errors. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

	LNVEGA	LNDELTA
	(1)	(2)
CASH	0.899***	0.838**
	[0.224]	[0.396]
SGRTH	0.288***	-0.251**
	[0.0618]	[0.109]
TAX_DUM	-0.159**	0.0526
	[0.0622]	[0.0724]
LEVERAGE	-0.525***	-0.301**
	[0.0780]	[0.139]
SIZE	0.580***	0.591***
	[0.0100]	[0.0178]
MARKET_BOOK	0.528***	0.234***
	[0.0171]	[0.0304]
PROFITABILITY	0.202	0.251
	[0.215]	[0.382]
TANGIBILITY	0.0788	-0.754***
	[0.0738]	[0.131]
DIVIDEND_PAYER	-0.0601**	0.112**
	[0.0260]	[0.0463]
CF_VOL	-2.046***	-1.072
	[0.392]	[0.695]
R&D	-1.120**	0.893
	[0.440]	[0.780]
UNRATED	0.0159	-0.0634
	[0.0300]	[0.0532]
REG_DUM	-0.0326	0.110***
	[0.0203]	[0.0360]
FIRM_AGE	-0.292	-1.096***
	[0.191]	[0.339]
CEO_SHARES	16.52***	-3.622***
	[0.284]	[0.505]
PAYSLICE	1.589***	2.046***
	[0.105]	[0.187]
Constant	-0.464***	-2.307***
	[0.147]	[0.261]
Observations	6,245	6,245
Industry dummies	YES	YES
Time dummies	YES	YES

A.6. Endogeneity Analysis: Probit Model

Table A.V: Endogeneity Analysis II for the Probit Model

This table presents the regression results on the relation between the degree of debt concentration and the sensitivities of CEOs' compensation to stock return volatility (**LNVEGA**) controlling for the sensitivity of CEO compensation to changes (in percent) to stock prices (**LNDELTA**), for firm and CEO characteristics, industry dummies (based on Fama-French 49) and year dummies and for the potential endogeneitiy of equity-based incentives. The dependent variable is a dummy equal to one if more than 90% of the debt structure is concentrated in only one type of debt (**Excl90**). We address endogeneity due to reverse causality by estimating the model with all right-hand side variables lagged one and two years (Column 1) and 2) respectively) and by estimating a single instrumental variable regression for Excl90 in columns 3 and 4 using different instrumental variables. The set of controls include **LEVERAGE** (total debt over total assets), **SIZE** (logarithm of total assets measured in millions US$), **MARKET_BOOK** (market value of equity plus total debt plus preferred stock liquidating value minus deferred taxes and investment tax credit over total assets), **PROFITABILITY** (operating income before depreciation over total assets), **TANGIBILITY** (net property, plant, and equipment over total assets), **DIVIDEND_PAYER** (a dummy equal to one if a firm pays common stock dividends), **CF_VOL** (the standard deviation of operating cash flows from operations calculated over the 3 year period before the observation year over total assets), **R&D** (research and development expenses over total assets), **UNRATED** (a dummy equal to one if a firm does not have a S&P rating on long-term debt, and zero otherwise), **REG_DUM** (a dummy equal to one for regulated firms defined as firms with a SIC code between 4,900 and 4,939), **FIRM_AGE** (the log transformation of one plus the number of years since the firm was added to the Compustat database), **CEO_SHARES** (number of shares owned by the CEO scaled by total shares outstanding) and **PAYSLICE** (the percentage of the total compensation to the top five executives that goes to the CEO). The instruments are **CASH** (amount of cash and short-term investments scaled by assets), **TAX_LOSS (**an indicator that is equal to one if a firm has a tax-loss carry-forward in any of the last three years and zero otherwise) and **LNBONUS** (1 plus log transformation) the total cash compensation received by the CEO). R Statistical significance is based on industry-year clustered standard errors. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

	1-lag	2-lag	IV
	Excl90	Excl90	Excl90
	(1)	(2)	(3)
LNVEGA	**0.049*** **	**0.046** **	**1.535*** **
	[0.019]	**[0.021]**	**[0.580]**
LNDELTA	**-0.102*** **	**-0.131*** **	0.243
	[0.031]	**[0.034]**	[0.530]
LEVERAGE	-2.024***	-1.689***	-1.584***
	[0.169]	[0.179]	[0.462]
SIZE	-0.036	0.002	-1.133**
	[0.026]	[0.029]	[0.494]
MARKET_BOOK	0.119***	0.144***	-0.397
	[0.045]	[0.044]	[0.342]
PROFITABILITY	0.045	-0.422	-0.916
	[0.411]	[0.416]	[0.819]
TANGIBILITY	-0.176	-0.036	0.969*
	[0.165]	[0.179]	[0.499]
DIVIDEND_PAYER	0.024	0.045	-0.115
	[0.054]	[0.061]	[0.116]
CF_VOL	2.339***	2.867***	4.779**
	[0.790]	[0.857]	[1.878]
R&D	5.015***	6.099***	2.503
	[0.936]	[0.943]	[1.636]
UNRATED	-0.100*	-0.081	-0.001
	[0.056]	[0.059]	[0.107]
REG_DUM	4.871***	4.691***	2.947***
	[0.115]	[0.137]	[0.994]
FIRM_AGE	-0.120***	-0.127***	-0.282***
	[0.042]	[0.044]	[0.094]
CEO_SHARES	0.364	1.809**	0.482
	[0.825]	[0.845]	[8.777]
PAYSLICE	0.018	0.222	-3.531**
	[0.201]	[0.220]	[1.589]
Constant	1.086***	0.850***	5.184***
	[0.262]	[0.257]	[1.494]
Observations	4,519	3,810	6,239
Industry dummies	YES	YES	YES
Time dummies	YES	YES	YES
Pseudo R2	0.123	0.115	.
Hansen test	.	.	0.505

A.7. Debt Concentration, Maturity and Leverage

Table A.VI: Debt Concentration, Debt Maturity, Leverage and CEO Risk-Taking Incentives

This Table reports the empirical results on the relation between the degree of debt concentration, measured via HHI, and the sensitivities of CEOs compensation to stock return volatility (**LNVEGA**), controlling for the sensitivity of compensation to changes (in percent) to stock prices (**LNDELTA**), based on a system of three Tobit equations allowing joint determination of the debt concentration equation (1), debt maturity equation (2) and leverage equation (3). Debt concentration is measured by a Herfindahl index of concentration of debt structure by type of debt (**HHI**). **ST3** is debt maturity measured by the ratio between debts with maturity lower than three years over total debts. The set of controls in debt concentration equation include **SIZE** (logarithm of total assets measured in millions US$), **MARKET_BOOK** (market value of equity plus total debt plus preferred stock liquidating value minus deferred taxes and investment tax credit over total assets), **PROFITABILITY** (operating income before depreciation over total assets), **TANGIBILITY** (net property, plant, and equipment over total assets), **DIVIDEND_PAYER** (a dummy equal to one if a firm pays common stock dividends), **CF_VOL** (the standard deviation of operating cash flows from operations calculated over the 3 year period before the observation year over total assets), **R&D** (research and development expenses over total assets), **UNRATED** (a dummy equal to one if a firm does not have a S&P rating on long-term debt, and zero otherwise), **REG_DUM** (a dummy equal to one for regulated firms defined as firms with SIC code is between 4,900 and 4,939), **FIRM_AGE** (the log transformation of one plus the number of years since the firm was added to the database Compustat), **CEO_SHARES** (number of shares owned by the CEO scaled by total shares outstanding) and **PAYSLICE** (the percentage of the total compensation to the top five executives that goes to the CEO). The debt maturity equation include as specific controls not included in debt concentration regression **ASSET_MAT** (the book value-weighted average of the maturities of property plant and equipment and current assets), **SIZE2** (the squared value of SIZE), **TERM** (yield on 10-year government bonds subtracted from the yield on 6-month government bonds at the fiscal year end), **ABNEARN** (a measure of abnormal earnings defined by earnings in year t+1 minus earnings in year t over the share price multiplied by outstanding shares in year t), **STD_DEV** (the standard deviation of asset returns computed as the monthly stock return standard deviation during the fiscal year multiplied by the ratio of the market value of equity to the market value of assets) and Z SCORE_DUM (a measure of distress risk based on Altman´s (1977) Z-score, equals one if Altman's Z-score is greater than 1.81, and zero otherwise). The set of control variables in the leverage equation not included in the first two equations consists of **LIQUIDITY** (Current assets scaled by current liabilities), **NOL_DUM** (a dummy equal to one if a firm has an operating loss carried forward and zero otherwise) and **ITC_DUM** (a dummy equal to one if the firm has an investment tax credit and zero otherwise). We include industry (Fama-French 49) dummies and year dummies in all specifications. Statistical significance is based on industry-year clustered standard errors. ***, **, and * denote significance at the 1%, 5%, and 10% levels respectively.

VARIABLES	HHI	ST3	LEVERAGE
	(1)	**(2)**	**(3)**
LNVEGA	**0.011*** **	**0.018*** **	**0.008*** **
	[0.003]	**[0.004]**	**[0.002]**
LNDELTA	**-0.023*** **	**-0.034*** **	**-0.025*** **
	[0.005]	**[0.007]**	**[0.003]**
HHI		**-1.083*** **	**-0.411*** **
		[0.103]	**[0.068]**
ST3	**-0.445*** **		**-0.510*** **
	[0.047]		**[0.031]**
LEVERAGE	**-0.736*** **	**-0.555** **	
	[0.064]	**[0.240]**	
SIZE	-0.015***	-0.288***	-0.016***
	[0.004]	[0.040]	[0.003]
MARKET_BOOK	0.045***	0.076***	0.050***
	[0.006]	[0.008]	[0.004]
PROFITABILITY	-0.012		-0.290***
	[0.060]		[0.041]
TANGIBILITY	0.008		
	[0.008]		
DIVIDEND_PAYER	-0.003		0.032*
	[0.023]		[0.017]
CF_VOL	0.604***		
	[0.124]		
R&D	0.929***		
	[0.121]		
UNRATED	0.030**	0.123***	
	[0.013]	[0.022]	
REG_DUM	0.236***	0.351***	0.170***
	[0.060]	[0.090]	[0.044]
FIRM AGE	-0.025***		
	[0.006]		
CEO_SHARES	0.371***	0.755***	0.450***
	[0.126]	[0.177]	[0.089]
PAYSLICE	-0.011	-0.027	-0.022
	[0.033]	[0.048]	[0.024]
SIZE2		0.017***	
		[0.002]	
ASSET_MAT		0.001	
		[0.001]	
TERM		-1.761	
		[2.102]	
ABNEARN		2.428	2.815***
		[1.563]	[0.718]
STD_DEV		0.830***	-0.249**
		[0.257]	[0.106]
ZSCORE_DUM		0.009	
		[0.037]	
LIQUIDITY			-0.020***
			[0.005]
NOL_DUM			0.004
			[0.005]
ITC_DUM			0.002
			[0.014]
Constant	1.258***	2.373***	1.054***
	[0.058]	[0.195]	[0.050]
Observations	6,115	6,115	6,115
Industry dummies	YES	YES	YES
Time dummies	YES	YES	YES