Negative Hedging:

Performance Sensitive Debt and CEOs' Equity Incentives

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Abstract

We examine the relation between CEOs' equity incentives and their use of performance-sensitive debt contracts. These contracts require higher or lower interest payments when the borrower's performance deteriorates or improves, thereby increasing expected costs of financial distress while also making a firm riskier to the benefit of option holders. We find that managers whose compensation is more sensitive to stock price volatility choose steeper and more convex performance pricing schedules, while those with high delta incentives choose flatter, less convex pricing schedules. Performance pricing contracts therefore seem to provide a channel for managers to increase firms' financial risk to gain private benefits.

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1. Introduction

Performance pricing in commercial debt contracts links the borrower's interest payments to a measure of financial performance, such as its current credit rating or certain balance sheet ratios. A typical performance sensitive debt (PSD) contract charges lower interest rates in times of good performance and higher interest during poor performance.

Some practitioners caution that performance pricing may exacerbate the costs of financial distress.[1] Consistent with these concerns, Manso, Strulovici and Tchistyi (2006) demonstrate that in a setting with bankruptcy costs and tax benefits, PSD obligations are less efficient than fixed-rate loans of the same market value, because PSD contracts precipitate default, increase bankruptcy costs and reduce the firm's value. Moreover, the inefficiency of PSD is greater when the slope of performance pricing is steeper.

This finding suggests that the existence of PSD obligations should be explained by other market frictions, and recent research has illuminated some possibilities. Manso et al. (2006) demonstrate that PSD can be used as a signaling or screening device in a setting with asymmetric information. Tchistyi (2006) shows that it is optimal to issue PSD in a dynamic setting with

[1] For example, see "Credit ratings can harm your wealth," *Investment Adviser*, December 9, 2002.

moral hazard. Asquith, Beatty, and Weber (2005) suggest that PSD can reduce contracting costs. In this paper we develop and test a further theory, that PSD contracts enable executives to transfer value to themselves at the expense of shareholders. In particular, our paper tests whether the existence and strength of PSD contract terms are related to managers' incentives from ownership and compensation.

Performance pricing increases the volatility of the firm's net earnings and, consequently, the volatility of equity returns. This creates a potential conflict of interest between the firm's managers and shareholders, in which managers may enter into debt contracts that reduce share values. This could occur because higher stock volatility due to performance pricing increases the value of stock options held by management, but it also may reduce the value of the firm because of higher expected costs of financial distress. As a result, equity value could decline, if we assume that banks that agree to performance sensitive loans negotiate pricing schedules leaving them no worse off than the alternative of issuing fixed rate debt. We illustrate this conflict of interest, which we call "negative hedging" by the manager, with a simple model in section 2 below.

To study whether managers with option and stock holdings exhibit systematic preferences for performance sensitive debt, we merge a large sample of commercial bank debt contracts with data about the equity ownership of the borrowing firms' CEOs. For each CEO in our sample, we calculate the delta, or sensitivity of stock and option values to changes in stock price, as well as the vega, or sensitivity of option values to changes in stock volatility. We hypothesize that managers with significant vega incentives from option holdings are likely to choose debt with a PSD feature and, within the subset of PSD contracts, should prefer steeper performance pricing schedules, since steep pricing schedules imply rapid appreciation of their option holdings when risk increases. Conversely, managers with higher deltas from stock and options are likely to disfavor PSD contracts and, when PSD is used, to prefer arrangements with flatter slopes, because these managers should be more concerned about their exposure to the higher expected distress costs associated with PSD contracts.

Although PSD is not the only risk-shifting device managers can use to increase the value of their stock options, its relative lack of transparency makes it attractive for this purpose. PSD is widely issued, but its incentive effects are more complex than those of straight or convertible debt and it is difficult to value.[2] More visible strategies for risk-shifting, such as undertaking risky investment projects or adding leverage to the capital structure, are easy for investors to observe and are often restricted by covenants on existing debt.

The results of our analysis, based upon Tobit regression estimations, support these hypotheses. Using a sample of several thousand loan contracts negotiated by 1,239 U.S. companies from 1994 to 2002, we find that firms whose CEOs exhibit high deltas from their stock and option holdings tend to have flatter performance pricing schedules; one standard deviation increase from the mean in delta corresponds to a 42 percent decrease in the slope of the performance pricing schedule. Conversely, we find that CEO's with high vegas from option inventories tend to have steeper performance pricing schedules: After controlling for heterogeneity in borrowers' characteristics and loan characteristics, a one standard deviation increase from the mean of log (1+vega) corresponds to a 17 percent increase in the performance pricing schedule's slope.

We examine the relation between CEOs' incentives and the PSD slope more closely in two different ways. We look at the "interest increasing" and "interest decreasing" segments of

[2] Stanford finance professor Darrell Duffie has stated in the news media that PSD contracts "have caused some head-scratching in terms of how to price them," *The New York Times*, January 29, 2002.

the PSD slope, those that lie at credit ratings below and above the firm's rating at the time of contracting. We find a stronger relation between CEOs' delta incentives and the interest increasing slope, implying that CEOs with high ownership are more concerned with avoiding expected costs of financial distress than with reaping the benefits of high rewards for performance improvements. We also examine the convexity, rather than the slope, of the PSD pricing schedule, and we find that both local and overall convexity are positively associated with CEOs' vega incentives and negatively related to their delta incentives.

We also explore whether borrowers with high monitoring needs negotiate more refined PSD schedules, with a large number of gradations included the pricing schedule to reflect possible changes in borrowers' credit quality. Consistent with this monitoring hypothesis, we find that firms whose CEOs have high vegas from their option holdings exhibit PSD contracts with larger numbers of steps in the contract pricing grid.

Despite PSD's growing importance, our knowledge of its role in corporate lending is limited. Our study is similar in design to the most comprehensive empirical study of PSD to date, Asquith, Beatty, and Weber (2005). That paper uses 8,761 bank loans from the Loan Pricing Corp. (LPC) Dealscan database and partitions the PSD contracts into two groups: interest decreasing loans, in which low-credit borrowers negotiate a schedule of interest reductions contingent upon improved performance, and interest increasing loans, which stipulate rising interest rates should a high-credit borrower's performance deteriorate. The authors conjecture that different economic motives lead to these different forms of PSD and verify their hypotheses using a variety of variables related to historical default rates, return volatilities, and measures of credit rating precision and information asymmetry. Other studies of PSD include Beatty and Weber (2003), Hillion and Vermaelen (2004), Lando and Mortensen (2005), and working papers by Manso, Strulovici, and Tchistyi (2006), and Tchystyi (2006). A related paper by Bhanot and Mello (2006) presents a theoretical model of debt contracts with rating triggers; these triggers can force either early payment of debt or increases in coupon rates when a firm's rating is lowered. The authors conclude that repayment triggers can be used to mitigate agency costs due to asset substitution, but that coupon rate triggers – which resemble the PSD contracts studied in our paper – do not help solve the asset substitution problem. Therefore we do not investigate a connection between PSD contracts and asset substitution.

Our findings contribute to a literature showing that managers' incentives from compensation and ownership can lead to risk-shifting behavior, redistributing value from among financial claim holders while potentially reducing the overall value of the firm. Important papers in this area include Agrawal and Mandelker (1987), DeFusco, Johnson and Zorn (1990), Parrino and Weisbach (1999), Cohen, Hall, and Viciera (2000), Jin (2002), and Knopf, Nam, and Thornton (2002).

This paper proceeds as follows. Section 2 presents our hypotheses. Section 3 presents institutional facts about PSD contracts and describes the data. Section 4 contains the basic analysis of the effects of managers' deltas and vegas upon the terms of PSD contracts. Section 5 concludes.

2. Hypothesis development

Jensen and Meckling (1976) describe a firm as a set of contacts. According to this view, managers' interests differ from those of shareholders, requiring contracts that provide mangers with incentives to maximize shareholders' wealth. This argument provides a rationale for the widespread use of stock options in executive compensation. However, under some circumstances option compensation may fail to align the interests of managers and shareholders. For example, option compensation has been linked to the incidence of accounting fraud at firms in the late 1990s (Burns and Kedia, 2006) and has been subjected to manipulations that permitted managers to adjust timing of awards for personal enrichment (Heron and Lie, 2007).

Following the set-of-contracts theory of the firm, a theoretical study by Tchistyi (2006) demonstrates that PSD is an optimal contract in a setting in which a manager can divert the firm's cash flows for private consumption at the expense of outside investors. PSD's higher interest rates associated with poor performance provide incentives for the manager not to steal the firm's cash flows. Manso et al. (2006) show that PSD can serve as a signaling or screening device in a setting with asymmetric information. In the equilibrium, a manager who is optimistic about the future of her firm prefers PSD, while a pessimistic manager prefers straight debt. Asquith, Beatty, and Weber (2005) suggest that PSD can reduce contracting and renegotiation costs, since PSD automatically adjust its interest rate according to the firm's performance.

In this paper, we investigate whether PSD contracts also enable CEOs to transfer value to themselves at the expense of shareholders due to the presence of stock options in CEOs' compensation packages. PSD reduces interest payments in states of good performance and increases interest payments in states of poor performance. These contractual adjustments result in higher equity payoffs in good states and lower equity payoffs in bad states. Because of the convexity of the option payoff, this tradeoff benefits option values.

Consider a firm that takes a performance-sensitive loan of amount D at time $t = 0$. The firm must pay back $(1 + r(v))D$ at time $t = 1$. The performance-sensitive yield $r(v)$ is a function of the firm's value v at $t = 1$. For simplicity, we assume the firm is liquidated at $t = 1$, there is no bankruptcy cost, and v is distributed according to p.d.f. $f(v)$ under a risk-neural probability measure. Then, the payoff on the debt at $t = 1$ is given by $\min((1 + r(v))D, v)$.

Assuming that the banking industry is competitive, the debt is issued at its fair market value:

$$D = \frac{1}{(1+r_f)} \int_0^{\infty} \min\left\{ \left(1+r(v)\right) D, v \right\} f(v) dv , \tag{1}$$

where r_f is the risk-free rate.

The CEO of the firm has N_c stock options with the strike price K and the expiration date $t = 1$. When the CEO exercises his options, the firm will issue N_c new shares. Let N be the number of shares outstanding at time $t = 0$. Then, the time zero value of the CEO's option package is given by

$$C = \frac{N_c}{(1+r_f)} \int_0^{\infty} \max\left\{ \frac{N}{N+N_c} \left(\frac{v - \left(1+r(v)\right) D}{N} - K \right), 0 \right\} f(v) dv . \tag{2}$$

It is clear from (2) that the value of the option package changes when the performance pricing changes: the lower the interest rate $r(v)$ when the options finish in-the-money, the higher the value of the options. Let $r(v)$ be bounded from below by $r_0 = r_f$. Assuming that the amount of debt is not extremely high:

$$D \leq \frac{1}{(1+r_f)} \left[\int_0^{NK+(1+r_0)D} v f(v) dv + \int_{NK+(1+r_0)D}^{\infty} \left(1+r_0\right) D f(v) dv \right], \tag{3}$$

the option value is maximized by any of the following performance-pricing profiles:

$$r^*(v) = \begin{cases} r_1(v), \; if \; \dfrac{v-(1+r_0)D}{N} \leq K \\ r_0, \quad \; if \; \dfrac{v-(1+r_0)D}{N} > K \end{cases} , \tag{4}$$

where $r_1(v) = r_0$ is such that the market value of the debt with the performance-pricing profile r^* at time zero is exactly D:

$$D = \frac{1}{(1+r_f)}\left[\int_0^{NK+(1+r_0)D} \min\left\{(1+r_1(v))D, v\right\} f(v)dv + \int_{NK+(1+r_0)D}^{\infty} (1+r_0)Df(v)dv\right]. \qquad (5)$$

Performance pricing is a tradeoff between lower interest rates in good states and higher interest rates in bad states. According to (4) and (5), this tradeoff is extreme for the performance-pricing profiles maximizing the value of the CEO's options: the lowest possible interest rate is charged whenever the options finish in-the-money ($\frac{v-(1+r_0)D}{N} > K$), and substantially higher interest rates are charged whenever the options finish out-of-the-money ($\frac{v-(1+r_0)D}{N} \leq K$). Figure 1 compares performance pricing profile r^* that maximizes the value of an option with a typical performance pricing profile in our sample. Because the tradeoff between lower rates in good states and higher rates in bad states is more pronounced for r^*, the slope and the convexity are also greater for r^*.

According to our analysis, performance pricing profiles with steeper slopes and higher degrees of convexity result in higher option values because they exacerbate the riskiness of the manager's option claim. This leads us to the hypothesis that CEOs with large vega incentives from their option holdings are likely to choose steeper and more convex performance pricing schemes. Vega, the derivative of option value with respect to stock volatility, is defined more completely below.

Our second hypothesis is based on the finding by Manso et al. (2006) that PSD obligations are less efficient than fixed-rate loans of the same market value. In particular, PSD obligations precipitate default, increase bankruptcy costs and reduce the firm's value and equity value, based on an assumption that the value of debt does not decrease since the bank issuing a PSD loan makes sure that it does at least as well as if it had made a fixed rate loan. Moreover, the inefficiency of PSD is greater when the slope of performance pricing is steeper. Hence, we hypothesize that managers with higher delta prefer PSD contracts with flatter slopes. Delta, the derivative of stock and option value with respect to stock price, is also defined more completely below.

3. Data description

We obtain data about PSD contracts from the LPC Dealscan database, which contains detailed information on more than 100,000 loans, high-yield bonds, and private placements mostly to larger borrowers. From 1994 to the present, Dealscan reports information about PSD features when they appear in debt contracts, including the PSD pricing grid. A pricing grid is essentially a step function schedule of interest payments contingent upon some aspect of the borrower's future performance or financial health, such as its debt rating. The Appendix provides illustrations of typical performance pricing contracts negotiated by one company.

According to Asquith, Beatty, and Weber (2005), Dealscan reports five major types of financial measures found among the universe of PSD constracts: debt-to-EBITDA ratio (used in 53.3% of contracts), debt ratings (24.9%), interest coverage ratio (8.4%), fixed charge ratio (4.8%), and leverage (8.6%). Among these possible variables, we exmine those using the senior debt rating as a measure of a borrower's performance.[3] This choice allows us to compare performance spreads across firms at different times. Also, the senior debt rating may be subject to less manipulation by managers than other PSD criteria. Beatty and Weber (2003) show that

[3] PSD contracts based upon credit rating generally use the higher of the senior debt ratings maintained by Moody's and Standard & Poor's for the issuing company at any given time. Pricing grids for these contracts are generally expressed using the S&P notation (e.g., BBB instead of Baa).

managers with PSD contracts tend to influence accounting information when performance measures are directly based on accounting figures. To achieve standardization of contract formats within the subsample we study, we narrow our observations to contracts issued between 1994 and 2002, by companies outside the financial industry (SIC codes 60-69), with LIBOR-based spreads, and without multiple performance criteria.

The riskiness of a PSD contract is measured by the slope of its performance pricing schedule. A steep slope indicates low interest payments when a firm performs well and high interest payments when a firm performs poorly. A flat slope, in contrast, indicates an ordinary fixed-rate debt contract where constant interest payments are charged regardless of how a firm performs. Measuring the slope is complicated by the possibility that it might change over different ranges of the performance measure; the example presented in the Appendix shows exactly this situation, for a company whose pricing schedule is flatter at extreme levels of performance than in the middle range.

We adopt two measures of the slope of a PSD contract, the "average slope" and the "local slope." To calculate average slope, we find the change in interest rates over each credit rating increment specified in a given PSD contract. We then divide each incremental change by the market-wide difference in yields over the same increment at the time the contract was negotiated, using corporate bond yield data obtained from Moody's.[4] Under this scaling, a contract will exhibit a slope of 1 if it calls for a change in interest rates mirroring the profile of prevailing market yields. The slope will exceed 1 if it is steeper than the market yield profile and will be less than 1 if it is flatter. Fixed rate debt will have a slope of zero. After calculating market-adjusted slopes for all rating increments individually, we take their average value for each

[4] Our market-wide data are based upon the Moody's end-of-month value weighted average yield for long-term corporate bonds in each ratings class, according to data from the Citigroup YieldBook. We thank Chenyang Wei for assistance in obtaining this data.

contract, over the range bounded by the upper and lower limits of credit ratings for which interest changes are specified (these upper and lower limits vary from one contract to another).

Our calculation of local slope is quite similar. Again we calculate the change in interest rates called for by the PSD contract over each rating increment and scale that change by the prevailing market-wide slope for each increment. While the average slope calculation uses data for all increments specified under the contract, local slope is calculated as the average over the rating increments immediately above and immediately below the company's rating at the time of contract negotiation. Local slope is therefore:

$$LocalSlope = \frac{1}{2}\left(\frac{Spread(i-1) - Spread(i)}{Moody(i-1) - Moody(i)} + \frac{Spread(i) - Spread(i+1)}{Moody(i) - Moody(i+1)} \right) \qquad (6)$$

where *Spread*(n) is the firm's interest cost above LIBOR at any rating n, *Moody* (n) is the market value-weighted average yield within rating class n, and i is the firm's rating at the time of contract negotiation. About 20 percent of our PSD contracts (281 observations out of 1,375) are written with the company's current credit rating as a "corner point" of the pricing schedule – meaning the changes in interest rates are specified only in one direction, exclusively above or exclusively below its current rating. For these observations we calculate local slope using only the single rating increment adjacent to its current rating. Figure 2 provides a graphical illustration of the calculation of local slope; intuitively, the slope of a PSD contract equals the change in spread (basis points above LIBOR) for each unit change in market spread at the firm's current credit rating.

To measure the convexity of a performance pricing profile r, we let CR_l and CR_h denote the lowest and the highest credit ratings used in the performance pricing schedule and N(CR) denote the number of credit rating notches between CR and CR_h. We define the linear extrapolation of performance pricing schedule *r* as follows:

$$r_L(CR) = r(CR_h) + \frac{r(CR_l) - r(CR_h)}{N(CR_l)} N(CR). \qquad (7)$$

We define the convexity of performance pricing profile *r* as the greatest deviation from the linear extrapolation:

$$x_r = sign(\mathrm{r}_\mathrm{L}(CR) - r(CR)) \cdot \max_{CR \in [CR_h, CR_l]} \left| \mathrm{r}_\mathrm{L}(CR) - r(CR) \right|. \qquad (8)$$

where $sign(a)$ is 1 if $a \geq 0$ and is -1 if $a < 0$. Figure 2 shows conceptually how we measure convexity. The large majority of our PSD contracts exhibit convexity according to this definition, although many contracts have inflection points between convex and concave segments, and our definition classifies a minority of 120 observations, or about 9 percent of our PSD sample, as concave. In our calculations of convexity we assign negative values to the concave observations, so that concavity is essentially treated as "negative convexity." We calculate values of overall convexity and local convexity based upon the same approach as used for average slope and local slope.

We merge our sample of debt contracts from Dealscan with borrowers' financial statement data from Compustat using a matching algorithm.[5] We gather variables measuring firm size (natural log of total assets), leverage (short-term plus long-term debt over total assets), market-to-book ratio, cash flow (EBITDA), and the time series volatility of cash flow (the standard deviation of EBITDA over the four years prior to the loan year, standardized by the mean value over the same period).

[5] The process involves using text extracts to match firm names as they appear on each database. After the automated matching process, we inspect each paired observation for errors due to pathologies of the algorithm. We thank Charles Himmelberg for providing a conversion table and helpful advice.

We obtain information on managerial compensation and ownership from the ExecuComp database. Following Guay (1999) and Core and Guay (1999, 2002), we use the sensitivity of CEO's stock and option values to changes in stock price (delta) and the sensitivity of CEO's stock and option values to changes in stock return volatility (vega) as measures for incentives provided by managerial compensation and ownership. Based on these measures, Coles, Daniel and Naveen (2006) find that higher vega leads to more risk-taking activities by management, such as lower investment in property, plant, and equipment, higher book leverage, and market leverage. In contrast, higher delta leads to less risky financial policies such as a decrease in leverage and an increase in capital expenditures.

We follow the procedure described by Core and Guay (2002) for constructing delta and vega, and we use these statistics as proxies for managerial incentives. The CEO's delta is obtained by weighting each CEO's delta for shares owned and delta for options owned by the number of shares and options held by that CEO. The delta for stock is 1 by definition, and the delta for stock option holdings is based on the derivative of the Black-Scholes formula with respect to stock price:

$$Delta_{option,i} = e^{-dT} \times \Phi(z) \tag{9}$$

$$z = \frac{\log(S/K) + (r - d + 0.5 \times s^2)T}{s\sqrt{T}} \tag{10}$$

where $\Phi(z)$ is the cumulative probability distribution function for the normal distribution, S is the price of the underlying stock, K is the exercise (strike) price of the option, s is expected stock-return volatility over the life of the option, r is the continuously compounded of risk-free interest rate, T is time to maturity of the option in years, and d is the continuously compounded expected dividend yield over the life of the option. The strike price is estimated from the difference between the year-end stock price and the CEO's intrinsic (in-the-money) option values:

$$K = S - \frac{InMonEx_i + InMonUn_i}{UnexNumEx_i + UnexNumUn_i} \quad (11)$$

Where S is the year-end stock price, $InMonEx_i$ is the intrinsic value of unexercised vested options, $InMonUn_i$ is the intrinsic value of unexercised unvested options, $UnexNumEx_i$ is the number of vested options, and $UnexNumUn_i$ is the number of unvested options; all these variables are disclosed for each CEO in firms' proxy statements and reported in ExecuComp. When K cannot be estimated because all of the CEO's options are out of the money with zero intrinsic value, we use certain alternative assumptions described by Core and Guay (2002). To take account of the size of the CEO's equity position relative to the total capitalization of the firm, we divide the delta of each CEO by the firm's total shares outstanding plus the CEO's options. The approach, following the functional form used by Yermack's (1995) study of delta incentives from CEO options, gives the value gain realized by each CEO for a $1.00 increase in the firm's equity value.

Since the vega for stock is very close to zero, we only need to evaluate vega for option holdings, which is provided by the derivative of the Black-Scholes formula with respect to volatility:

$$Vega_{option,i} = e^{-dT} \times f(z) \times S \times \sqrt{T} \quad (12)$$

where z, S, T, and d are defined as above. Due to the skewness of *vega*'s distribution, we generally use the functional form log(1+*vega*) in our regression estimations.

To estimate each CEO's delta and vega for option grants, we use a standard set of assumptions and data sources. The year-end stock price S is obtained from ExecuComp. The annualized volatility s is estimated as the standard deviation of daily logarithmic stock returns (from CRSP) over 252 trading days, multiplied by the square root of 252. The remaining time to maturity t for the inventory of a CEO's option grants is assumed to be 6 years, following Core and Guay (2002). The risk-free rate r is obtained from the zero-coupon U.S. Treasury strip with comparable maturity, as reported by Bloomberg. The expected dividend rate d is estimated from Compustat data by dividing per-share dividends paid during the corresponding fiscal year by year-end stock price. We match each PSD contract with the CEO's prior year-end delta and vega for each issuing company.

After discarding firms without adequate data availability, we have a sample of 1,375 PSD contracts for 461 firms. Together with 3,918 non-PSD contracts for 1,148 firms, our whole sample consists of 5,293 contracts for 1,239 firms who compete in 57 different primary two-digit SIC industries. Table 1 presents summary statistics.

CEOs' equity incentives appear significantly different between firms issuing PSD and those issuing ordinary debt contracts. The mean CEO delta is 0.023 for the PSD loan sample while that of the non-PSD loan sample is 0.029, significantly different at the 1 percent level. The vega, in contrast, is larger for the PSD sample than the non-PSD sample, with the difference again significant at the 1 percent level.

Since the firms in our sample are public companies with bank relationships, they tend to be large. The median market capitalization for the PSD sample is $3.2 billion while that of the non-PSD sample is $1.9 billion. The median value of total assets is $4.3 billion for firms with PSD contracts and is $2.7 billion for firms without PSD contracts, which is substantially larger than the average for the entire Compustat population. Firms with PSD contracts have lower market-to-book ratios and cash flow (EBITDA) than those without PSD contracts. PSD borrowers are somewhat older than straight debt borrowers. Figure 3 shows that both PSD and non-PSD issuers in our sample generally have high credit quality, but the distribution is somewhat tighter for PSD, with straight debt accounting for most of the observations with very high and very low ratings.[6] We do not find noticeable industry differences in our samples of PSD and non-PSD contracts. Table 2 presents the five highest and lowest industries for PSD use, ranked according to the ratio of PSD contracts over all debt contracts in our sample. Industries are arranged according to the 48 Fama-French SIC groups.

Loan characteristics of PSD contracts and ordinary debt contracts also exhibit noticeable differences. Loan amounts of PSD contracts are larger than those of the ordinary debt contracts. The numbers of lenders involved in PSD contracts are significantly larger than those involved in ordinary debt contracts. This is consistent with Asquith et al. (2005), who find that performance pricing is used to reduce renegotiation costs, which can become prohibitively high when many lenders are involved. PSD contracts have shorter maturity than ordinary debt contracts.

Our summary statistics for the average slope and local slope of PSD contracts indicate mean values of approximately 0.28 and 0.32, respectively. Our measure of overall convexity exhibits mean and median values just below 0.20, indicating that pricing schedules tend to be bowed toward the origin at a maximal deviation of about 20 percent below the linear projection between a schedule's endpoints. However, most PSD contracts exhibit very little convexity near the debt rating at the time of contract inception, as the mean value for local convexity is just 0.03 and the median value for local convexity is zero.

[6] A certain number of observations are non-rated in both the PSD and non-PSD samples and are not used in Figure 3. It is possible for a non-rated bond to have a PSD pricing schedule based upon its credit rating, and this happens 72 times on our sample. In these cases the loan contract generally treats non-rated status as equivalent to having the lowest possible credit rating.

In Table 3 we show the sample correlations between average slope, local slope, overall convexity, local convexity, and a fifth variable equal to the number of individual rating steps specified in each PSD contract. These five quantities are used as dependent variables in our regression analysis below. We show correlations both for the entire sample, including fixed-rate debt with no pricing schedule, and for the subsample of PSD contracts only. We see very strong correlations among most of the dependent variables within the overall sample, due to the majority of zero-valued observations for all four of them. Within the subsample of PSD contracts, sample correlations have much more modest magnitudes, the largest being the correlation of 0.545 between average slope and local slope. The two convexity measures exhibit weakly negative correlations with both average slope and local slope.

Figure 4 provides some preliminary evidence that CEO incentives play an important role in the decision to issue PSD instead of straight debt. The figure shows PSD issuance frequencies for a subsample of 248 CEOs who receive very large stock option awards, which we define as more than 1% of the company's shares outstanding. We display the probability that the firm's next debt issue following a large CEO option award is PSD, with the data shown separately depending upon whether the last debt issue prior to the option award was PSD or straight debt. For comparison purposes, data are also shown in the same format for our remaining sample of 4,450 pairs of debt contracts issued in sequence by individual firms, with no large CEO stock option award occurring between each contract pair. The figure shows that while prior PSD issuers continue to exhibit a preference for PSD in their next debt contracts, a large CEO option award leads to a markedly greater likelihood of PSD issuance regardless of the characteristics of the prior issue. Among the group of prior straight debt issuers, for instance, the probability that the next debt issue is PSD is about 40 percent following the receipt of a large option award by the CEO, and about 25 percent otherwise. The difference is somewhat less dramatic for prior PSD issuers but is statistically significant at the 5 percent level in both cases.

4. Analysis of PSD contract terms

In this section, we examine the impact of CEO's equity incentives on firms' choice of PSD contract parameters. As described in the previous section, we expect CEOs with high values of vega to prefer more risky PSD contracts, and CEOs with high values of delta to prefer less risky contracts.

4.1. Slope

We begin by using the slope of the PSD performance pricing schedule as our measure of the risk of a PSD contract. Because the straight-debt contracts in our sample exhibit zero slope by definition, we employ a Tobit regression specification:

$$Slope_i = \max(Slope_i^*, 0)$$

$$Slope_i^* = a + a_{Industry} + a_{Year} + b_1 \cdot Delta_i + b_2 \cdot Vega_i + X_i \cdot g + e_i \qquad (13)$$

$$e_i \sim N(0, s^2)$$

$Slope_i$ is the dependent variable (the slope of PSD contract), $Delta_i$ is the delta of CEO's equity grants normalized by shares outstanding, $Vega_i$ is the vega of CEO's equity grants specified as log(1+vega), X_i are control variables, $a_{Industry}$ are two-digit SIC dummy variables, a_{Year} are year dummy variables, and e_i is the error term. We draw independent variables from prior literature on CEO compensation (e.g., Core and Guay, 1999) and on capital structure (e.g., Barclay and Smith, 1995) to control for heterogeneity in borrowers' characteristics and loan characteristics. These control variables in our models include firm size, leverage, market-to-book ratio, return on assets (based upon EBITDA), the time series volatility of EBITDA (the standard deviation over the prior four years, scaled by the mean over the prior four years), and an indicator variable for whether the firm's senior debt is rated by either Moody's or Standard & Poor's. In order to control for heterogeneity in loan characteristics, we use loan amount (scaled by total assets) and the log of maturity, as well as the log of the total number of PSD contracts for each firm reported in Dealscan, whether or not these contracts meet the data criteria for inclusion on our sample. These control variables account for differences in borrowing capacity, investment opportunities and activities, uncertainty in borrowers' performance, and basic loan conditions. In order to account for the clustering of PSD contracts within firms and the heteroskedasticity of the error terms (e), we cluster all standard errors at the firm level.

Endogeneity of the main delta and vega explanatory variables poses a potential problem for our estimation framework. It is possible that a CEO's incentive structure and aspects of the firm's capital structure are determined simultaneously by many of the same economic forces. To deal with this possibility, we estimate our models in a two stage least squares Tobit framework. A 2SLS Tobit model in which more than one explanatory variable may be endogenous is provided by Blundell and Smith (1986). The model is:

$$y_1^* = b_1' x_1 + g_2 y_2 + g_3 y_3 + \cdots + e_1 \quad \text{(Tobit)}, \qquad (14)$$
$$y_2 = p_2' x_2 + e_2,$$
$$y_3 = p_3' x_3 + e_3,$$

and so on.

The authors show that under the null hypothesis of no simultaneity, the following procedure is asymptotically equivalent to a score, or Lagrange multiplier test of weak exogeneity, i.e., Cov[e_1, e_j] = 0, j=2,…:

Step 1. Use OLS to regress y_j on x_j for j = 2,… (the regression equations) and keep the resuduals (as v_j, say)

Step 2. Estimate the Tobit model as specified above by maximum likelihood, but include the residual vectors from equations 2, 3, . . . , as additional right hand side variables.

Step 3. To determine the presence of endogeneity, test the joint hypotheses that the slopes on the residuals equal zero.

For nearly all of our models, Wald tests indicate that the null hypothesis of exogeneity for delta and vega is rejected, so we adopt the 2SLS approach in our regressions throughout the paper. To implement this model, we need separate independent variables for the first-stage OLS models of CEOs' delta and vega incentives. We estimate the delta model with the dependent variables equal to the log of cash compensation (salary plus bonus), earnings 1 year growth, return to shareholders, the Gompers-Ishii-Metrick governance index, firm size (log of total assets), years tenure as CEO, year dummy variables, and two-digit industry dummy variables. For the vega model the independent variables are the log of cash compensation, earnings 1 year growth, return to shareholders, the governance index, the market-to-book ratio, and two-digit industry dummies. Data availability limitations for the first stage force us to cut our sample from 5,293 to 4,451 observations in order to estimate the 2SLS model.

As a measure for the goodness of the fit of the Tobit model, we adopt the following:

$$R^2_{DECOMPOSITION} = \frac{\frac{1}{n}\sum_{i=1}^{n}(\hat{y}_i - \bar{y})^2}{\frac{1}{n}\sum_{i=1}^{n}(\hat{y}_i - \bar{y})^2 + \frac{1}{n}\sum_{i=1}^{n}(y_i - \hat{y}_i)^2} \qquad (15)$$

where $\hat{y}_i$ is the value predicted by a maximum likelihood estimation, y_i is the actual value observed in the data, and $\bar{y}$ is the sample mean.[7]

[7] In nonlinear regression, there is no well behaved counterpart to the R^2 from linear regression. One of the shortcomings of the above fit measure is that it does not relate to the proportion of variation explained; it only ranges from zero to one because of a mechanical normalization. For further discussion on fit measures for nonlinear

Table 4 shows parameter estimates for our 2SLS Tobit model given in Equation (14) with the dependent variables equal to the average and local slopes of the performance pricing function. As shown in the table, we find that a CEO's delta has a negative impact on firms' choices of PSD slopes (significant for average slope but not local slope), whereas vega has significantly positive impact that is similar for both dependent variables. These estimates are consistent with our moral hazard hypothesis that CEOs with high delta prefer flatter PSD contracts to mitigate the expected costs of financial distress, while CEOs with high vega prefer steeper PSD contracts because they increase the riskiness of the firm and volatility of stock returns.

To assess the economic significance of the estimated coefficients for the CEO delta and vega variables, we evaluate the impact of a one standard deviation change in each variable upon the average slope. Based on the descriptive statistics from Table 1, a one standard deviation increase in the CEO's delta, which is 0.048, corresponds to a decrease of 0.105 in the average slope of the pricing schedule, according to estimates in the left column of Table 4. Compared to the median value of 0.254, this change implies a reduction in magnitude of about 42 percent. For the log(1+vega) variable, a one standard deviation change in the vega variable implies a change in the PSD slope of about 17 percent. All of these results about the importance of delta and vega are robust to various combinations of subsets of control variables specified in Equation (13), as well as to tests on delta and vega alone by themselves without the other.

Analyzing estimates for other control variables in Table 4, we see that firms with smaller size, lower leverage, and higher cash flow (EBITDA) choose steeper PSD contracts. These results are broadly consistent with certain theories in corporate finance about optimizing behavior of the borrowers and lenders. For example, firms with high leverage may negotiate less

regressions, we refer the reader to the modeling guide of LIMDEP software, which we use for the estimation of our Tobit model (Greene, 2002).

risky PSD contracts to reduce agency costs of debt related to asset substitution. Firms with higher cash flow likely face lower expected costs of financial distress and therefore bear fewer implicit costs from steeper-sloped PSD contracts.

4.2. Interest increasing and interest decreasing slope segments

Our results in Table 4 indicate a connection between the slope of PSD contracts and the structure of CEOs' equity incentives. To understand this link in greater detail, we investigate the PSD slope in both directions starting from the firm's credit rating at the time of contract inception. If a firm's credit quality worsens, it moves into the "interest increasing" range of the PSD pricing schedule and must pay greater coupon rates. In the other direction, if credit quality improves the firm may move into the "interest decreasing" PSD range and pay lower rates. In our sample of 1,375 PSD contracts, approximately 14 percent are strictly interest increasing, specifying rate changes only in the direction of credit deterioration, and another 6 percent are strictly interest decreasing. However, the overwhelming majority of 80 percent of contracts exhibit both interest increasing and interest decreasing slope components. In Table 5, we present regression results in which the dependent variable equals the slope of each of these pieces; for example, for the interest increasing contracts the dependent variable equals the actual PSD slope at all credit ratings below the current rating, and zero at all ratings above it.

Estimates in Table 5 indicate that the relation between managers' delta and the PSD slope is negative over both the interest increasing and interest decreasing segments, but the magnitude is far stronger for the interest increasing segment and is only significant in this direction. We conclude that delta incentives cause managers to have greater concern over avoiding the costs of financial distress than with the possibility of reducing the firm's credit costs in times of good performance. This pattern recalls the "asymmetric benchmarking" of CEO compensation incentives documented by Garvey and Milbourn (2006). CEOs' vega incentives are estimated as positive in both directions but without statistical significance.

4.3. Convexity

Having identified significant relations between PSD contract slopes and CEO incentives, we examine whether similar patterns exist for the convexity of PSD contracts. Convexity provides an alternative measure of PSD contract riskiness, since convex pricing schedules accelerate the rate of increase interest payments and thereby accelerate the rate of financial burden as the firm approaches states of low cash flow. Such convexity will increase the likelihood of financial distress, but it will also benefit CEOs with option-based risk incentives by providing very large rewards for improvements in firm performance. Following similar arguments used in the previous section, we expect CEOs with high delta to prefer flat PSD contracts that avoid deterioration of firm value due to increased expected bankruptcy costs, while high vega CEOs should prefer riskier PSD contracts with convex performance pricing schedules.

We estimate least squares regressions to test associations between convexity and CEO incentive variables; the least squares framework is used instead of Tobit since a minority of PSD contracts – those with concave schedules – are treated as having negative values for convexity. As dependent variables, we use both overall and local measures of convexity; these are estimated over the entire contract performance range and the rating segments immediately adjacent to the rating at contract inception, respectively.

Results of the estimation appear in Table 6. Similar to our earlier findings about PSD slopes, we find significantly negative parameter estimates for the CEO delta variable in both models and significant positive estimates for vega in one out of two. These results buttress our earlier evidence that managers with risk-taking incentives arising from option holdings use PSD contracts as a risk-shifting device, while managers with high ownership incentives from shares and options tend to do the opposite.

4.4. Gradation of PSD pricing schedules

PSD contracts are specified in step-function form, and these contracts exhibit a large variation in the number of pricing steps, ranging from 1 to 20. One possible explanation for this variation is lenders' desire to use finely-tuned pricing grids as substitutes for direct monitoring of management when moral hazard risks are high; i.e., lenders prefer to set fine pricing grids for those borrowers that are likely to experience frequent changes in performance that would otherwise require a high degree of outside monitoring.[8] In relation to the managerial ownership variables introduced earlier, we expect CEOs with high vega incentives to fall into this group. We therefore re-estimate our Tobit regressions models with the dependent variable equal to the number of steps in the performance pricing schedule of each PSD contract, and equal to zero for straight debt contracts. Parameter estimates are shown in Table 7. Consistent with our hypothesis about refined pricing grids serving as substitutes for direct monitoring of management, we find that firms with high-delta CEO equity grants have smaller numbers of pricing steps while firms with high-vega CEO equity grants have a greater numbers.

5. Conclusions

[8] Since the PSD contracts in our sample use the Standard & Poor's or Moody's credit rating as the performance measure, our hypothesis requires a conjecture that the rating agency can monitor the borrower firm more accurately, or at least more cost effectively, than the lender can.

This paper explores the effect of CEO equity incentives on the structure of performance sensitive debt contracts. PSD contracts require larger interest payments during a downturn in a borrower's performance but lower interest during states of performance improvement. This pattern tends to increase firm risk and lower overall equity value by exacerbating the expected costs of financial distress. However, option holders would generally benefit from PSD contracts, since that pattern of payoffs to an optionee has a convex relation to overall equity value.

We estimate relations between a large sample of PSD schedules and the structure of CEOs' delta and vega incentives from their personal holdings of shares and options. We find that CEOs with high vega incentives from their option holdings tend to choose steeper and more convex performance pricing schedules than those with low vegas. These effects accord with our hypotheses about how the risk-taking incentives from personal option holdings should influence managers' choices when negotiating PSD schedules. Moreover, we find the opposite result for CEOs with high delta incentives, suggesting that they negotiate flatter and less steep PSD contracts in order to reduce the expected costs of financial distress. We also find evidence that PSD schedules exhibit more detailed refinement, with more individual steps appearing in the pricing grid under conditions in which lenders' incentives to monitor CEOs should be especially strong.

Appendix: Examples of PSD Contracts

Table A1 shows three loans from Nortel Networks Inc., illustrating how typical PSD contracts are described in performance pricing grids. These loans were 364-day facilities borrowed from syndicates of banks during 2001 and 2002, a period during which the company's credit rating was in decline. On July 31, 2001, Nortel's S&P senior debt rating was A, which subsequently fell to BBB- on December 20, 2001, and then to "not-rated" on April 8, 2002. The loan amounts ranged from $660 million to $1.22 billion.

Performance grids for the three loan contracts appear at the bottom of Table A1 and in Figure A1. Performance spreads are measured in basis points over LIBOR and are contingent upon the borrower's credit rating. The first contract specified future credit rating contingencies below the borrower's current credit rating, while the last contract specified future credit rating contingencies higher than current borrower's credit rating. The former is called an interest-increasing PSD contract, and the latter is referred as an interest-decreasing PSD contract. The performance grid of the first contract, when Nortel Networks Inc. was A-rated, ranged from A to BBB-, while the performance grids when Nortel Networks Inc. was BBB- or NR rated ranged from BBB+ to BB. Thus, the performance grids specified detailed pricing schedules near a borrower's current credit rating, while leaving ranges far from the current rating as a flat schedule. Finally, the number of pricing steps was smaller when Nortel had high credit quality (A rated) compared to when it had poor credit quality (BBB- and NR).

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Table 1
Summary statistics
Descriptive statistics for a sample of performance sensitive debt (PSD) and regular debt contracts. Data are drawn for observations representing the intersection of the Dealscan, Compustat, and ExecuComp databases between 1994 and 2002, from all industries except financial industry (SIC 6000-6999). The PSD sample includes only contracts for which the performance measure is based exclusively upon the company's senior debt rating. The delta and vega variables for each company's CEO are based upon holdings of stock and options. Leverage equals total debt / total assets. Volatility of sales is the time series standard deviation of annual sales over the four years prior to the loan year, divided by the time series mean value. The slope and convexity of the PSD loan pricing schedules are based upon changes in the interest spread for different rating intervals, as described more completely in the text. The PSD sample includes 1,375 contracts negotiated by 461 individual firms, while the non-PSD contract includes 3,918 contracts from 1,148 firms.

	PSD contracts			Non-PSD contracts			Difference in means	
CEO incentives	Median	Mean	Std. Dev.	Median	Mean	Std. Dev.	Difference	t-statistic
Delta	0.0070	0.0230	0.0480	0.0095	0.0295	0.0575	(0.0065)	-3.77
log(1+Vega)	15.9	14.5	4.7	15.3	13.7	5.2	0.8	5.20
Cash compensation (000)	$1,260	$1,587	$1,181	$992	$1,402	$1,508	$184	4.11
Years tenure in office	5	7.6	7.4	5	7.3	7.0	0.3	1.26
Borrower characteristics								
Market capitalization (mm)	$3,196	$7,665	$13,862	$1,936	$10,979	$34,311	($3,314)	-3.48
Firm age (years)	30	32.0	21.4	25	29.5	22.9	2.5	3.60
Total assets (mm)	$4,297	$9,257	$15,485	$2,657	$11,236	$38,333	($1,979)	-1.86
Leverage	0.33	0.33	0.14	0.32	0.33	0.21	0.01	1.20
Market-to-book ratio	1.40	1.68	0.93	1.40	1.85	1.85	(0.17)	-3.21
PP&E (mm)	$1,438	$3,476	$5,059	$841	$3,437	$6,973	$38	0.19
Cash flow (EBITDA, mm)	$559	$1,046	$1,695	$314	$1,237	$3,140	($191)	-2.14
Volatility of cash flow	0.317	0.503	2.018	0.328	0.529	10.143	(0.026)	-0.10
Senior debt rating at loan date	BBB+			BB+				
Loan characteristics								
Amount (mm)	$400	$705	$917	$196	$433	$814	$272	10.32
Maturity (months)	36	36.8	23.2	36	43.1	40.6	(6.3)	-5.42
Number of lenders	14	16.4	11.5	5	8.2	9.6	8.2	25.87
Steps in pricing schedule	5	5.1	1.1					
Average slope	0.254	0.284	0.156					
Local slope	0.281	0.316	0.244					
Overall convexity	0.198	0.189	0.177					
Local convexity	0.000	0.030	0.242					

Table 2
PSD issuance frequency by industry: highest and lowest
Performance sensitive debt issuance frequency in various industries, according to observations from the Dealscan database between 1994 and 2002, from all industries except financial industry (SIC 6000-6999). The table shows the fraction of PSD contracts in the five industries with the highest and lowest PSD frequencies, as well as the frequency for the overall sample. Industries are sorted into 48 groups according to the Fama-French SIC code mapping. Industries with fewer than 50 observations are not shown in the table.

Industry	Debt contracts in sample	PSD frequency
Printing and publishing	88	44.3%
Construction materials	101	41.6%
Apparel	108	38.0%
Consumer goods	99	35.4%
Chemicals	253	35.2%
. . .		
ENTIRE SAMPLE	5,293	26.0%
. . .		
Automobiles and trucks	137	16.8%
Restaurants and lodging	90	13.3%
Health care	86	12.8%
Pharmaceuticals	113	9.7%
Computer equipment	144	7.6%

Table 3
Correlations among dependent variables
Sample correlations among key dependent variables. The top panel shows Pearson correlations for the entire sample of 5,293 debt contracts, and the bottom panel shows correlations for the subsample of 1,375 performance sensitive debt (PSD) contracts. Data are drawn from the intersection of observations in the Dealscan, Compustat, and ExecuComp databases between 1994 and 2002, from all industries except financial industry (SIC 6000-6999). The slope and convexity of the PSD loan pricing schedules are based upon changes in interest spreads for different rating intervals, as described more completely in the text. The number of steps is a count variable equal to the number of individual changes in interest rates specified by PSD contracts, which generally are written in a step-function form.

All observations	Average slope	Local slope	Overall convexity	Local convexity
Local slope	0.823***			
Overall convexity	0.505***	0.498***		
Local convexity	0.092***	-0.006	0.208***	
Number of steps	0.804***	0.701***	0.688***	0.117***

PSD observations	Average slope	Local slope	Overall convexity	Local convexity
Local slope	0.545***			
Overall convexity	-0.168***	-0.011		
Local convexity	0.004	-0.127***	0.186***	
Number of steps	-0.003	-0.043*	0.190***	0.052*

Significant at 1% (***), 5% (**) and 10% (*) levels.

Table 4

Average and local slopes of PSD contracts

Regression estimates of the average slope and local slope of the pricing schedules of performance sensitive debt contracts. The sample includes 5,293 debt contracts issued by 1,239 firms between 1994 and 2002, both with and without PSD contract features. The average slope of the pricing schedule equals the mean of the ratio of the differential interest cost over each credit rating interval covered by a PSD contract, divided by the differential Moody's value weighted average interest cost over the same interval at the time of contract negotiation. Local slope is the average slope measured over the two rating intervals immediately adjacent to the firm's rating; if performance pricing is defined only in one direction, local slope is calculated only for the single adjacent interval. For non-PSD (straight) debt, the majority of the sample, this slope equals zero by construction. Key explanatory variables are the sensitivity of CEO stock and option values to stock price (delta), and the sensitivity of CEO option values to stock price volatility (vega). Standard errors clustered at the firm level are shown in parentheses. Estimates use a two stage least squares Tobit framework described more fully in the text.

Dependent variable:	Average slope x 10^2	Local slope x 10^2
Delta	-219.816	-164.320
	(85.632)**	(125.568)
Log (1+vega)	0.936	1.114
	(0.549)*	(0.691)*
Firm size (log of assets)	-3.906	-4.141
	(1.170)***	(1.502)***
Leverage (total debt / total assets)	-33.362	-46.653
	(7.165)***	(10.022)***
Market-to-book ratio	-0.687	0.165
	(0.867)	(1.120)
EBITDA / total assets	27.011	30.485
	(10.386)***	(13.031)**
EBITDA time series volatility	-0.022	-0.019
	(0.071)	(0.094)
Sr. debt rated by S&P or Moody's (indicator)	31.955	39.781
	(3.285)***	(4.585)***
Loan amount / total assets	0.190	0.353
	(0.979)	(1.347)
Log of Maturity (months)	0.265	0.480
	(0.956)	(1.212)
Log of Number of PSD contracts / firm	38.663	47.043
	(1.777)***	(2.803)***
Year & 2-digit SIC indicators	Yes	Yes
Pseudo-R^2	0.445	0.461
Observations	4,451	4,451

Significant at 1% (***), 5% (**) and 10% (*) levels.

Table 5
Interest increasing and interest decreasing slope segments of PSD contracts
Regression estimates of the average slope of the pricing schedules of performance sensitive debt contracts. The sample includes 5,293 debt contracts issued by 1,239 firms between 1994 and 2002, both with and without PSD contract features. The average slope dependent variable, which is defined more completely in the text, is decomposed into two segments. In the first column, the dependent variable equals the average slope at all credit ratings below the firm's rating at the time of contract inception (the "interest increasing" range), and zero at all higher ratings. In the right column, the dependent variable equals the average slope at all credit ratings above the firm's current rating (the "interest decreasing" range) and zero otherwise. For non-PSD (straight) debt, both dependent variables always equal zero. Key explanatory variables are the sensitivity of CEO stock and option values to stock price (delta), and the sensitivity of CEO option values to stock price volatility (vega). Standard errors clustered at the firm level are shown in parentheses. Estimates use a two stage least squares Tobit framework described more fully in the text.

Dependent variable:	Slope of interest increasing segment x 10^2	Slope of interest decreasing segment x 10^2
Delta	-232.110	-79.546
	(79.955)***	(83.629)
Log (1+vega)	0.769	0.381
	(0.500)	(0.529)
Firm size (log of assets)	-4.676	-2.730
	(1.097)***	(1.107)**
Leverage (total debt / total assets)	-36.729	-27.243
	(7.151)***	(6.950)***
Market-to-book ratio	-0.146	-1.961
	(0.839)	(0.965)**
EBITDA / total assets	25.574	26.061
	(10.212)**	(9.270)***
EBITDA time series volatility	-0.002	-0.023
	(0.055)	(0.065)
Sr. debt rated by S&P or Moody's (indicator)	172.002	22.627
	(9.377)***	(3.225)***
Loan amount / total assets	-0.009	-0.085
	(0.824)	(0.769)
Log of Maturity (months)	0.222	0.397
	(0.900)	(0.894)
Log of Number of PSD contracts / firm	34.763	31.428
	(1.724)***	(2.064)***
Year & 2-digit SIC indicators	Yes	Yes
Pseudo-R^2	0.479	0.470
Observations	4,451	4,451

Significant at 1% (***), 5% (**) and 10% (*) levels.

Table 6
Global and local convexity of PSD contracts

Two-stage least squares regression estimates of the global and local convexity of pricing schedules of performance sensitive debt contracts. The sample includes 5,293 debt contracts issued by 1,239 firms between 1994 and 2002, both with and without PSD contract features. Convexity is calculated based upon the most extreme departure of the pricing schedule slope from the linear projection of the schedule between the upper and lower limits of credit ratings for which performance pricing is contracted. Concave pricing schedules, about eight percent of the sample, are assigned negative values for convexity. Global convexity is measured over the entire range of credit ratings for which performance pricing is specified, while local convexity is measured over the two rating intervals immediately adjacent to the firm's rating; if performance pricing is defined only in one direction, local convexity is calculated only for the single adjacent interval. For non-PSD (straight) debt, the majority of the sample, convexity always equals zero by construction. Key explanatory variables are the sensitivity of CEO stock and option values to stock price (delta), and the sensitivity of CEO option values to stock price volatility (vega). Standard errors clustered at the firm level are shown in parentheses.

Dependent variable:	Global convexity x 10^2	Local convexity x 10^2
Delta	-43.078	-59.480
	(22.991)*	(25.713)**
Log (1+vega)	0.267	0.060
	(0.144)*	(0.151)
Firm size (log of assets)	-0.606	-0.096
	(0.336)*	(0.390)
Leverage (total debt / total assets)	-7.731	-3.626
	(1.435)***	(1.484)**
Market-to-book ratio	0.350	0.078
	(0.162)**	(0.188)
EBITDA / total assets	-1.505	0.812
	(1.416)	(1.146)
EBITDA time series volatility	-0.006	-0.004
	(0.013)	(0.014)
Sr. debt rated by S&P or Moody's (indicator)	3.428	1.349
	(0.577)***	(0.637)**
Loan amount / total assets	0.161	0.110
	(0.317)	(0.190)
Log of Maturity (months)	0.442	0.205
	(0.242)*	(0.236)
Log of Number of PSD contracts / firm	6.342	6.188
	(0.540)***	(0.770)***
Year & 2-digit SIC indicators	Yes	Yes
Adjusted R^2	0.143	0.144
Observations	4,451	4,451

Significant at 1% (***), 5% (**) and 10% (*) levels.

Table 7
Number of gradations in PSD contract schedules
Regression estimate of the number of individual steps in the pricing schedules of performance sensitive debt contracts. The sample includes 5,293 debt contracts issued by 1,239 firms between 1994 and 2002, both with and without PSD contract features. PSD contracts are typically specified in step-function form, with interest rates increasing if the firm's credit rating is revised downward. The dependent variable counts the number of these revisions over the entire range of credit ratings specified in each contract. For non-PSD (straight) debt, the majority of the sample, the dependent variable always equals zero. Key explanatory variables are the sensitivity of CEO stock and option values to stock price (delta), and the sensitivity of CEO option values to stock price volatility (vega). Standard errors clustered at the firm level are shown in parentheses. Estimates use a two stage least squares Tobit framework described more fully in the text.

Dependent variable: Number of steps in performance pricing schedule	
Delta	-27.375
	(11.530)**
Log (1+vega)	0.141
	(0.072)**
Residual of Delta	26.077
	(11.550)**
Leverage (total debt / total assets)	-5.250
	(0.963)***
Market-to-book ratio	-0.064
	(0.120)
EBITDA / total assets	3.430
	(1.490)**
EBITDA time series volatility	-0.001
	(0.009)
Sr. debt rated by S&P or Moody's (indicator)	4.336
	(0.409)***
Loan amount / total assets	0.042
	(0.131)
Log of maturity (months)	0.100
	(0.122)
Log of Number of PSD contracts / firm	4.958
	(0.175)***
Year & 2-digit SIC indicators	Yes
Pseudo-R^2	0.440
Observations	4,451

Significant at 1% (***), 5% (**) and 10% (*) levels.

Table A1
Examples of performance pricing grids

Data for Nortel Networks Inc.'s syndicated 364-day facilities issued on July 31, 2001, December 20, 2001, and April 8, 2002, as reported by Dealscan. Each loan's pricing was tied to Nortel's long-term senior unsecured rating by Standard & Poor's. At the time of contracting, Nortel's S&P senior debt rating was A on July 31, 2001, BBB- on December 20, 2001, and not rated on April 8, 2002. The performance grids show spreads measured by basis points over LIBOR, contingent upon the company's S&P rating.

Loan characteristics	Contract 1	Contract 2	Contract 3
Date	July 31, 2001	December 20, 2001	April 8, 2002
Type	364-day facility	364-day facility	364-day facility
Amount	$1,220 million	$660 million	$1,175 million
Lenders in syndicate	10	11	25
Lead bank	Chase Manhattan & Credit Suisse	JPMorgan Chase & Credit Suisse	JP Morgan Chase
Senior	Yes	Yes	Yes
Secured	No	Yes	N/A
Covenant (million)	$3,500 (Net worth)	$1,880 (Tangible net worth)	N/A
Company's S&P senior debt rating	A	BBB-	NR
Performance grid (basis points over LIBOR)			
Greater than A	45	-	-
Greater than A-	55	-	-
Greater than BBB+	77.5	77.5	77.5
Greater than BBB	100	100	100
Greater than BBB-	120	120	120
Greater than BB+	-	150	150
Greater than BB	-	162.5	162.5
Less than BB	-	175	175

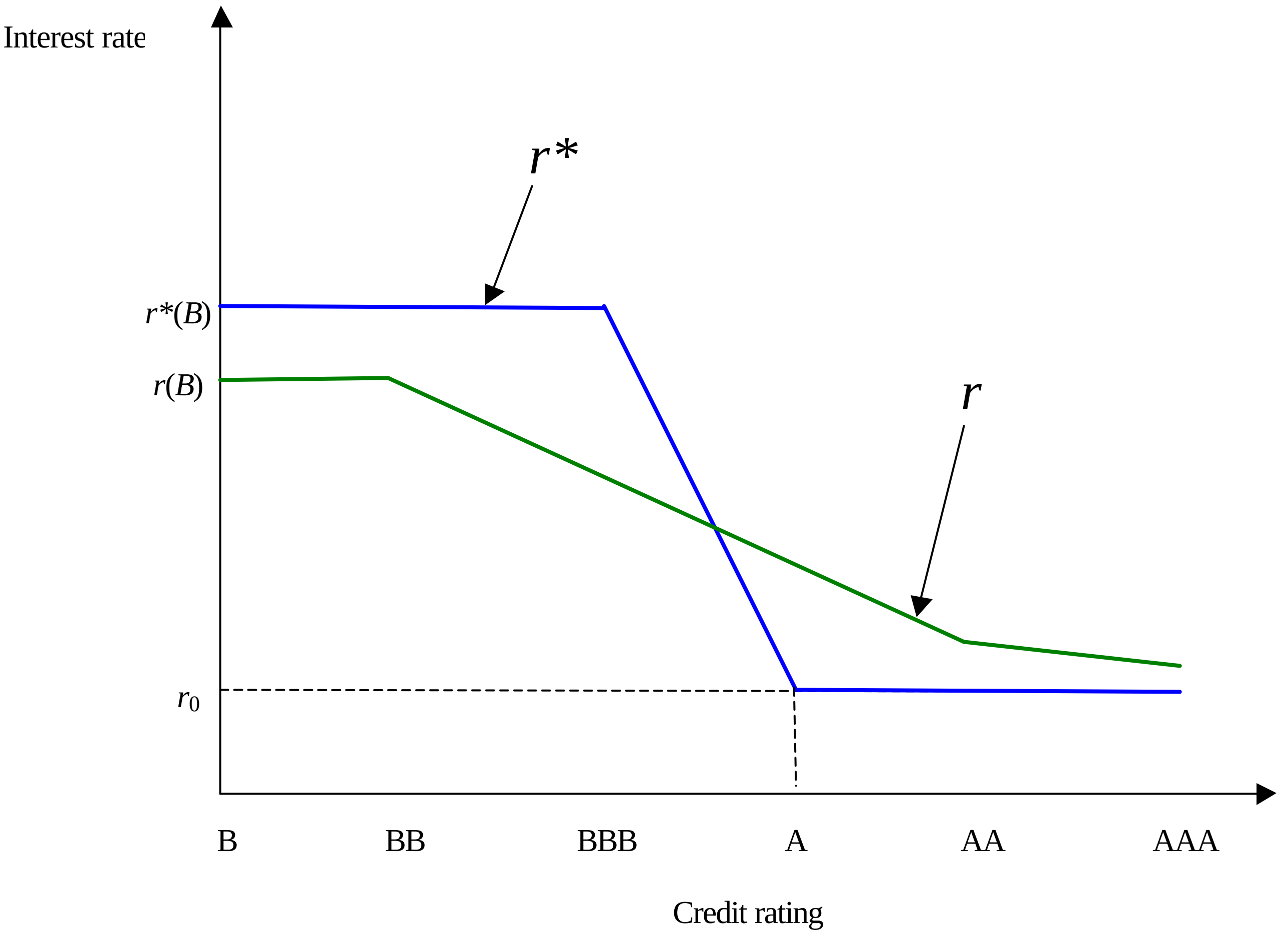

Figure 1
Performance pricing profiles
Profile r is a typical performance pricing profile for the performance sensitive debt contracts in our sample. Profile $r*$ is the pricing schedule that maximizes the value of an executive stock option that has exercise price $K = (v(A) - (1 + r_0)\ D) / N$, where *v(A)* is the value of the firm corresponding to credit rating *A*, *N* is the number of shares outstanding, r_0 is the interest rate on debt with the highest possible credit rating, and *D* is face value of debt issued by the firm. As drawn, the tradeoff between lower interest rates in good credit rating states and higher interest rates in poor credit rating states is more pronounced for profile $r*$.

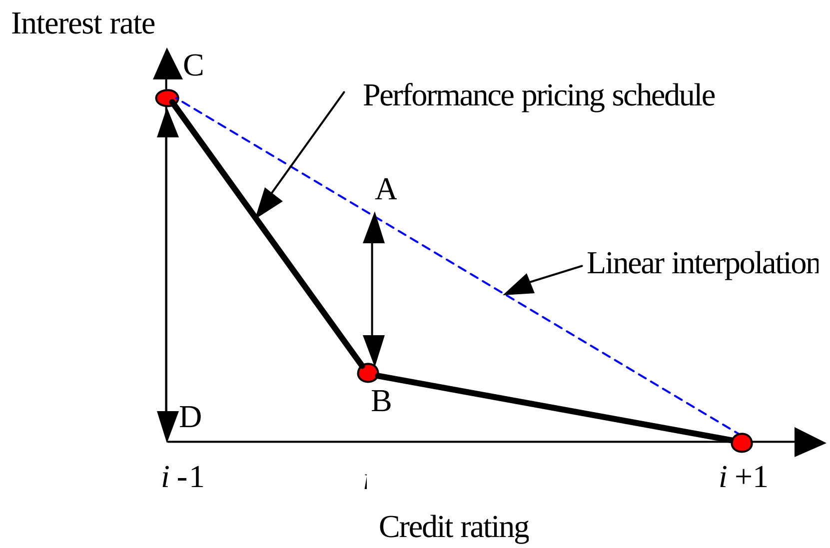

Figure 2
Slope and convexity of a performance pricing profile
The figure shows a hypothetical performance pricing profile for a firm that has credit rating *i* and negotiates a performance sensitive debt contract calling for higher interest payments if the credit rating deteriorates and lower interest payments if it improves. The figure shows how the interest rate might change above and below the firm's current rating. If $i - 1$ and $i + 1$ represent the credit ratings immediately adjacent to current rating, then our definition of local slope is:

$$\frac{1}{2}\left(\frac{Spread(i) - Spread(i-1)}{Moody(i) - Moody(i-1)} + \frac{Spread(i+1) - Spread(i)}{Moody(i+1) - Moody(i)}\right)$$

Where $Spread(n)$ is the interest charged at credit rating n, measured as basis points above LIBOR, and $Moody(n)$ is the value-weighted average yield for long-term corporate bonds of credit rating n during the month in which the contract is negotiated. Our definition of average slope is analogous, except it is measured using the mean ratios for all rating segments between the upper and lower limits of credit ratings specified in each contract. Our definition of overall convexity, which is described more fully in the text, is based upon the maximum deviation of a pricing profile from linearity and is therefore similar to the ratio:

$$\frac{A - B}{\left\| C - D \right\|}$$

Convexity therefore equals zero for perfectly linear pricing schedules and takes a negative value for concave schedules.

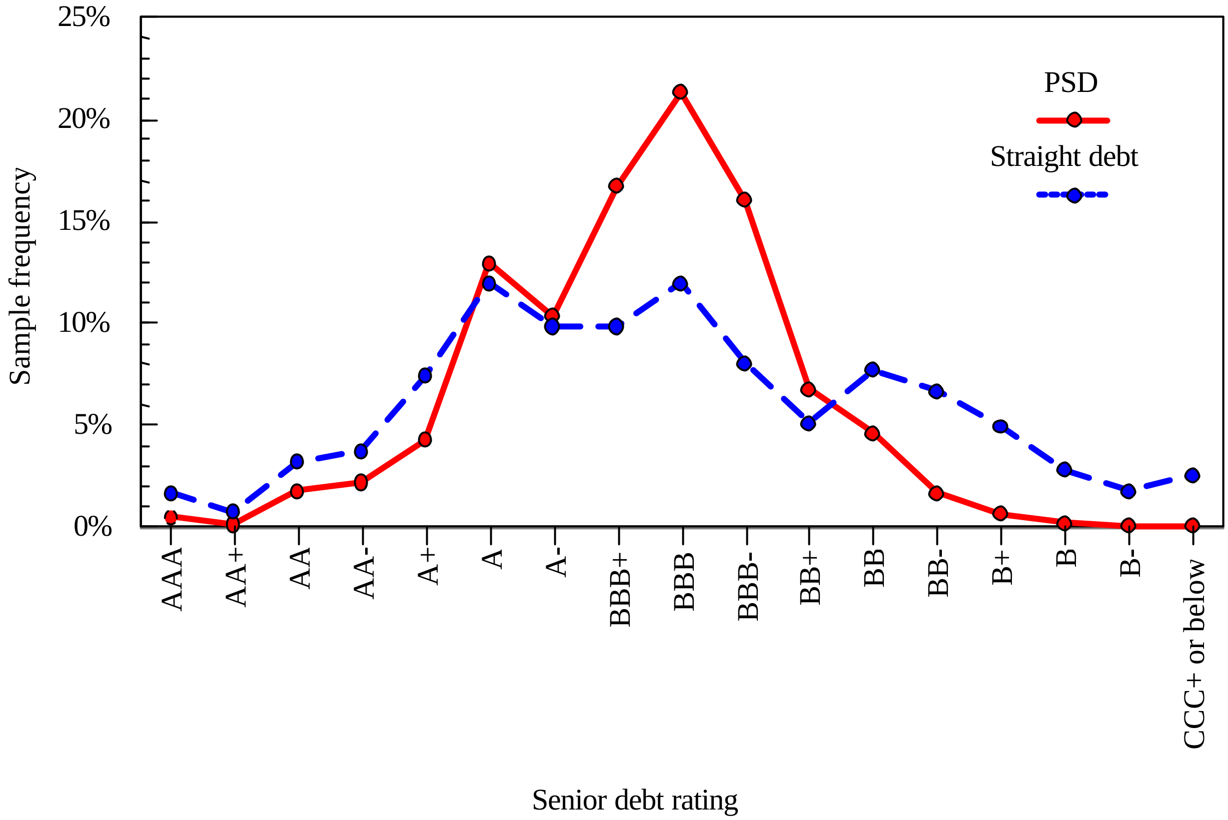

Figure 3
Credit quality of PSD and straight debt issuers
The figure shows the frequency distribution of senior debt ratings at the time of contract inception for samples of 1,303 performance sensitive debt contracts and 2,666 straight debt contracts. The PSD and straight debt samples analyzed in the paper are somewhat larger, but the figure does not include debt issues by companies that are not rated by S&P or Moody's.

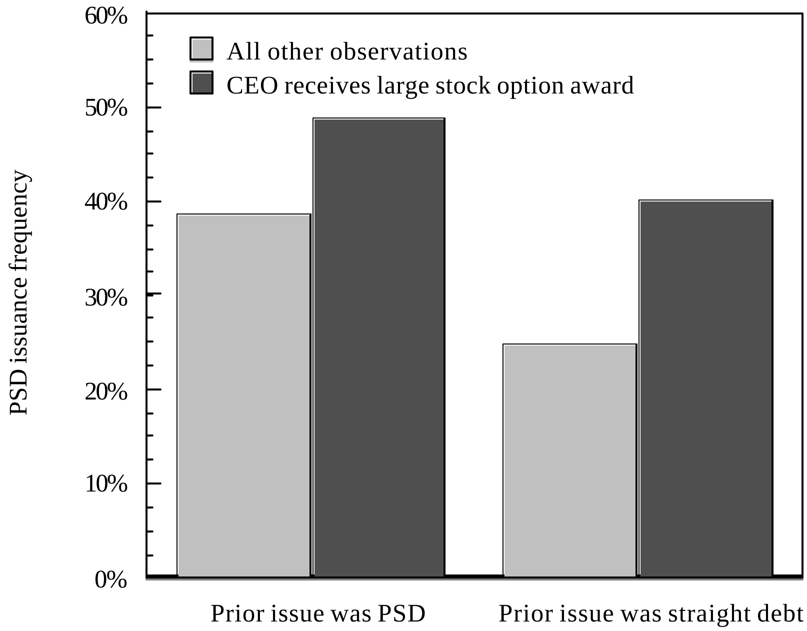

Figure 4
PSD issuance frequencies and large CEO stock option awards
The figure shows performance sensitive debt issuance frequencies for subsamples partitioned according to whether the company's prior debt issue in the Dealscan database was PSD or straight debt. Within each subsample, PSD frequencies are shown separately based upon whether the CEO received a large stock option award between the prior and subsequent debt issues, with a large option award defined as greater than 1.0% of shares outstanding. The overall sample includes 248 observations associated with large CEO option awards, and 4,450 observations with no large awards. In both subsamples, the difference between the two bars shown is statistically significant at the 5% level.

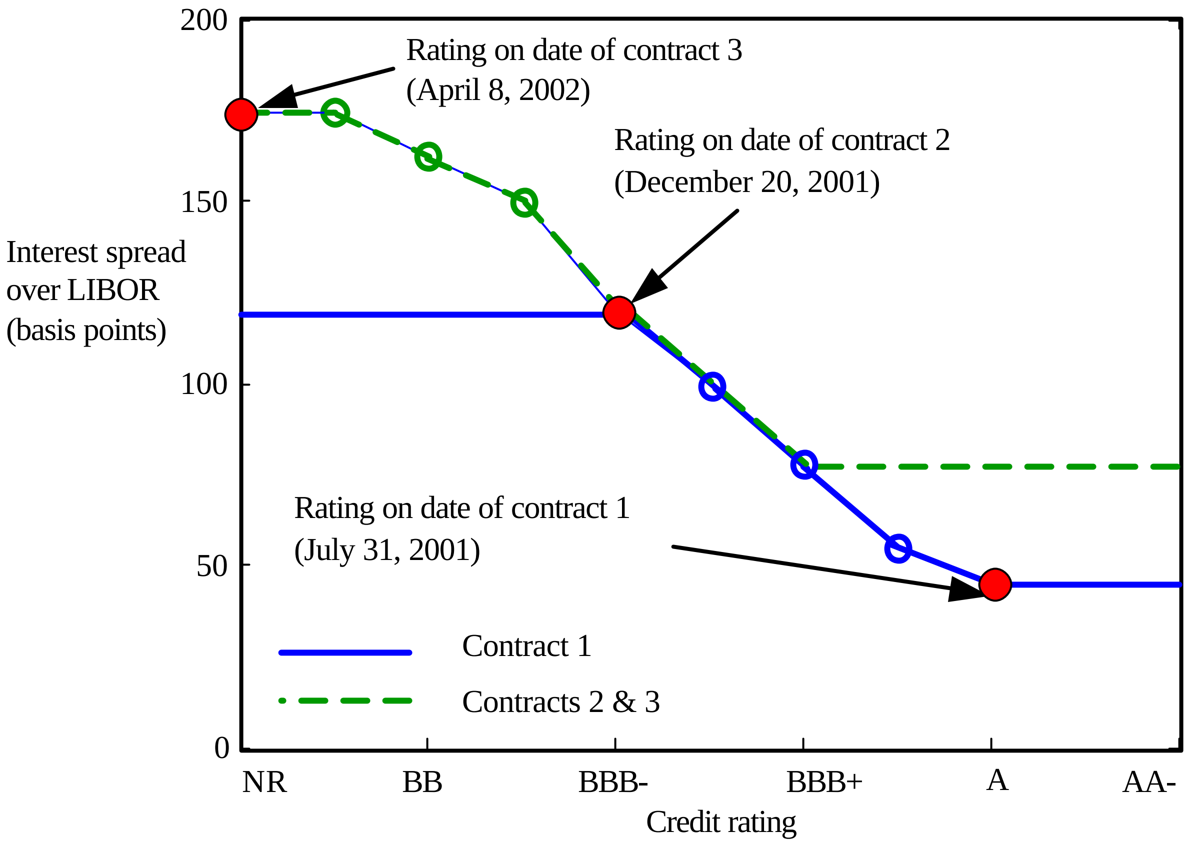

Figure A1
Examples of performance pricing grids
The figure shows examples of pricing grids in performance sensitive debt contracts negotiated by Nortel Networks Inc., according to data from Loan Pricing Corp.'s Dealscan database. The solid blue line shows interest rates for a 364-day credit facility negotiated on July 31, 2001, contingent upon the company's future credit rating. The dashed green line shows the pricing schedule for similar loans to the same company on December 20, 2001, and April 8, 2002. Nortel's S&P senior debt rating was A on July 31, 2001, BBB- on December 20, 2001, and NR on April 8, 2002.