The Incentives of Creditors to Monitor via Debt Specialization: The Impact of CEO Horizons Compensation

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Abstract

Using a sample of US listed companies we extend the literature on how executive compensation influences a firm's capital structure. We show that an increase in any form of risk-taking incentives in CEO pay leads to a greater concentration in lending relationships (measured via the specialization of a firm's debt structure by debt type). When the risk-taking incentives are in the form of a higher sensitivity of CEO compensation to equity volatility, the tendency towards an increasing debt specialization becomes stronger for shorter compensation horizons and furthermore for riskier firms. We also show that a higher degree of debt specialization neutralizes the loss in the market value of debt produced when CEO risk-taking incentives increase. Overall, the results point towards creditors responding to CEO compensation schemes (designed to align the interests of CEOs and shareholders) via increased debt specialization.

JEL classification: G30, G32 J33, M12

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1. Introduction

It is a widely accepted view that the design of executive compensation contributes to aligning the interests of managers with those of shareholders (Coles et al., 2006; Brockman et al., 2010; Dow and Raposo, 2005; Lo, 2003). In this respect, a pivotal role is played by equity-based incentives that link the value of executive pay to stock return volatility and to stock price. These incentives aim at reducing the agency costs rooted in the potential conflicts between managers and shareholders by aligning the risk-appetite of managers to the purpose of maximizing shareholder value (Low, 2009).

However, another effect produced by the presence of equity-based incentives in executive pay is the potential 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 particular, equity-based incentives that favor risk-taking might induce managers to replace safe activities with riskier ones thus transferring wealth from debtholders to shareholders; and this myopic behavior (Stein, 1989) has been found driven by the amount of equity to be sold by CEOs in the short run (Edmans et al., 2015) Nevertheless, it has been shown that creditors understand the risk incentives offered to managers via their compensation and the related potential negative effects for debtholders (Brockman et al., 2010; Kabir et al., 2013; John and John, 1993; Liu and Mauer, 2011; Ortiz-Molina, 2007). Creditors are, therefore, expected to take actions to curtail the impact of these incentives on their wealth.

In this paper we show that one such action is the increase in the concentration of the lending relationships with borrowing firms as this facilitates monitoring by creditors. Our point of departure is the evidence reported in Brockman et al. (2010) that an increasing presence of risk-taking incentives in CEO compensation, and the related risk of asset substitution problems, leads to a growing share of short-term debt in the capital structure. Essentially, the debt structure becomes characterized by an increasing presence of debts that provide creditors with a powerful monitoring tool (Barclays and Smith, 1995; Stulz, 2000) and that offer additional flexibility to monitor managers with minimum effort (Rajan and Winton, 1995).

The maturity of debt contracts is not, however, the only characteristic of a firm's debt structure that the literature has identified as having the potential to facilitate the effectiveness of the monitoring activity by creditors (see Diamond, 1984; Allen, 1990). Specifically, the concentration of debt claims in fewer lenders is supposed to alleviate information collection problems for creditors (and the related agency costs), and reduce free-rider problems amongst creditors and the risk of duplicating monitoring effort (Diamond, 1984; Allen, 1990; Platikanova and Soonawalla, 2014). This is because debtholders have incentives to effectively monitor corporate borrowers provided that they have a sufficient claim in the firm (Diamond, 1991; Park, 2000). In contrast, the dispersion of creditors increases the risk of mutual free-riding (Holmström, 1982). Furthermore, and crucially for our analysis, multiple creditors have been shown to suffer from coordination problems that might facilitate expropriation by shareholders (Bernardo and Talley, 1996; Bris and Welch, 2005; Gertner and Scharfstein, 1991). Overall, the concentration of debt claims appears preferable to creditors when they have incentives to effectively monitor managerial actions, as is the case of when managers receive high risk-taking incentives in executive pay.

We build our analysis around the theoretical framework above to show that the potential negative effects that the design of executive compensation might produce in terms of asset substitution problems, stressed for short-term horizon compensations, do not influence only the maturity of the lending relationships - as shown by Brockman et al. (2010) - but they also affect the degree of concentration of these relationships.

We base our analysis on a sample of listed US firms for the period 2001-2012 and we rely on two widely known measures of equity-based incentives in executive pay, the sensitivity of compensation to stock return volatility (Vega) and the sensitivity of compensation to stock price

(Delta), to capture the risk-taking incentives embedded in executive pay. Both Vega and Delta have the potential to affect the risk appetite of CEOs, though in opposite ways. A higher Vega has been usually linked to higher risk-taking as it signals the possibility to gain in compensation in the presence of a more volatile business (Cohen et al., 2000; Coles et al., 2006; Dong et al., 2010; Gormley et al., 2013; Guay, 1999). In contrast, a higher Delta, linking compensation to changes in equity prices, should increase the propensity of managers to generate value but also to be more prudent in their risk taking given they hold relatively undiversified portfolios with respect to firm-specific wealth (Coles et al., 2006). We compute a comprehensive Vega and Delta for each firm CEO and then distinguish vested and unvested Vega and Delta to separately analyze short-term and long-term horizons. 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.

We relate these measures of equity-based incentives to proxies of the degree of concentration of the lending relationships that we construct following the approach proposed by Colla et al. (2013) and employed by Platikanova and Soonawalla (2014). These proxies are based on the degree of concentration of the debt structure across different types of debt (henceforth debt specialization) and are motivated by the idea that firms using a lower number of types of debt (indicating higher specialization) are also more likely to have a lower number of creditors (see Colla et al., 2013; Li et al., 2014).

While, admittedly, debt specialization is an imperfect measure of the degree of concentration of the lending relationships in fewer creditors, it has been shown to be significantly higher in companies where creditors have more incentives to monitor - such as those characterized by a higher degree of information asymmetry (Colla et al., 2013; Li et al., 2014; Platikanova and

Soonawalla, 2014). In essence, debt specialization is higher when the presence of a lower number of creditors is expected to facilitate the monitoring of borrowing firms.

We start our analysis by finding consistently an increase (decrease) in debt specialization when the compensation package's sensitivity to stock return volatility (stock price) increases (decreases). Our empirical results are robust to the addition of controls that have been shown to explain debt specialization, to changes in the econometric method and, in particular, remain unchanged when we control for the potential endogeneity of equity-based incentives under an instrumental variable setting.

To further deepen in the executive compensation analysis, in the line of Edmans et al. (2012), we consider how the vesting of executive compensation affects the degree of debt concentration, finding that short-term vesting compensation is the type behind the increase in debt specialization when the compensation to stock return volatility increases.

We then proceed by evaluating how the nexus between debt specialization and equity-based incentives is influenced by a firm's default risk. We conjecture that there are at least two reasons that motivate greater debt specialization in more risky companies when executive pay might lead to more severe asset-substitution problems. First, in the presence of a default, a dispersed group of creditors tends to be inefficient in organizing and coordinating negotiation efforts (Bolton and Scharfstein, 1996; Hart and Moore, 1995; Hubert and Schfer, 2002; Ivashina and Scharfstein, 2010). Second, asset substitution problems are also more likely to occur when firms are closer to financial distress (Black and Scholes, 1973; Gavish and Kalay, 1983; Green and Talmor, 1986; Leland, 1998). In such a case shareholders might benefit from risky investments if these investments go well, while debtholders will bear the costs in the case of a negative scenario (Eisdorfer, 2008). By using different proxies for firm default risk, we find support for the validity of our conjecture but only in the case of Vega and, more specifically, in the case of vested Vega; namely for the most direct proxy of risk-taking incentives that are present in shorter horizons executive-pay. An increase in Vega (and vested Vega) raises the degree of debt specialization significantly more in riskier firms while an increase in Delta tends to produce a similar decrease in the degree of debt specialization in both low and high risk firms.

While the analyses summarized above generally indicate that creditors perceive a higher degree of debt specialization as being beneficial in the presence of more pronounced agency costs of debt, they say little as to what extent these costs are reduced when the debt structure becomes more concentrated. To quantify the potential benefits for creditors we, therefore, rely on a similar empirical setting as in Eisdorfer (2008) and relate the percentage change of the market value of debt to Vega and Delta, distinguishing also vested and unvested components of Vega. In effect, this approach implies that the agency costs of debt materialize via a reduction in the market value of debt when Vega (Delta) increases (decreases), being this effect driven by short horizons in the case of Vega. By comparing the impact of Vega and Delta on the percentage change of the market value of debt in firms with low and high degree of debt specialization, we find that the negative influence of equity-based incentives on debtholder wealth is limited to the group of firms with short-term incentives and a less concentrated debt structure. This result is, therefore, in line with the view that debt specialization is an effective tool to curtail asset substitution problems.

Finally, we extend the evidence presented in Brockman et al. (2010) by assessing whether debt maturity and debt specialization act as complement or substitute tools in reducing the potential agency costs of debt generated by executive compensation. To this end, we estimate a system of equations that allows us to control for the simultaneity in the decisions concerning debt maturity and the degree of debt specialization. Under this empirical framework, we show that the degree of debt specialization acts as an alternative tool to a decrease in the maturity of debt to curtail risk-taking incentives in executive pay. In short, we find that, controlling for risk-taking incentives in executive pay, the degree of debt specialization is significantly higher in firms characterized by longer debt maturity, while an increase in debt specialization reduces the need to shorten the maturity of debt. Hence, debt maturity and specialization are perceived by creditors as playing a similar role against the agency cost of debt, but they tend to operate as substitutes rather than complements.

Our analysis offers a number of contributions to the extant literature. First, our study extends the existing evidence on the role of executive compensation in influencing a firm's capital structure. 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), we are the first to find evidence of a strong relationship between the degree of specialization of corporate debt structures and executive compensation as motivated by the agency costs of debt.

Next, we contribute to the literature by showing that short-term horizon incentives imply a higher degree of debt concentration since it is a powerful tool to mitigate the risky decisions of managers taken in a short term. Specifically, we provide evidence that the increase in the concentration of borrowing facilitates monitoring by creditors, especially in managers with myopic behavior.

Finally, we extend the empirical evidence on the drivers of debt-specialization in Colla et al. (2013) and Platikanova and Soonawalla (2014) and, in particular, on the importance of the monitoring incentives of creditors. Essentially, we show how debt specialization might be used as a tool to curtail the agency costs of debt produced by the design of executive compensation and how this is especially the case for short-term horizon compensations and for riskier firms. Finally, we contribute to the literature on the creditor perception of pay incentives in executive compensation. Previous studies have observed a positive (negative) bond price reaction in the presence of an increase in Delta (Vega) (Billett et al., 2010), and a higher cost of debt when compensation risk is higher (Brockman et al., 2010; Daniel et al., 2004).

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. Executive compensation and the incentives of creditors to monitor

The incentives to monitor by creditors are influenced by the design of executive compensation in the borrowing firms and the related managerial incentives to engage in asset substitution (risk-shifting) that might favor shareholders (Brockman et al., 2010).

Specifically, 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 (Cohen et al., 2000; Coles et al., 2006; Dong et al., 2010; Gormley et al., 2013; Guay, 1999). 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). In contrast, the sensitivity of compensation to stock price (Delta) should favor value-increasing investments but it is also expected to lead undiversified managers to be more prudent in their risk taking (see Brockman et al., 2010; Coles et al., 2006; Knopf et al., 2002). Accordingly, a higher Delta has been associated with decreases in R&D expenditures, increases in capital expenditures (Coles et al., 2006), decreases in leverage (Coles et al., 2006; Cohen et al., 2013) and more hedging with derivative securities (Knopf et al., 2002). Overall, a higher (lower) Vega (Delta) is expected to amplify the agency costs of debt due to asset substitution problems and lead to greater monitoring by creditors (Brockman et al., 2010).

Creditors understand and rationally price the managers' risk incentives. For instance, Billett et al. (2010) show that the bond price reaction to an increase in Vega (Delta) is negative (positive). Similarly, Daniel et al. (2004) provide evidence of a positive relationship between credit spreads and CEO risk-taking compensation, while Liu and Mauer (2011) show that CEOs with a high Vega are required to hold excess cash balances to diminish bondholder risk. Furthermore, an increase in Vega (Delta) has been linked to a shorter (longer) maturity of the debt structure (Brockman et al., 2010). This finding offers clear support for a nexus between monitoring incentives and executive compensation. Shorter-term debt can reduce managerial incentives to increase risk and reduce or even eliminate agency costs associated with asset substitution (Barnea et al., 1980; Leland and Toft, 1996) as it provides creditors with a powerful monitoring tool (Rajan and Winton, 1995; Stulz, 2000). Under short-term contracts lenders are in the position to frequently review whether to continue providing credit and to restrict borrowers from increasing the riskiness of the underlying assets (Barnea et al., 1980).

However, numerous theoretical studies demonstrate that the monitoring activity by lenders is also facilitated by an increase in the degree of concentration of the debt claims (Diamond, 1984; Allen, 1990). In essence, debt providers have incentives to effectively monitor corporate borrowers provided that they have a sufficient claim in the firm (Diamond, 1991; Park, 2000), while the dispersion of creditors increases the risk of mutual free-riding (Holmström, 1982). Furthermore, the diversification of the claims over the assets of a borrower might increase coordination problems amongst lenders with a consequent higher risk of suffering from costly debt renegotiation and liquidations (Bris and Welch, 2005; Platikanova and Soonawalla, 2014). More generally, coordination problems have been shown to facilitate expropriation by shareholders (Bris and Welch, 2005; Bernardo and Talley, 1996; Gertner and Scharfstein, 1991).

Empirical support for a nexus between debt concentration and the incentives of creditors to monitor is offered by Sufi (2007) who finds that debtholders form a more concentrated lending syndicate if the firm requires stronger monitoring and due diligence. In a similar vein, using the specialization of debt types as a proxy for concentrated debt claims, Colla et al. (2013) and Platikanova and Soonawalla (2014) show that when creditors suffer from larger information asymmetry the borrowing firms exhibit a more specialized debt structure. Furthermore, Li et al. (2014) show that firms with a weak internal control system are characterized by a higher degree of debt specialization.

The highlighted role of the concentration of the lending relationships as a tool to facilitate effective monitoring by creditors, and the established impact of executive compensation on the monitoring incentives by creditors, lead us to formulate the following first hypothesis:

H1: An increase in the sensitivity of a CEO's compensation to stock return volatility (Vega), and a decrease in the sensitivity to stock prices (Delta), increases the degree of debt specialization in a firm's capital structure.

Essentially, as in Colla et al. (2013) and Platikanova and Soonawalla (2014), we employ measures of the degree of specialization of the debt structure by debt types as a proxy for the presence of concentrated lending relationships. Accordingly, we expect that when executive compensation is designed in a way that amplifies the agency costs of debt linked to asset substitution problems, the degree of specialization in the debt structure increases given the higher incentives for creditors to monitor.

2.2. Debt specialization, and CEO horizons

Jensen and Murphy (1990) indicate that how CEOs pay is designed is even more important that how much the pay is. In the previous section we have paid attention to the vehicles of the executive compensation, but 'how' concerns another relevant aspect of the design of executive compensations, that is the horizon to exercise the incentives. Prior literature shows an active debate on the optimal duration of executive compensation, finding positive and negative aspects of short-term incentives. Bebchuk and Fried (2010) indicate that pay contracts are focused excessively on short-term performance and it could lead to self-interested and often myopic managerial behavior. However, Bolton et al. (2006) show that optimal compensation contracts may emphasize short-term stock performance from the perspective of the firm's existing shareholders. Furthermore, they find that managers take myopic options to increase the current stock price. Short-term horizon influential investors could provide managers with short-term horizon incentives through compensation contracts (Cadman and Sunder, 2014) On the other hand, Dikolli et al. (2009) show that the compensation contract design can be used as a tool to mitigate the short-term incentives.

Prior literature has identified pay duration links to numerous firm characteristics. Gopalan et al. (2014) find that the executive pay duration is longer in larger firms, in firms with more growth opportunities and higher R&D, with a higher proportion of long-term assets, and better past stock performance. Besides, riskier firms are found to offer shorter duration pay contracts. Concerning the corporate governance proxies, pay duration is shorter for better-governed firms whereas other proxies suggest the opposite. Thus, Gopalan et al. (2014) indicate a negative relation between short-term horizons and the fraction of independent directors on the board, since the pay duration in longer in these firms.

In line with the use of compensation contracts to mitigate short-termism (Dikolli et al., 2009), Edmans et al. (2015) indicate that equity planned to be held for the long-term may deter the CEOs' myopic behavior. Bebchuk and Fried (2010) and Gopalan et al. (2014) find short pay duration as likely incentives for managers to take excessive risks.

Therefore, the role played by debt specialization as a tool to mitigate assets substation costs and the positive relationship between risky executive polices and short pay duration established in the literature lead us to formulate the following hypotheses:

H2a: An increase in the sensitivity of a CEO's short-term compensation to stock return volatility (Vega) increases the degree of debt specialization in a firm's capital structure.

H2b: An increase in the sensitivity of a CEO's short-term compensation to stock prices (Delta) decreases the degree of debt specialization in a firm's capital structure.

Thus, we pose that those firms in which CEOs have short-term incentives will suffer substitution problems in a higher degree, inducing creditor incentives to monitor debt structure.

2.3. Debt specialization, firm risk and the incentive of creditors to monitor

The relationship between debt specialization and executive pay incentives postulated above is 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 debt specialization in the presence of risk-taking incentives in executive compensation.

First, a dispersed group of creditors is supposed to be inefficient in organizing and coordinating negotiation efforts in the presence of a default (Hart and Moore, 1995; Hubert and Schfer, 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). Though these models offer some contrasting empirical predictions on the potential effects produced by a more concentrated debt structure, they both suggest that creditors benefit from more concentrated lending relationships in the case of firm liquidations. For instance, Bris and Welch (2005) focus on creditors that must proactively seek to enforce their claims and show that, in the presence of team free-riding and of a fixed level of debt, a distressed firm with a number of uncoordinated small creditors is less likely to be forced to pay its obligations than a firm with only one creditor. It follows that creditors should be more inclined to impose a more specialized debt structure on a firm when asset substitution problems, which might be generated by executive pay, are more likely to lead to the default of the company.

Second, asset substitution problems are also more likely to occur when firms are closer to financial distress (Black and Scholes, 1973; Leland, 1998). In such a case shareholders might benefit from risky investments if these 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 the investment intensity increases asset volatility in distressed firms while it reduces asset volatility in healthier firms. In a similar vein, Gavish and Kalay (1983) and Green and Talmor (1986) show that the incentive to shift risk is increasing in a firm's exposure to risky debt.

Taken together, the two arguments above lead us to formulate the following third hypothesis:

H3: An increase in the sensitivity of the CEO's compensation to stock return volatility (Vega), and a decrease in the sensitivity to stock prices (Delta), increases the degree of debt specialization in a firm's capital structure, especially in riskier firms.

In general, we argue that an increasing firm default risk amplifies creditor concerns over asset substitution problems and consequently the incentives to monitor as reflected in a firm's debt structure.

3. Data overview and variable measurement

3.1 Data sources and sample selection

We use four main data sources in this paper: 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 specialization as detailed in section 3.3) from Capital IQ for the period from 2001 to 2012. Following previous studies on debt specialization, 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, we match the initial sample with the firms included in the Standard and Poor´s ExecuComp database that we employ to collect CEO compensation data and compute the sensitivities of CEOs' compensation to the volatility of stock returns (Vega) and to stock price (Delta). For the firms with available data on debt structure and executive compensation we then obtain firm level characteristics from Compustat and market data from CRSP.

The final sample excludes 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 is less than 0 or greater than 1, since they are potentially erroneous (Brockman et al., 2010).

[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 8.2%.

3.2 Measuring risk-taking incentives in CEO pay

Vega and Delta are two conventional measures 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 should express the incentives for CEOs to undertake investments that increase firm risk. Delta is the sensitivity of a CEO's portfolio to stock price (Delta) defined by the change in the value of a CEO's stock and option portfolio in response to a 1% increase in the price of the firm's common stock. As a consequence, Delta is a measure of the incentives for CEOs to undertake value-enhancing investments but indirectly also of the exposure of undiversified managers to firm risk. Therefore, an increase in Delta is often associated with a decline in managerial risk-taking.

The computation of Vega 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 Coles et al. (2006) and Core and Guay (2002). Besides we decompose both the Vega and Delta measures into vested and unvested pay incentives. Unvested Vega is the value sensitivity to stock return volatility of all unexercisable options, including those of newly granted options and existing unvested options and, vested Vega is defined as the value sensitivity to stock return volatility of all exercisable options which are existing vested options. Delta is also divided into two components: unvested Delta, computed as the value sensitivity of newly granted and existing unvested options, as well as restricted stock; and vested Delta, defined as the value sensitivity of all exercisable stocks and options including existing vested options and common stocks.

Details of the methodology employed to compute the six measures are reported in the Appendix. To reduce the skewness of the distribution of the measures of equity pay-incentives, we follow Kim et al. (2011) and Brockman et al. (2010) and employ the log transformation of Vega (LNVEGA), unvested Vega (LNVEGA_UNVEST), vested Vega (LNVEGA_VEST), Delta (LNDELTA), unvested Delta (LNDELTA_UNVEST) and vested Delta (LNDELTA_VEST) and instead of the raw measures in the empirical tests.

3.3 Measures of firm debt specialization

Following Colla et al. (2013) and Platikanova and Soonawalla (2014) we use measures of debt specialization based on debt types as proxies of the degree of concentration of the debt claims in a firm's capital structure.

Our preferred proxy of debt specialization is the normalized Herfindahl-Hirschman Index (**HHI**) of debt sources usage. 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, CP to capital leases, and Other (including securities sold under an agreement to repurchase, securities debt, total trust-preferred stock and other unclassified borrowing) to the remaining debt in a firm's capital structure. 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, lower borrowing diversity) while lower values of HHI indicate a lower debt specialization (namely, a higher borrowing variety).

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

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 specialization. The majority of the debt is in the form of senior bonds and notes (with a sample mean of approximately 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[1]. The

[1]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 total adjustment to total debt are nearly zero.

measure of debt specialization 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). Overall, on average firms are likely to show a high degree of debt specialization.

[Insert Table 2 here]

In the Appendix we report the sample distribution of debt specialization by industry. There is a considerable variation in the degree of debt specialization across the industrial categories. For instance, companies in the "Fabricated products" sector show an average degree of debt specialization of approximately 43.9%, while for companies in the "Computer Software" sector the average increases to above 86.7%. All estimated specifications, therefore, contain industry dummies to limit the risk that our results are driven by omitted industry controls.

3.4 Estimation method and control variables

To estimate how risk-taking incentives in executive compensation impact on the degree of debt specialization, following Colla et al. (2013) we initially select an econometric approach that is appropriate to deal with the censored nature of our preferred measure of debt specialization (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:

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

Where HHI_{it} is the degree of debt specialization 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 the 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 variables are constructed are presented in Table 3. The vector of firm characteristics *(X)* that, based on Colla et al. (2013), are considered determinants of debt specialization, includes book leverage (LEVERAGE), size (SIZE), the market to book ratio (MTOB), firm profitability (PROF), the degree of asset tangibility (TANG), a dummy equal to one if a firm is a dividend payer (DIV_PAYER), cash flow volatility (CF_VOL), the value of R&D expenses divided by total assets (R&D)[2], 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 specialization (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 the firm age as the number of years since incorporation (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 specialization. The vector of CEO control variables (Z) includes CEO ownership, defined as the percentage of a company´s shares owned by the CEO (OWN), 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). As these variables might influence the CEO behavior, their omission might bias the potential effect of compensation on our measure of debt specialization.

Table 3 presents the summary statistics for the explanatory variables employed in the debt specialization regression. LNVEGA presents a mean (median) value of 4.085 (4.375) and LNDELTA shows a mean (median) value of 5.546 (5.551). Concerning the mean values of vested and unvested incentives, we observe a higher mean value of vested Vega (3.366) and

[2]Following Himmelberg et al. (1999) and Edmans et al. (2014) we replace missing R&D values by zero.

Delta (5.276) compared to unvested Vega (3.088) and Delta (3.210). The summary statistics for our control variables are, in general, consistent with those reported in Colla et al. (2013), Billett et al. (2007), and Li et al. (2014) among others.

[Insert Table 3 here]

4. Empirical results

4.1 The impact of executive compensation on debt specialization

In the first four columns of Table 4 we report the empirical results from the Tobit regression model where the degree of debt specialization, measured via HHI, is modeled as a function of executive 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 coefficients assigned to the two measures of executive incentives are in line with our first hypothesis. Specifically, the presence of higher risk-taking incentives in the forms of a higher sensitivity of CEO pay to stock return volatility, as indicated by higher values of LNVEGA, increases the degree of debt specialization in a firm's capital structure. LNDELTA enters all models with a negative coefficient, significant at customary levels, suggesting that an increase in the value incentives that should favor more prudent business choices by CEOs reduces the need for a more specialized debt structure. In essence, both results confirm the view that creditors seem to impose a higher degree of debt specialization when CEO incentives amplify the risk of asset substitution. In summary, when the potential conflicts between debtholders and shareholders are increased by the design of executive pay incentives, the enhanced monitoring incentives of creditors are reflected in a less dispersed debt structure.

In terms of economic impact, we observe that, using the results for the model reported in column 4, an increase from the 25^{th} to the 75^{th} percentile of the sample distribution in LNVEGA

(LNDELTA) increases (reduces) the degree of debt specialization in the debt structure by 1.6% (2.7%).

[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 specialization. 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 that captures the degree of debt specialization at the firm level. Again, our results on the effects of Vega and Delta on the degree of debt specialization remain qualitatively unchanged. In unreported tests, we also repeat our analysis excluding utilities from our sample like Colla et al. (2013); our findings remain similar. 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 specialization (Colla et al., 2013, and Platikanova and Soonawalla, 2014). Specifically, the estimated coefficients on LEVERAGE and SIZE are negative and statistically significant at customary levels while increases in MTOB, CF_VOL, and R&D increase the degree of debt specialization. Furthermore, the degree of debt specialization is greater in more regulated industries as proved 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 validate our first hypothesis that creditors perceive debt specialization as a mechanism that favors monitoring and mitigates the incentives (generated by the compensation structure) for CEOs to engage in asset substitution.

4.2 Controlling for the endogeneity of executive incentives

One possible concern over the validity of the results reported in the previous section refers to the potential endogeneity of Vega and Delta. For instance, numerous studies have suggested that corporate policy might also affect the way the compensation packages offered to executives are designed (see for instance Coles et al., 2006; and Guay, 1999). One obvious source of endogeneity is, therefore, the potential reverse causality between debt specialization and pay incentives. In the context of our analysis, it might be the case that a higher concentration of creditors in the capital 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 Table 5.

[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 four columns of Table 5 we re-estimate both the most comprehensive specification of the Tobit model reported in the previous section and the Probit specification for Excl90, with one and two period lags, respectively, of all explanatory variables. Our results remain qualitatively similar; we find again support for the idea that an increase (decrease) in Vega (Delta) increases the degree of debt specialization in a firm’s capital structure.

Next, we address reverse causality by estimating instrumental variable Tobit and Probit models (see, for instance, Purnanandam, 2008) that resemble the more conventional use of 2SLS in Coles et al., (2006) and Bhagat and Bolton (2008). To identify potential instruments for our measures of equity-pay incentives, we follow Kini and Williams (2012) that use industry benchmarks. Accordingly, we employ the mean values of Vega and Delta by industry and year as instruments for Vega and Delta at the firm level. Furthermore, similarly to Brockman et al. (2010) we employ the log transformation of (1 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 Vega and Delta.

The results for the instrumental variable models are reported in the last two columns of Table 5 where we use the Wald test of exogeneity and the Hansen J-statistic of over-identifying restriction to test the validity of the selected instruments. In this respect, the statistical significance of the Wald test and the insignificant values of the Hansen test (under the null hypothesis that the instruments are valid) confirm the model is well identified and that our instruments satisfy the required conditions. More importantly, under this new empirical setting we generally confirm the results of the previous tests. In other words, we still find that an increase in LNVEGA (LNDELTA) increases (decreases) the degree of debt specialization.

Overall, the results reported in this section suggest that our key conclusion on the impact of pay incentives on debt specialization remains valid when we control for the potential presence of reverse causality[3].

4.3 Debt specialization and short-term horizon CEO incentives

Vega and Delta of a CEO's compensation portfolio capture its sensitivities to movements in its volatility and stock price respectively. However these measures do not capture the short and long term incentives in the pay contract. Therefore, in this section we examine the relationship between debt specialization and CEOs pay duration using vested and unvested incentives.

[3] Besides, to examine the effects of managers' incentives on different aspects of a firm's financial policy and to control for a possible endogeneity, we have estimate an OLS system of three equations with debt specialization, debt maturity and leverage as dependent variables. LNVEGA and LNDELTA influence debt maturity and leverage in a similar manner as to how they affect the degree of debt specialization. More importantly, our measure of debt specialization enters with a negative and highly significant coefficient in the maturity equation, showing that debt specialization can be seen as an alternative tool of debt policy to contain the risk of asset substitution generated by executive pay.

CEO's short-term contracts or vested pay incentives have been shown to incline managers to decisions with short-term effects, being likely to induce riskier choices.

In this section we explore how CEO horizon pay incentives derived from compensation contracts are related to debt specialization. We should expect that the presence of CEOs with short horizons and higher risk-taking incentives increases the degree of debt specialization in a firm's capital structure. In general, firms with shorter-duration pay contracts choose more aggressive policies, therefore we expect debt specialization is more used to mitigate agency costs of debt. Bondholders or shareholders will benefit from the manager's short-horizon actions at the expense of debtholders or creditors.

Some studies recognize the role of vesting terms for constructing measures of pay duration such as Lambert (2010) and Gopalan et al. (2014). They find evidence that managers with vested equity are more likely to undertake myopic decisions.

We extend our baseline model by including vested and unvested Vega and Delta (LNVEGA_VEST, LNVEGA_UNVEST, LNDELTA_VEST, and LNDELTA_UNVEST), as defined in section 3.2. Besides, we add an analysis with the proportion of the sensitivity of the manager's portfolio to stock return volatility of all unvested options (R_UNV_VEGA), and the proportion of the sensitivity CEO's portfolio to stock prices of all unvested options (R_UNV_DELTA).

We have included vested and unvested Vega and Delta in different regressions because of a multicollinearity problem[4]. We include the same set of control variables than in the previous sections using the Tobit model in the first three columns for HHI as dependent variable and the Probit model in the last three columns for Excl90 as dependent variable.

[Insert Table 6 here]

[4] We cannot simultaneously decompose Delta and Vega because of the high correlation between unvested Vega and Delta.

In columns (1) and (4) we extend the regression model by splitting Vega into vested and unvested incentives. We observe that the coefficients of vested Vega (LNVEGA_VEST) are positive and significant in both, for the Tobit (0.0102) and the Probit (0.0334) models. Furthermore the results for unvested Vega (LNVEGA_UNVEST) are not significant, showing a higher debt specialization in firms whose managers have short-term horizons incentives. Since a higher degree of debt specialization could mitigate the asset substitution risk for creditors, this result supports our second hypothesis. Delta maintains a significant and negative coefficient in both models ((-0.0129) for Tobit and (-0.0450) for Probit).

In columns (2) and (5) we use vested and unvested Delta instead of the previous comprehensive Delta. The results remain similar since the coefficients in both cases are negative and significant for both models.

Finally, columns (3) and (5) report the baseline model shown in Table 4 after adding two new variables, the proportion of options not vested yet (R_UNV_VEGA and R_UNV_DELTA). The negative coefficients in the proportion of value sensitivity manager's portfolio to stock return volatility of all options that have not been vested yet (R_UNV_VEGA) show that a lower degree of debt specialization is needed in firms with a higher proportion of unvested Vega since creditors do not need to act to prevent the asset substitution problem.

Overall, the analysis reported in this section provides support to the idea that debt specialization could be a tool to mitigate the agency cost of debt especially in firms where the horizons of the executive incentives are shorter. In fact, we find significant only the vested incentives what indicates that the main results analyzed in previous sections and consistent with the prior literature can be driven just by short-term horizon incentives.

4.4 Debt specialization and corporate risk

In this section we test the validity of our third hypothesis; namely, that, as debt specialization is motivated by asset substitution problems, its role as a tool to mitigate the agency costs of debt is stronger when firms become riskier. To test this hypothesis, we extend our baseline Tobit and Probit specifications with interaction terms between the two measures of executive pay-incentives (LNVEGA and LNDELTA) and two alternative proxies of firm distress risk: two different measures of the distance to default based on market data.

More precisely, the first distance to default measure (DD) is based on Merton (1974) and is computed according to the formula reported below:

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

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 firm 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, among others, in Hillegeist et al. (2004), Vallascas and Hagendorff (2013) and Vassalou and Xing (2004).

The second measure of the distance to default 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:

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

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

As for both measures of distance to default, smaller values imply a higher likelihood that a default will occur; to conduct the empirical tests we multiply each measure by minus one. This allows us to ease the comparability with the findings obtained by using equity volatility. In other words, in all specifications, larger values of the selected risk variables will consistently signal higher firm risk.

[Insert Table 7 here]

The results of the extended Tobit regression models with interaction terms between LNVEGA, LNDELTA and firm 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). In the following four columns we estimate the results separating LNVEGA into Vega for vested (LNVEGA_VEST) and unvested (LNVEGA_UNVEST) incentives. The results of the extended Tobit regression models with interaction terms between LNVEGA_VEST, LNVEGA_UNVEST and firm 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). 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, LNVEGA_VEST AND LNVEGA_UNVEST have to be interpreted as referring to a company with average firm risk; namely, when the interaction term with one of the measures of firm 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 (corporate risk proxy equal to the 25th percentile of the sample distribution) and high risk firms (corporate risk proxy equal to the 75th percentile of the sample distribution)[5].

In general, the regression results of Table 7 show that a creditor perceives risk incentives linked to stock return volatility as being more dangerous in more risky firms: an increase in LNVEGA increases the degree of debt specialization especially in more risky firms. The result is not affected by the way we measure firm risk: in all specifications the interaction between LNVEGA and firm risk is positive and highly significant. More importantly, the marginal effects reported in Panel B tend to be significant only when firms are characterized by higher default risk.

Less consistent are the results when the focus is on LNDELTA. None of the interaction terms enter the models with a significant coefficient and, more importantly, the marginal effects tend to be significant in both low and high risky firms. 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 is not statistically different between low and high risky firms.

The result is not affected by the way we measure firm risk: in all specifications the interaction between LNVEGA and firm risk is positive and highly significant. More importantly, the marginal effects reported in Panel B tend to be significant only when firms are characterized by higher default risk.

When we distinguish the duration of incentives through vested vs unvested Vega (columns (5) and (7)), our results show that creditors perceive a higher need to monitor when CEOs have short-term incentives as well as in riskier firms. The positive coefficients of the interaction indicate an increase of the degree of debt specialization for firms with lower distance to default

[5] More specifically, for the Tobit model we compute the marginal effects of the censored expected value. These marginal effects describe how the observed variable change with respect to the regressors.

bot for vested and unvested incentives. However, the marginal effects reported in panel B point to a significant effect only for vested incentives.

Overall, when firm risk increases it appears that creditors are more concerned because of the presence of risk-incentives linked to stock return volatility rather than because of the presence of risk-taking incentives linked to CEO Delta, being this effect stronger for vested incentives. This finding is not entirely surprising. Differently from Delta, it is likely that risk-incentives linked to stock return volatility have a more direct impact on firm default risk by favoring investments by managers in more volatile projects. As a result they are likely to be especially detrimental to the survival of firms that are characterized by a higher degree of riskiness.

In summary, while the findings reported in this section confirm the key conclusion of our analysis of debt specialization having a role in mitigating the agency costs of debt, they suggest that these costs are perceived as being higher in riskier firms, in the presence of an increase in our more direct proxy of risk-taking incentives linked to stock return volatility (Vega) especially when the horizon of CEO incentives is short. The influence of Delta on debt specialization does not seem instead to vary with firm risk.

4.5 Debt specialization, managerial incentives and the percentage change in the market value of debt

Our analysis so far implies that debtholders perceive a higher degree of debt specialization as being beneficial in reducing the potential negative effects that might be generated by the presence of risk-taking incentives in CEO pay. Nevertheless, it says little as to the extent to which debt specialization is indeed beneficial for debtholders in reducing these agency costs produced by executive compensation.

In this section we assess the benefits for debtholders stemming from debt specialization by taking as a point of departure the view that the presence of the agency costs of debt could lead to a decrease in the market value of debt because of the propensity of managers to engage in asset substitution via riskier projects (Eisdorfer, 2008). In accordance with this view, we expect that the agency cost of debt related to risk-taking incentives in executive pay should materialize via a reduction in the percentage change in the market value of debt when Vega (Delta) increases (decreases). To be effective in curtailing the agency cost of debt, a higher degree of debt specialization should, therefore, mitigate the impact of risk-taking incentives on the percentage change in the market value of debt.

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

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

$$\%\Delta V_{Dit} = \beta_0 + \beta_1 LNVEGA\_VEST_{it} + \beta_2 LNVEGA\_UNVEST_{it} + \beta_3 LNDELTA_{it} + \beta_4 INVESTMENT_{it} + \beta_5 X_{it} + \beta_6 Z_{it} + \sum_{k=1}^{49} S_k + \sum_{t=2001}^{2012} Y_t + \varepsilon_{it} \quad (7)$$

Similarly to Eisdorfer (2008), the dependent variable is the 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 market value of debt is the difference between the market value of firm assets and the market value of equity.

Our key explanatory variables in equation (6) are LNVEGA and LNDELTA. In equation (7) LNVEGA is substituted by and LNVEGA_VEST and LNVEGA_UNVEST to analyze the short horizon effect of CEO incentives, while INVESTMENT is the investment intensity, calculated as in Eisdorfer (2008) as capital expenditures scaled by property, plant and equipment, and is expected to increase the market value of debt. In addition, we include the vector of firm characteristics (X) and the vector of CEO control variables (Z), both described in section 4.1.

[Insert Table 8 here]

The results for the model (6) are reported in column (1) of Table 8 and confirm that the design of executive pay significantly impacts on debtholder wealth. In short, in line with our prediction an increase (decrease) in LNVEGA (LNDELTA) reduces the percentage change in the market value of debt. Next, to assess the role of debt specialization in safeguarding the interests of debtholders, we repeat the analysis by splitting our sample into firms with low and high degrees of debt specialization. Specifically, 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 the effects of Vega and Delta on the percentage change in debt value materializes only in firms with a low degree of debt specialization. In other words, when debt specialization is low, Vega has a negative effect on the value of debt with a coefficient of -0.0117 (-0.0123) for firms with a HHI index below the sample median (for firms with Excl90 equal to zero). In contrast, Vega and Delta do not have a significant impact on the percentage change in the market value of debt in firms with a higher degree of debt specialization. Overall, this analysis provides support to the view that debt specialization mitigates the agency costs of debt by showing that a decline in the market value of debt in the face of risk-taking incentives in executive pay is confined to firms with a less concentrated debt structure.

After distinguishing Vega for vested and unvested compensations, the results reported in columns (6) to (10) confirm that short-term vesting concentrates the significant impacts of executive compensation of debtholders wealth. In line with our second hypothesis, an increase in LNVEGA_VEST reduces the percentage change in the market value of debt as is observed in column (6) for the full sample. Then, considering firms with different degrees of debt specialization, we find that the effects of vested Vega on the percentage change in debt value are materialized only in firms with a low degree of debt specialization. In short, vested Vega has a negative effect on the value of debt with a coefficient of -0.0172 (-0.0185) only for firms with a HHI index below the sample median (for firms with Excl90 equal to zero)[6]. On the other hand, unvested Vega does not affect to the percentage change in the market value of debt. This analysis supports the idea that a high degree of debt specialization mitigates the firms' risk shifting by showing a decline in the market value of debt, but the effect is relevant only for firms with short-term horizons in CEO compensation (vested Vega).

5. Conclusions

Previous studies identify the shortening of the maturity of debt as an efficient way for creditors to monitor managerial behavior and reduce the risk of asset substitution that arises from the design of executive compensation (Brockman et al., 2010). In this paper, we extend the existing literature on the impact of executive pay on debt structure by analyzing the role of another characteristic of firm debt policy, the degree of debt specialization, in moderating the agency costs of debt produced by executive pay.

We show that the specialization of the debt structure in fewer debt types is perceived by creditors as another way to attenuate the potential agency costs of debt produced by the way executive compensation is designed. Specifically, we find that when CEOs are expected to have greater incentives for asset substitution because of higher Vega or lower Delta, the degree of debt specialization increases. Furthermore, the effect on debt specialization comes from the specific group of short-term horizon CEO incentives, as the increase of debt specialization is significant for the Vega computed for those firms with vested compensations unlike the Vega computed for firms with unvested compensation.

Our empirical results are robust to controls for numerous factors that have been shown to affect debt specialization, to changes in the econometric setting and in particular to the potential

[6] We observe a negative and significant coefficient of vested Vega on the change in debt value for firms above HHI above median (Column (8)). However this coefficient is lower and less significant than for firms with HHI below median (-0.0172) vs (-0.00699).

endogeneity of equity-based incentives. We also demonstrate that the sensitivity of debt specialization to equity-based incentives that favor investments in more volatile business lines is more pronounced in riskier firms, and again, the effect is stressed (more pronounced) when the CEO compensation has a short term horizon. This finding is in line with the view that creditors aim to enhance monitoring when borrowing firms show higher incentives to engage in risk-shifting in the interest of shareholders and when this risk-shifting is more likely to lead to the default of the company.

Finally, we offer a direct test of the benefits of debt specialization in mitigating the agency costs of debt by quantifying how a more concentrated debt structure mitigates the impact of executive-pay incentives on the percentage change in the market value of debt. In essence, we show that after controlling for the level of investments, only in firms with a lower degree of debt specialization does an increase (decrease) in Vega (Delta) reduce the market value of debt. Furthermore, the increase in Vega in firms with less debt specialization takes place only for short-term horizons compensation. In contrast, the design of executive compensation has no effect on the market value of debt in firms characterized by a higher degree of debt specialization.

Our analysis extends the literature on how creditors react to the design of executive pay and the evidence provided by Colla et al. (2013) on the possible drivers of debt specialization at the firm level by offering support for a strong causal relationship between the structure of debt types and executive compensation. Specifically, we find that the executive pay exerting influence on the creditors' policies is that one vesting in the short run. Crucially, we also demonstrate that the creditors' assessment of the nexus between executive compensation and risk-seeking behavior by managers leads to the recognition that debt specialization is a similar but also an alternative mechanism to the use of debt with a shorter maturity.

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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	4.429
2002	401	6.365
2003	446	7.079
2004	474	7.524
2005	480	7.619
2006	533	8.460
2007	589	9.349
2008	606	9.619
2009	593	9.413
2010	620	9.841
2011	644	10.222
2012	635	10.079
Total	6300	100.000

Panel B: Sample Distribution by Industry

Industries	Fama-French 49 sectors	N	%
Agriculture	1	23	0.365
Food Products	2	162	2.571
Candy & Soda	3	23	0.365
Beer & Liquor	4	15	0.238
Tobacco Products	5	22	0.349
Toys Recreation	6	35	0.556
Fun Entertainment	7	68	1.079
Books Printing and Publishing	8	60	0.952
Consumer Goods	9	139	2.206
Clothes Apparel	10	79	1.254
Healthcare	11	116	1.841
Medical Equipment	12	183	2.905
Drugs Pharmaceutical Products	13	206	3.270
Chemicals	14	273	4.333
Rubber and Plastic Products	15	44	0.698
Textiles	16	34	0.540
Construction Materials	17	167	2.651
Construction	18	116	1.841
Steel Works, etc.	19	146	2.317
Fabricated Products	20	6	0.095
Machinery	21	363	5.762
Electrical Equipment	22	104	1.651
Automobiles and Trucks	23	128	2.032
Aircraft	24	72	1.143
Ships Shipbuilding, Railroad Equipment	25	16	0.254
Guns Defence	26	26	0.413
Precious Metals	27	14	0.222
Mines Non-Metallic and Industrial Metal Mining	28	43	0.683
Coal	29	33	0.524
Oil Petroleum and Natural Gas	30	354	5.619
Utilities	31	512	8.127
Communication	32	168	2.667
Personal Service	33	96	1.524
Business Service	34	292	4.635
Computer Hardware	35	119	1.889
Computer Software	36	233	3.698
Electronic Equipment	37	368	5.841
Measuring and Control Equipment	38	159	2.524
Paper Business Supplies	39	172	2.730
Shipping Containers	40	78	1.238
Transportation	41	252	4.000
Wholesale	42	249	3.952
Retail	43	304	4.825
Meals Restaurants, Hotels, Motels	44	129	2.048
Others	49	99	1.571
Total		6300	100.000

Table 2: Summary Statistics of Debt Types and Debt Specialization

This table shows summary statistics for the ratios of different debt types to total debt, as well as for the two measures of debt specialization 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	$\{[[CP/(\text{Total debt})]^2 + [DC/(\text{Total debt})]^2 + [TL/(\text{Total debt})]^2 + [SBN/(\text{Total debt})]^2 + SUB/(\text{Total debt})]^2 + [CL/(\text{Total debt})]^2 + [(\text{Other})/(\text{Total debt})]^2] - (1/7)\}/(1 - (1/7))$	6300	0.697	0.281	0.463	0.719	0.966	1.000	0.254
Excl90	Dummy equal 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 specialization 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.
LNVEGA	Natural log of one plus the change in the value of the 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 the 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 the 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
LNDELTA_UNVEST	Natural log of one plus the change in the value of the CEO's stock and option portfolio of unvested stocks and options due to a 1% increase in the value of the firm's common stock price plus one. Ln(1+Delta Unvested)	3.210	1.968	0.000	1.883	3.635	4.699	6.744
LNVEGA_VEST	Natural log of one plus the change in the value of the 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
LNDELTA_VEST	Natural log of one plus the change in the value of the CEO's stock and option portfolio of vested stocks and options due to a 1% increase in the value of the firm's common stock price plus one. Ln(1+Delta Vested)	5.276	1.444	1.490	4.312	5.287	6.200	9.148
R_UNV_VEGA	Unvested vega over total vega	0.445	0.284	0.000	0.239	0.445	0.652	1.000
R_UNV_DELTA	Unvested delta over total delta	0.202	0.190	0.000	0.031	0.162	0.315	0.791
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
MTOB	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
PROF	Operating income before depreciation over total assets	0.139	0.076	-0.113	0.094	0.133	0.179	0.389
TANG	Net property, plant, and equipment over total assets	0.314	0.236	0.019	0.126	0.238	0.472	0.892
DIV_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 has not 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
OWN	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 Specialization and CEO Risk-Taking Incentives

This table presents regression results to examine the relation between the degree of debt specialization and the sensitivities of CEO´s wealth to stock return volatility (**LNVEGA**) and to changes (in percent) to stock prices (**LNDELTA**) controlling for firm, CEO characteristics, industry and time dummies. In the first five columns the dependent variable is an Herfindhal index of concentration of debt structure by type of debt (**HHI**) while in the last columns is a dummy equal to one if more than 90% of the debt structure is concentrated in only one type of debt (**Excl90**). Columns from (1) to (4) present the regression results using the Tobit methodology. In column (1) we include leverage, size, and market to book as controls and in column (2) we add profitability, tangibility, dividend payer, cash flow volatility, and R&D expenses. In column (3) we add a dummy equal to one for unrated firms and a dummy equal to one for regulated firms and in column (4) we add firm age, CEO ownership and CEO payslice. Column (5) shows the results using Ordinary Least Squares as estimation method while Column (6) shows the results when we use as the dependent variable Excl90 and estimate the model by means of a Probit methodology. 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.

	Dependent Variable:					
		HHI				**Excl90**
		Tobit			OLS	Probit
	(1)	(2)	(3)	(4)	(5)	(6)
LNVEGA	**0.00843*** **	**0.00793*** **	**0.00805*** **	**0.00881*** **	**0.00648** **	**0.0338** **
	[0.00263]	**[0.00266]**	**[0.00263]**	**[0.00291]**	**[0.00256]**	**[0.0148]**
LNDELTA	**-0.0139*** **	**-0.0111*** **	**-0.0109*** **	**-0.0121** **	**-0.00893** **	**-0.0457* **
	[0.00370]	**[0.00369]**	**[0.00370]**	**[0.00480]**	**[0.00418]**	**[0.0248]**
LEVERAGE	-0.556***	-0.557***	-0.565***	-0.570***	-0.466***	-2.259***
	[0.0274]	[0.0266]	[0.0274]	[0.0274]	[0.0233]	[0.137]
SIZE	-0.0254***	-0.0218***	-0.0247***	-0.0212***	-0.0160***	-0.0770***
	[0.00394]	[0.00397]	[0.00412]	[0.00432]	[0.00376]	[0.0223]
MTOB	0.0489***	0.0413***	0.0420***	0.0394***	0.0278***	0.126***
	[0.00605]	[0.00740]	[0.00742]	[0.00763]	[0.00544]	[0.0332]
PROF		-0.0364	-0.0459	-0.0437	-0.0191	0.0509
		[0.0605]	[0.0610]	[0.0612]	[0.0496]	[0.317]
TANG		0.0209	0.0263	0.0181	0.00702	-0.148
		[0.0285]	[0.0290]	[0.0293]	[0.0257]	[0.141]
DIV_PAYER		0.00378	0.00407	0.0158	0.0168**	0.0603
		[0.00961]	[0.00961]	[0.00973]	[0.00802]	[0.0459]
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			-0.0119	-0.0149	-0.0209***	-0.106**
			[0.00911]	[0.00907]	[0.00770]	[0.0468]
REG_DUM			0.159***	0.164***	0.144***	1.216***
			[0.0502]	[0.0500]	[0.0493]	[0.466]
FIRM_AGE				-0.0333***	-0.0238***	-0.131***
				[0.00679]	[0.00565]	[0.0348]
OWN				-0.0101	-0.0105	-0.223
				[0.129]	[0.107]	[0.650]
PAYSLICE				0.0153	0.0216	0.0521
				[0.0352]	[0.0291]	[0.178]
Constant	1.079***	1.019***	1.047***	1.115***	0.780***	1.493***
	[0.0342]	[0.0367]	[0.0396]	[0.0439]	[0.0376]	[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: Endogeneity analysis

This table presents the regression results on the relation between the degree of debt specialization and the sensitivities of CEO´s wealth to stock return volatility (**LNVEGA**) and to changes (in percent) to stock prices (**LNDELTA**) controlling for firm, CEO characteristics, industry and time dummies and for the potential endogenetiy of equity-based incentives. In columns (1), (3) and (5) the dependent variable is an Herfindhal index of concentration of debt structure by type of debt (**HHI**) while in columns (2), (4) and (6) 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 models with all right-hand side variables lagged one year (columns 1 and 2 for HHI and Excl90 respectively), all right-hand side variables lagged two years (columns 3 and 4 for HHI and Excl90 respectively) and a single instrumental variable regression for HHI in column 5 based on the Tobit methodology and for Excl90 in column 6 based on the Probit methodology. The set of control variables include leverage, size, the market to book ratio, profitability, tangibility, dividend payer, cash flow volatility, R&D expenses, a dummy equal to one if firms are unrated, a dummy equal to one if firms belong to a regulated industry, firm age, CEO ownership and CEO payslice. 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.

	1 Lag		2 Lags		Tobit (IV)	Probit (IV)
	Tobit	Probit	Tobit	Probit	Tobit	Probit
	HHI	Excl90	HHI	Excl90	HHI	Excl90
LNDELTA	-0.0176***	-0.102***	-0.0226***	-0.131***	-0.108***	-0.541***
	[0.00596]	[0.0314]	[0.00628]	[0.0341]	[0.0235]	[0.139]
LNVEGA	0.0123***	0.0494***	0.00981**	0.0460**	0.0219**	0.103*
	[0.00364]	[0.0191]	[0.00394]	[0.0211]	[0.0106]	[0.0624]
LEVERAGE	-0.490***	-2.024***	-0.410***	-1.689***	-0.516***	-2.517***
	[0.0335]	[0.169]	[0.0358]	[0.179]	[0.0261]	[0.159]
SIZE	-0.0144***	-0.0356	-0.00943*	0.00243	0.0326**	0.171**
	[0.00500]	[0.0256]	[0.00560]	[0.0288]	[0.0134]	[0.0792]
MTOB	0.0371***	0.119***	0.0451***	0.144***	0.0780***	0.380***
	[0.00980]	[0.0454]	[0.0102]	[0.0441]	[0.0132]	[0.0786]
PROF	-0.0919	0.0454	-0.189**	-0.422	0.0513	0.404
	[0.0862]	[0.411]	[0.0901]	[0.416]	[0.0570]	[0.339]
TANG	0.0335	-0.176	0.0637*	-0.0363	0.0248	-0.0655
	[0.0334]	[0.165]	[0.0376]	[0.179]	[0.0235]	[0.139]
DIV_PAYER	0.00574	0.0237	0.0126	0.0454	0.00806	0.0189
	[0.0113]	[0.0537]	[0.0119]	[0.0606]	[0.00805]	[0.0478]
CF_VOL	0.510***	2.339***	0.590***	2.867***	0.274**	1.741**
	[0.165]	[0.790]	[0.183]	[0.857]	[0.127]	[0.751]
R&D	1.539***	5.015***	1.705***	6.099***	0.872***	4.486***
	[0.216]	[0.936]	[0.227]	[0.943]	[0.120]	[0.733]
UNRATED	-0.0136	-0.100*	-0.0225*	-0.0806	-0.0183**	-0.0923*
	[0.0116]	[0.0561]	[0.0134]	[0.0589]	[0.00892]	[0.0527]
REG_DUM	0.156***	4.871***	0.239***	4.691***	0.129**	1.144**
	[0.0503]	[0.116]	[0.0491]	[0.137]	[0.0580]	[0.499]
FIRM_AGE	-0.0288***	-0.120***	-0.0251***	-0.127***	-0.0300***	-0.162***
	[0.00846]	[0.0419]	[0.00885]	[0.0437]	[0.00628]	[0.0371]
OWN	0.0655	0.364	0.261	1.809**	1.679***	8.233***
	[0.162]	[0.825]	[0.172]	[0.845]	[0.412]	[2.441]
PAYSLICE	-0.00925	0.0184	-0.000665	0.222	0.145***	0.696**
	[0.0423]	[0.201]	[0.0441]	[0.220]	[0.0478]	[0.284]
Constant	1.008***	1.086***	0.968***	0.850***	0.976***	1.393***
	[0.0494]	[0.262]	[0.0543]	[0.257]	[0.0486]	[0.288]
Observations	4,524	4,519	3,814	3,810	6,300	6,294
Industry dummies	YES	YES	YES	YES	YES	YES
Time dummies	YES	YES	YES	YES	YES	YES
Pseudo R2	0.418	0.123	0.402	0.115	.	.
.Model Wald chi-squared	.	.	.	.	1614	949.3
Sig. Wald chi-squared	.	.	.	.	0	0
Wald chi-squared test of exogeneity	.	.	.	.	20.17	14.05
Sig.Wald chi-squared test of exogeneity	.	.	.	.	0.000	0.001
Hansen test	.	.	.	.	0.135	0.145

Table 6: CEO Horizons Incentives and Debt Specialization

This table reports the empirical results on the relation between debt specialization and CEO incentives divided into vested or short term (LNVEGA_VEST and LNDELTA_VEST), unvested or long term (LNVEGA_UNVESTED and LNDELTA_UNVESTED), as well as the proportion of delta/vega unvested, controlling for firm, CEO characteristics, industry and time dummies. Columns from (1) to (3) present the regression results using the Tobit methodology being the dependent variable an Herfindhal 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 (4) we include delta CEO, unvested and vested Vega CEO. In columns (2) and (5) we add Vega CEO as well as vested and unvested Delta, and in columns (3) and (6) we include the ratios with the proportion of unvested Vega and Delta. 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.

		Tobit			Probit	
	HHI	HHI	HHI	Excl90	Excl90	Excl90
	(1)	(2)	(3)	(4)	(5)	(6)
LNVEGA		**0.0130*****	**0.0173*****		**0.0487*****	**0.0554****
		[0.00348]	**[0.00476]**		**[0.0179]**	**[0.0231]**
LNDELTA	**-0.0129*****		**-0.0194*****	**-0.0450***		**-0.0692****
	[0.00476]		**[0.00662]**	**[0.0250]**		**[0.0346]**
LNVEGA_VEST	**0.0102*****			**0.0334****		
	[0.00264]			**[0.0141]**		
LNVEGA_UNVEST	**-0.00111**			**-0.00216**		
	[0.00257]			**[0.0135]**		
LNDELTA_VEST		**-0.00834****			**-0.0337***	
		[0.00402]			**[0.0200]**	
LNDELTA_UNVEST		**-0.00727****			**-0.0255***	
		[0.00292]			[0.0149]	
R_UNV_VEGA			-0.0397**			-0.182*
			[0.0174]			[0.0958]
R_UNV_DELTA			0.0114			0.161
			[0.0329]			[0.169]
LEVERAGE	-0.573***	-0.570***	-0.553***	-2.266***	-2.262***	-2.168***
	[0.0274]	[0.0274]	[0.0285]	[0.138]	[0.137]	[0.144]
SIZE	-0.0205***	-0.0223***	-0.0219***	-0.0745***	-0.0802***	-0.0742***
	[0.00433]	[0.00417]	[0.00478]	[0.0223]	[0.0215]	[0.0248]
MTOB	0.0411***	0.0398***	0.0397***	0.130***	0.127***	0.129***
	[0.00759]	[0.00755]	[0.00803]	[0.0331]	[0.0326]	[0.0358]
PROF	-0.0382	-0.0432	-0.0168	0.0679	0.0555	0.178
	[0.0612]	[0.0612]	[0.0642]	[0.318]	[0.317]	[0.329]
TANG	0.0186	0.0193	0.0189	-0.15	-0.145	-0.152
	[0.0293]	[0.0293]	[0.0294]	[0.141]	[0.141]	[0.145]
DIV_PAYER	0.0158	0.0154	0.0196*	0.0607	0.0593	0.0734
	[0.00970]	[0.00972]	[0.0101]	[0.0457]	[0.0459]	[0.0473]
CF_VOL	0.661***	0.658***	0.773***	2.866***	2.847***	3.078***
	[0.135]	[0.135]	[0.139]	[0.671]	[0.671]	[0.698]
R&D	1.341***	1.358***	1.424***	4.735***	4.783***	5.031***
	[0.183]	[0.182]	[0.193]	[0.788]	[0.790]	[0.834]
UNRATED	-0.0153*	-0.0156*	-0.0181*	-0.107**	-0.108**	-0.108**
	[0.00913]	[0.00908]	[0.00950]	[0.0469]	[0.0467]	[0.0485]
REG_DUM	0.161***	0.163***	0.159***	1.207***	1.214***	1.199**
	[0.0504]	[0.0506]	[0.0523]	[0.466]	[0.466]	[0.475]
FIRM_AGE	-0.0342***	-0.0338***	-0.0366***	-0.133***	-0.133***	-0.140***
	[0.00683]	[0.00680]	[0.00698]	[0.0349]	[0.0349]	[0.0352]
OWN	-0.0066	-0.0684	0.0513	-0.277	-0.403	0.461
	[0.127]	[0.127]	[0.147]	[0.649]	[0.631]	[0.736]
PAYSLICE	0.0239	0.021	0.0158	0.0819	0.0724	0.035
	[0.0356]	[0.0354]	[0.0376]	[0.180]	[0.178]	[0.191]
Constant	1.114***	1.105***	1.145***	1.484***	1.458***	1.576***
	[0.0445]	[0.0443]	[0.0451]	[0.228]	[0.226]	[0.229]
Observations	6,300	6,300	5,847	6,294	6,294	5,841
Industry dummies	YES	YES	YES	YES	YES	YES
Time dummies	YES	YES	YES	YES	YES	YES
Pseudo R2	0.439	0.439	0.441	0.136	0.136	0.138

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

Panel A presents the regression results to examine whether the relations between the degree of debt specialization and the sensitivities of CEO´s wealth to stock return volatility (**LNVEGA**) and to changes (in percent) to stock prices (**LNDELTA**) vary with firm risk. In all specifications we control for firm, CEO characteristics, industry and time dummies. In columns (1), (2). (5) and (6) the dependent variable is an Herfindhal 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 and unvested. Firm risk is defined through two alternative proxies: distance to default and naïve distance to default. Firm controls include leverage, size, market to book, profitability, tangibility, dividend payer, cash flow volatility, R&D expenses, a dummy equal to one for unrated firm, a dummy equal to one for regulated firms and firms' age. CEO controls refer to CEO ownership and CEO payslice. Panel B reports the marginal effects of LNVEGA and LNDELTA for the Tobit and Probit models computed for low and high risk firms. 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.

	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	0.00984***	0.00970***	0.0387***	0.0391***				
	[0.00289]	[0.00289]	[0.0148]	[0.0149]				
LNDELTA	-0.0134***	-0.0143***	-0.0489**	-0.0562**	-0.0145***	-0.0155***	-0.0501**	-0.0568**
	[0.00474]	[0.00476]	[0.0247]	[0.0247]	[0.00470]	[0.00476]	[0.0249]	[0.0251]
LNVEGA_VEST					0.0110***	0.0111***	0.0360**	0.0370**
					[0.00265]	[0.00269]	[0.0143]	[0.0145]
LNVEGA_UNVEST					-0.00046	-0.000712	0.00204	0.000638
					[0.00255]	[0.00256]	[0.0135]	[0.0136]
DD	0.000931		0.00056		0.000929		0.000511	
	[0.00157]		[0.00786]		[0.00157]		[0.00789]	
DD*LNVEGA	0.00292***		0.0121***					
	[0.000642]		[0.00322]					
DD*LNDELTA	-0.000768		-0.00472		-0.000839		-0.00549	
	[0.000932]		[0.00448]		[0.000951]		[0.00462]	
NAÏVEDD		0.00121		0.00257		0.00118		0.00243
		[0.00162]		[0.00801]		[0.00162]		[0.00803]
NAÏVEDD*LNVEGA		0.00290***		0.0125***				
		[0.000648]		[0.00314]				
NAÏVEDD*LNDELTA		-0.000379		-0.00323		-0.000353		-0.00352
		[0.000927]		[0.00439]		[0.000940]		[0.00451]
DD*LNVEGA_VEST					0.00154**		0.00453	
					[0.000704]		[0.00350]	
DD*LNVEGA_UNVEST					0.00174**		0.00958***	
					[0.000728]		[0.00335]	
NAÏVEDD*LNVEGA_VEST						0.00162**		0.00503
						[0.000709]		[0.00344]
NAÏVEDD*LNVEGA_UNVEST						0.00149**		0.00880***
						[0.000717]		[0.00334]
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)	0.0034	0.003	0.0051	0.0045	.	.	.	.
Vega (high risk firms)	0.0143***	0.0142***	0.0239***	0.0247***	.	.	.	.
Delta (low risk firms)	-0.0097**	-0.011***	-0.0134	-0.0167*	-0.0105**	-0.0120***	-0.0133	-0.0167*
Delta (high risk firms)	-0.0125***	-0.0124***	-0.0208**	-0.0219**	-0.0136***	-0.0133***	-0.0219**	-0.0224**
Vega vested (low risk firms)	.	.	.	.	0.0065***	0.0063***	0.0092*	0.0090*
Vega vested (high risk firms)	.	.	.	.	0.0122***	0.0125***	0.0162***	0.0171***
Vega unvested (low risk firms)	.	.	.	.	-0.0031	-0.0031	-0.0056	-0.0059
Vega unvested (high risk firms)	.	.	.	.	0.0034	0.0027	0.0093*	0.0083

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

This Table shows the regression results of the percentage change in debt value in a given year on managerial incentives (**LNDELTA, LNVEGA_VEST and LNVEGA_UNVEST**) and a set of control variables. The model is estimated via OLS. Debt specialization is measured by a Herfindhal 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**). The set of control variables include leverage, size, the market to book ratio, profitability, tangibility, dividend payer, cash flow volatility, R&D expenses, a dummy equal to one if firms are unrated, a dummy equal to one if firms belong to a regulated industry, firm age, CEO ownership and CEO pay slice. In Columns (1) to (5) the general Delta and Vega are used, whereas the remaining columns study Vega separated into vested and unvested. 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. 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.

	Percentage change in debt value									
VARIABLES	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	-0.00876***	-0.0117***	-0.00456	-0.0123***	-0.00314					
	[0.00264]	[0.00390]	[0.00364]	[0.00373]	[0.00375]					
LNDELTA	0.0193***	0.0274***	0.00952	0.0248***	0.00922	0.0212***	0.0290***	0.0117	0.0264***	0.0116
	[0.00517]	[0.00742]	[0.00704]	[0.00708]	[0.00720]	[0.00523]	[0.00735]	[0.00720]	[0.00703]	[0.00730]
LNVEGA_VEST						-0.0126***	-0.0172***	-0.00699*	-0.0185***	-0.00438
						[0.00271]	[0.00395]	[0.00401]	[0.00375]	[0.00420]
LNVEGA_UNVEST						0.00239	0.00409	0.000641	0.00521*	-0.00130
						[0.00241]	[0.00310]	[0.00361]	[0.00299]	[0.00385]
INVESTMENT	0.163***	0.204***	0.138**	0.233***	0.107*	0.162***	0.202***	0.137**	0.232***	0.106*
	[0.0439]	[0.0645]	[0.0590]	[0.0625]	[0.0618]	[0.0439]	[0.0642]	[0.0591]	[0.0624]	[0.0618]
LEVERAGE	0.179***	0.188***	0.164***	0.190***	0.145***	0.183***	0.193***	0.167***	0.195***	0.147***
	[0.0304]	[0.0430]	[0.0443]	[0.0398]	[0.0483]	[0.0306]	[0.0434]	[0.0443]	[0.0402]	[0.0482]
SIZE	0.00945**	0.00323	0.0118**	0.00627	0.0102	0.00886**	0.00299	0.0112*	0.00569	0.0101
	[0.00404]	[0.00579]	[0.00576]	[0.00561]	[0.00618]	[0.00404]	[0.00578]	[0.00576]	[0.00559]	[0.00619]
MTOB	0.0165**	0.00301	0.0261***	0.00517	0.0268***	0.0141**	-0.000243	0.0246***	0.00124	0.0258***
	[0.00698]	[0.0118]	[0.00873]	[0.0114]	[0.00928]	[0.00703]	[0.0118]	[0.00881]	[0.0114]	[0.00934]
PROF	-0.188**	-0.314**	-0.111	-0.299**	-0.107	-0.195**	-0.323**	-0.115	-0.305**	-0.108
	[0.0782]	[0.127]	[0.100]	[0.122]	[0.106]	[0.0781]	[0.125]	[0.101]	[0.120]	[0.107]
TANG	-0.00405	-0.0375	0.0409	-0.0302	0.0396	-0.00628	-0.0416	0.0391	-0.0337	0.0368
	[0.0253]	[0.0329]	[0.0373]	[0.0313]	[0.0415]	[0.0252]	[0.0331]	[0.0374]	[0.0314]	[0.0415]
DIV_PAYER	-0.00295	0.0127	-0.0176	0.0116	-0.0181	-0.00328	0.0111	-0.0172	0.00976	-0.0177
	[0.00948]	[0.0121]	[0.0143]	[0.0120]	[0.0149]	[0.00948]	[0.0121]	[0.0143]	[0.0119]	[0.0150]
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	0.0487***	0.0341**	0.0564***	0.0396***	0.0543***	0.0496***	0.0353**	0.0566***	0.0404***	0.0544***
	[0.00947]	[0.0140]	[0.0145]	[0.0134]	[0.0154]	[0.00954]	[0.0140]	[0.0145]	[0.0134]	[0.0155]
REG_DUM	0.00323	0.0189	-0.0292	0.00679	-0.110	0.00432	0.0122	-0.0246	0.00737	-0.111
	[0.0153]	[0.0203]	[0.0324]	[0.0170]	[0.231]	[0.0143]	[0.0194]	[0.0328]	[0.0153]	[0.232]
FIRM_AGE	-0.0200***	-0.0255***	-0.0131	-0.0264***	-0.0107	-0.0184***	-0.0231**	-0.0122	-0.0240***	-0.0100
	[0.00675]	[0.00957]	[0.00960]	[0.00914]	[0.00999]	[0.00675]	[0.00951]	[0.00960]	[0.00906]	[0.0100]
OWN	-0.218	-0.478**	0.0460	-0.426**	0.0458	-0.244*	-0.492**	0.0101	-0.437**	0.000711
	[0.141]	[0.216]	[0.201]	[0.207]	[0.206]	[0.141]	[0.215]	[0.200]	[0.206]	[0.204]
PAYSLICE	0.0138	0.0771	-0.0422	0.0729	-0.0476	0.00265	0.0650	-0.0483	0.0571	-0.0486
	[0.0407]	[0.0611]	[0.0521]	[0.0580]	[0.0538]	[0.0412]	[0.0615]	[0.0534]	[0.0585]	[0.0552]
Constant	-0.0383	-0.0734	0.0557	0.322	0.0665	-0.0366	-0.0840	0.0526	0.327	0.0613
	[0.135]	[0.0564]	[0.240]	[0.393]	[0.241]	[0.137]	[0.0569]	[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
R-squared	0.117	0.143	0.115	0.139	0.120	0.119	0.148	0.116	0.145	0.121
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	0.0881	0.105	0.121	0.0866	0.121	0.0882

Appendix

A. Estimation of Vega and Delta

We define the volatility sensitivity or Vega as the change in the value of the 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 Core and Guay (2002) and Coles et al. (2006).

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

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

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

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 of 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 option - needed to compute the maturity of the options as of the fiscal year end.	
Stock price	Stock price at fiscal year end.	

- 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 Core and Guay (2002) and Coles et al., (2006), 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 Guay (1999) and Coles et al. (2006), 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 in vested and unvested.

Vega is split in two parts, unvested Vega calculated as the value sensitivity 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 CEO's portfolio to stock return volatility of all exercisable options (LNVEGA_VEST).

Then Delta is divided in unvested and vested Delta. Unvested Delta is the value sensitivity CEO's portfolio to stock price of all unvested stocks and options including newly granted options existing unvested option and restricted stock (LNDELTA_UNVEST). Vested delta is the value sensitivity CEOs portfolio to stock prices of all exercisable stocks and options including common stock and existing vested option (LNDELTA_VEST).

B. Tables

Table B.I. Debt Specialization by Industry.

Table B.I reports the industrial distribution of the degree of debt specialization (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