Managerial Risk-Shifting Incentives of Option-Based Compensation: Firm Risk, Leverage, and Moneyness ⋆

Toke L. Hjortshøj *

School of Economics and Management, University of Aarhus, Building 322, DK-8000 Aarhus C, Denmark

4 June 2007
(First Draft: 4 June 2006)

Abstract

This paper studies the relation between option-based compensation grants and managerial risk-taking behavior. We examine risk-shifting in stock and asset risk, where the unobservable asset risk is estimated using the volatility restriction method and Moody's KMV algorithm in a Merton (1974) framework. Our empirical results provide support for the hypothesis that managers increase stock risk by increasing both asset risk and leverage. Furthermore, our unique dataset allows us to investigate whether grant date moneyness affects mangers' risk-shifting behavior. Consistent with recent theoretical predictions we find that out-of-the-money option grants cause increased risk-taking, while deep-in-the-money option grants reduce managerial risk-taking.

JEL classification: G30; G32; G34; J33

Keywords: Executive Compensation; Incentives; Stock Options; Risk-Shifting; Corporate Finance

⋆ The author is grateful for helpful comments from Yakov Amihud, Ken L. Bechmann, Jennifer N. Carpenter, Bent Jesper Christensen, Charlotte Christiansen, Juanna Schrøter Joensen, Peter Løchte Jørgensen, S. Abraham Ravid, Bruce A. Rayton, Greg Trojanowski, David Yermack and seminar participants at the Copenhagen Business School Workshop on Executive Stock Options, International Workshop on Executive Compensation, Midwest Finance Association 2006 Meetings, The Danish Doctoral School of Finance PhD Workshop 2005, The Doctoral Tutorial at the European Finance Association 2006 Meeting, and University of Aarhus. Any remaining errors are the author's responsibility.

* E-mail: thjortshoej@econ.au.dk.

1 Introduction

It is well known that conflicts between managers and shareholders are reduced by relating managerial compensation to firm performance (e.g., Jensen and Meckling (1976), and Holmström (1979)). Haugen and Senbet (1981) point out that when the performance-based compensation consists of stocks only, a risk averse manager might pass up risky positive net-present-value projects, which may not necessarily align the interests of the managers with those of the well diversified shareholders. Option-based compensation (OBC) can be the solution to the risk-related incentive problem since a convex compensation scheme mitigates the effect of the manager's risk aversion and provides incentives to increase risk (see also e.g., Amihud and Lev (1981), Smith and Stulz (1985), Lambert (1986), Hirshleifer and Suh (1992), and May (1995)).

Several empirical papers examine cross-sectional relations between OBC incentives and firm characteristics. Previous work of Guay (1999), Cohen et al. (2000), and Rajgopal and Shevlin (2002) show that a firm's stock return volatility is positively related to the convexity of the total compensation scheme. By using vega to measure OBC risk incentives, Guay (1999) and Coles et al. (2006) find that R&D intensity and growth opportunities have a positive association with vega incentives. Both Cohen et al. (2000) and Coles et al. (2006) provide empirical evidence of a positive relation between OBC risk incentives and firm leverage. On the other hand, Graham et al. (2004) find a reduction in corporate taxes and a more conservative debt policy for firms with an extensive use of OBC. Finally, empirical analyzes in the corporate hedging literature show a negative relation between firm hedging and risk-taking incentives (e.g., Smith and Stulz (1985), Tufano (1996), and Rogers (2002)).

Only a few empirical studies investigate whether firm risk increases after the adoption of an OBC plan. By using data of companies listed at the New York Stock Exchange from 1978 to 1982, DeFusco et al. (1990) find an increase in the firm's stock return variance following the announcement of a change in the OBC plan. On the basis of U.K. data from 1984 to 1995, Brookfield and Ormrod (2000) show that single granting firms exhibit greater stock return variance after OBC grants.

This paper complements the empirical research by DeFusco et al. (1990) and Brookfield and Ormrod (2000) and examines several other issues not considered in their study. First, the existing literature has primarily focused on the relation between option risk incentives and stock risk. This is indeed also the first effect to analyze since the option value is increasing in stock risk. With this in mind, the next obvious step is to examine whether managers increase stock risk by increasing leverage and/or asset risk. The leverage effect on future stock risk has already been widely addressed in previous work of Lewellen (2006), Coles et al. (2006), and others, while Rajgopal and Shevlin (2002) is to our knowledge the only paper studying risk incentives' impact on future exploration risk. The reason for the almost non-existing work in this area is mainly because of difficulties in finding a valid procedure to estimate the asset risk. One approach in estimating the unobservable asset risk is to use the Merton (1974) model, where the market value of equity is a residual claim on the value of the firm's assets after all debt obligations are met. When estimating the variance of the firm's assets, we implement two empirical approaches, the volatility restriction method used by Ronn and Verma (1986), Agrawal and Mandelker (1987), and Ericsson and Reneby (2005) and Moody's KMV method used by Crosbie and Bohn (2003) and Vassalou and Xing (2004).

We use a hand collected dataset on Danish OBC contracts to test for risk-shifting following option grants. Consistent with DeFusco et al. (1990) and Brookfield and Ormrod (2000), we find a positive and highly significant change in the stock risk. Furthermore, we provide empirical evidence that managers increase stock risk by increasing asset risk, suggesting that options indeed encourage managers to increase the risk in future investments. The positive effect from changes in asset risk on changes in stock risk still remains after controlling for changes in leverage, indicating that managers increase stock risk by increasing both asset risk and leverage.

Recent analytical studies show that risk-taking incentives are highly sensitive to the manager's ability to influence firm risk, the manager's risk aversion and the characteristics of the compensation scheme (e.g., Lambert et al. (1991), Carpenter (2000), Feltham and Wu (2001), Ross (2004), Nohel and Todd (2004), and Parrino et al. (2005)). [1] Related to these theoretical studies, we define a certainty-equivalent risk incentive measure for the risk-averse and undiversified manager in a utility-based model. Analyzing our new measure across the option's moneyness leads to the following prediction that in-the-money option grants reduce risk-taking, while out-of-the-money option grants encourage excessive risk-taking.

Neither DeFusco et al. (1990) nor Brookfield and Ormrod (2000) examine the moneyness' impact on future managerial risk-taking. DeFusco et al. (1990) focus on at-the-money OBC grants, since the U.S. tax authorities punish in-the-money grants. Besides, U.S. firms rarely grant out-of-the-money options. [2]

---

[1] Oyer (2004) discusses why broad-based stock option plans exist when the employees' actions have no impact on stock value. Aggarwal and Samwick (2003) find that the manager's responsibility affects the OBC incentives. Lewellen (2006) analyzes leverage choice and risk incentives. Johnson and Tian (2000a), Johnson and Tian (2000b), Ingersoll (2002), Ju et al. (2002), Jørgensen (2002), Johnson and Tian (2004), and Brisley (2006) all investigate risk incentives of nontraditional compensation schemes.

[2] Aboody et al. (2004) find that almost all U.S. firms apply the APB No. 25 tax rule by setting the exercise price of the OBC award equal to the stock price at the grant date. In this way, the firms need to disclose only a pro forma net income with a fair value of the OBC scheme at the measurement date under SFAS No. 123. More information about U.S. accounting rules are found via the Financial Accounting Standards Board (FASB) home page, www.fasb.org.

Brookfield and Ormrod (2000) do not provide the price-to-strike ratios of the options at the grant date.[3] Our unique sample does, however, allow for an empirical analysis of managerial risk-shifting across grant date price-to-strike ratios. To our knowledge, this paper is the first empirical work to analyze how exercise price decisions may affect managerial risk-taking behavior.

In order to capture the expected concave relation between moneyness and risk-shifting in stock risk, we follow Huddart and Lang (1996) and include moneyness and moneyness-squared in our regression analysis. Consistent with our hypothesis, we find that the partial effect from moneyness and moneyness-squared on changes in stock risk increases in moneyness until in-the-money option grants, whereas the partial effect is decreasing for deep-in-the-money option grants. This is partly inconsistent with our hypothesis since we expected that the partial effect would start decreasing at a much lower moneyness level. One possible explanation for our somewhat surprising empirical results could be that the average Danish executive's option component of the entire compensation package is three times smaller than the average option component in the U.S. (see e.g., Bechmann and Jørgensen (2004), and Jensen and Murphy (2004)). This makes Danish managers less undiversified and exposed to much lower downside risk, which all may have a positive impact on future managerial risk-taking.

The remainder of this paper is organized as follows. Section 2 describes the relation between OBC and managerial risk-taking incentives. Section 3 describes the sample, presents two estimation methods to compute the unobservable asset variance and provides summary statistics of key variables. Section 4 reports the empirical results and Section 5 concludes.

2 Managerial risk-taking incentives

Consistent with empirical studies by Smith and Stulz (1985) and others, the objective of this paper is to investigate whether OBC grants mitigate the effect of the manager's risk aversion and encourage greater managerial risk-taking. In order to show how OBC induces risk-taking, we define two measures of OBC risk incentives. First, we present the general approach to measurement of the OBC risk incentives following the definition by Guay (1999).[4] Second,

[3] Stathopoulos et al. (2004) point out that prior January 2004 the treatment of OBC grants by the UK tax authorities has resulted in a great variety in the price-to-strike ratios on the grant date. After January 2004, U.K. firms need to expense a fair value of the total OBC scheme according to the International Accounting Standards Board 2003 (IASB). More information about the international accounting rules is found via the IASB home page, www.iasb.org.

[4] Rajgopal and Shevlin (2002), Bettis et al. (2005), Coles et al. (2006), Garvey and Mawani (2005), and Rogers (2005) all use the definition by Guay (1999) to measure

we measure the risk incentives for a risk averse manager in an expected utility-based framework introduced by Lambert et al. (1991). [5]

Guay (1999) use the Black and Scholes (1973) (BS) model to measure the OBC risk incentives,

$$v_{\text{BS}} = nP\sqrt{T}N'(d_1) * 0.01, \tag{1}$$

where v_{BS} is the BS option value sensitivity to a 1% increase in the underlying annualized stock return volatility σ, n is the number of options granted, P is the underlying grant date stock price, $N'(\cdot)$ is the normal density function, $d_1 = [\ln(P/X) + (r + \sigma/2)T] / \sigma\sqrt{T}$, X is the strike price with the time-to-maturity in years T and r is the continuous risk-free interest rate.

Lambert et al. (1991) point out that the assumptions underlying the BS model do not necessarily apply to the characteristics associated with OBC. When a risk averse and undiversified manager is granted stock options, he is often prohibited from trading or hedging of his stock options to eliminate the firm specific risk. This will influence the OBC value from the perspective of the manager, meaning that the managerial risk-taking incentives are no longer straightforward and might even under some circumstances provide the incentives to decrease firm risk.

Consistent with the existing literature we analyze the risk incentives of stock options in an expected utility framework (see e.g., Lambert et al. (1991), Carpenter (2000), Hall and Murphy (2002), and Lewellen (2006)). The value of the OBC grant from a manager's perspective is estimated as the certainty-equivalent value, CE, of the total option grant, which makes the manager indifferent between holding stock options or receiving riskless cash. The manager is assumed to have non-firm-related $Wealth$ and a cash payment of $Salary$, which both are invested at the continuous risk-free interest rate r until time T. The manager is granted n one-to-one nontradable European stock options with exercise price, X, and time-to-maturity T. Under these assumptions, the manager's total wealth, $Wealth_T$, with options at time T can be written as,

$$Wealth_T = (Wealth + Salary)\exp(rT) + n\max[0, P_T - X], \tag{2}$$

where P_T is the stock price at the maturity date. [6]

On the other hand, if the manager is compensated with the certainty-equivalent in cash rather than OBC, the manager's total wealth at time T is

the managerial risk-taking incentives.

[5] Carpenter (2000), Hall and Murphy (2002), Ju et al. (2002), Lewellen (2006), Johnson and Tian (2004), Nohel and Todd (2004), and Parrino et al. (2005) all use the utility-based framework to value OBC.

[6] Using the Capital Asset Pricing Model (CAPM) the nondividend paying stock price P is lognormally distributed, $\ln(P_T/P_0) \sim N\left(\left(r + \beta(r_m - r) - \sigma^2/2\right)T, \sigma^2 T\right)$ and is assumed to follow the geometric Brownian motion process $dP = \alpha P dt + \sigma P dW_P$ with an instantaneous drift α, an instantaneous stock volatility σ and a standard Brownian motion W_P.

given by:

$$Wealth_T^{\text{CE}} = (Wealth + Salary + \text{CE}) \exp(rT), \tag{3}$$

where CE is assumed to be invested at the continuous risk-free interest rate.

The certainty-equivalent approach is applied and the riskless amount of cash, CE, is found numerically when the manager is indifferent between receiving CE and holding n stock options,

$$\int U(Wealth_T) f_z(z) dz = \int U(Wealth_T^{\text{CE}}) f_z(z) dz, \tag{4}$$

where $f_z(z)$ is the standard normal probability density function.[7]

The manager is assumed to be a utility maximizer and has a constant relative risk-aversion utility function $U(W_T) = \frac{(W_T)^{1-\rho}-1}{1-\rho}$, where W_T is the manager's total wealth at time T and ρ is the manager's risk-aversion coefficient.

To evaluate the managerial risk incentives from holding OBC in an expected utility framework, we numerically solve for the certainty-equivalent value sensitivity to a 1% increase in the underlying annualized stock return volatility,

$$v_{\text{CE}} = \frac{\text{CE}(\sigma + \varepsilon) - \text{CE}(\sigma)}{\varepsilon} * 0.01, \tag{5}$$

where v_{CE} is the OBC risk incentives for holding n options and $\varepsilon = 0.0001$.

In this paper, it is assumed that managers hold options until expiration date. However, it is worth mentioning that in practice most options are exercisable after a prespecified vesting period. Previous empirical studies find that option holders have a suboptimal exercise behavior, which will affect the OBC risk incentives (see e.g., Huddart and Lang (1996), Carpenter (1998), and Bettis et al. (2005)).

In the rest of this section, we illustrate the OBC risk incentives using both the Black-Scholes model and the certainty-equivalent approach, where the illustration will be used to motivate the hypothesis for later empirical testing. Unless otherwise noted, we determine the OBC risk incentives using base-case parameters consistent with the median firm in our sample, where all monetary values are reported in U.S. dollars.[8] To determine the median salary and option grant per executive we use the results in Bechmann and Jørgensen

---

[7] Hall and Murphy (2002) write the certainty-equivalent approach as $\int U(Wealth_T) f_{P_T}(P_T) dP_T = \int U(Wealth_T^{\text{CE}}) f_{P_T}(P_T) dP_T$. If $\ln(P_T/P_0)$ is standardized, $P_T = P_0 \exp\left\{\ln\left[r + \beta(r_m - r) - \sigma^2/2\right] T + \sigma\sqrt{T} z\right\}$, and the *change of variables formula* is applied, we can convert the infinite integral in P_T into an equivalent one with the standard normal random variable z, where $z = g(P_T)$ is a smooth differentiable mapping with a one-to-one relation, hence $P_T = g^{-1}(z)$. The rewriting is found in Appendix A.

[8] The present exchange rate (9 May, 2007) is 100 DKK = 17.68 USD = 13.20 EUR.

(2004), which is based on the same sample as the empirical analysis in this paper. We assume that the manager has a fixed salary of \$391,082 and is granted 14,330 stock options, which is equivalent to a BS value of \$67,184. Furthermore, the option is granted at-the-money and has a time-to-maturity of 5 years. Following Hall and Murphy (2002) and Lewellen (2006) we assume that the continuously compounded logreturns are determined by CAPM, where the stock price is \$17.68, the median risk-free interest rate is 4%, the median equity risk-premium, $r_m - r$, is 3%, the median stock return volatility is 20%, and beta is 0.65. We use information from Statistics Denmark to find the median non-firm-related manager wealth of \$583,440. Finally, we follow the existing literature and use a relative risk-aversion level of 2 (see e.g., Hall and Murphy (2002), Lewellen (2006), Bettis et al. (2005), and Parrino et al. (2005))

[Insert Figure 1]

Figure 1 illustrates how the option value sensitivity to a 1% increase in the stock return volatility varies across a range of price-to-strike ratios. A large part of the literature has used the definition by Guay (1999) to measure the managerial risk incentives from OBC and find empirical evidence of a positive association between managerial risk incentives and stock return volatility (see e.g., DeFusco et al. (1990), Brookfield and Ormrod (2000), Cohen et al. (2000), Rajgopal and Shevlin (2002), and Coles et al. (2006)). Consistent with prior work, Figure 1 shows that the BS risk incentives are positive across the range of price-to-strike ratios, which naturally leads to the following hypothesis,

H_1: *Option grants will increase managerial risk-taking.*

There exists, however, theoretical work questioning whether the BS model is the correct model to use when examining the manager's incentives to take risk. Lambert et al. (1991) and Carpenter (2000) point out, that it is not necessarily obvious that options granted to a risk-averse manager will encourage greater risk-taking. Ross (2004) shows that the risk-averse manager's utility function affects the risk-taking behavior.

Figure 1 presents the certainty-equivalent value sensitivity to volatility across a range of price-to-strike ratios. First, we find the BS value of the 14,330 granted options for every strike price and adjust the salary to keep the total compensation value constant. In addition, comparing descriptive statistics on OBC in Denmark and U.S. we find that the manager's average option component of the total compensation scheme is three times smaller in Denmark than in U.S., which obviously has an impact on the risk-averse manager's incentives (see e.g., Bechmann and Jørgensen (2004), and Jensen and Murphy (2004)). In order to compare the base-case CE risk incentives with the CE risk incentives of a manager holding three times more options than our median Danish manager, we reduce the salary to \$256,714 and scale the base-case option component by three, which is equivalent to 42,990 number of options with a BS value of $201,552. Again, we find the BS value for every strike price and adjust the salary to keep the total compensation value constant.

Consistent with the existing work, Figure 1 shows that managers have excessive risk-taking incentives for out-of-the-money grants, whereas managers have incentives to decrease risk-taking for in-the-money option grants (see e.g., Lambert et al. (1991), Ju et al. (2002), Lewellen (2006), Nohel and Todd (2004), and Parrino et al. (2005)). When distinguishing between managers holding 14,330 and 42,990 number of options, we find that as the option component of the total compensation package increases the CE risk incentives decreases, suggesting that the managers become more undiversified and less willing to take future risky investments. Furthermore, Figure 1 also indicates that in-the-money option grants increases the manager's downside risk, which is consistent with the conjectures given by Brisley (2006), who predicts a decrease in managerial risk-taking if options move deep in-the-money and thereby lose their convexity.

In sum, Figure 1 indicates that the CE risk incentives vary across the price-to-strike ratios and this leads to the following hypothesis;

H_2 : *Risk-shifting varies across price-to-strike ratios:*
In-the-money grants will reduce risk-taking and
out-of-the-money grants will encourage risk-taking.

3 Sample collection, variable measurement, and descriptive statistics

In this section, we describe the sample collection and provide descriptive statistics on the option-based compensation dataset. Furthermore, we define two procedures to estimate the unobservable asset risk and present the key variables and summary statistics.

3.1 The sample

The data on Danish OBC contracts are based on a hand collected dataset by Bechmann and Jørgensen (2004), which contains all publicly available information about the characteristics of options granted by Danish listed companies traded at the Copenhagen Stock Exchange (CSE) from 1995 to the mid 2003. In this paper the period is extended to December, 2004.

Under the Danish Securities Trading Act and Rules Governing Securities Listing on the CSE, all firms are required to immediately disclose details of the granted OBC scheme, including the grant date. This means that we would expect to find the grant date of the OBC scheme in an immediate announcement and in the annual report.[9]

Unfortunately, Bechmann and Jørgensen (2004) find that very few firms follow the Rules of CSE and thereby fail to disclose vital characteristics of the compensation scheme. In this study the grant date is a crucial factor and therefore we first systematically searched through all company announcements and second we went through all financial reports and articles of association.[10] After going through the first two steps for each firm, we still missed grant dates for 39 firms in the sample. As the final effort in order to obtain the grant dates, we mailed the firms' departments of Investor Relations and received 28 answers of which 19 were positive.

Our initial sample consists of 109 firms with 616 grants between December, 1996 and December, 2004. We deleted 20 firms as a result of grants with an unspecified grant date. Firms in the banking and insurance industry are excluded from the sample since these industries are generally considered tightly regulated which limit their risk-taking. This criteria results in a sample of 84 firms with 509 grants. In order to estimate the stock and asset volatility prior to and after the option grant, the firm has to be listed at the CSE 125 days before and 250 days after the grant date. This criteria excludes 2 firms. Many stocks listed at the CSE are traded infrequently, and firms with a low trading frequency obviously result in a less accurate estimate of stock and asset volatility. We therefore require the firm to be traded at least 1/3 of the estimation period, resulting in exclusion of 5 firms.

For each firm in the sample we use annual financial data from the Account database for year 1996 to 2003, and for the financial year 2004 we hand collect the financial data from the annual reports.[11] Datastream data are used to generate measures of stock-return volatility, market-return volatility and market value of equity. As risk-free interest rate we use the one-year Copenhagen Inter-Bank Offered Rates (CIBOR) compiled from the Danish Central Bank.[12]

The final sample consists of 77 firms with 379 grants on 257 firm specific grant dates between December, 1996 and May, 2004.

3.1.1 Summary statistics on option-based compensation

[Insert Table 1]

[9] The Danish Disclosure Rules are found via the CSE home page, www.cse.dk.
[10] All stock exchange announcements are extracted from the StockWise database, which can be found via the CSE home page, www.cse.dk.
[11] The Account database contains annual reports on Danish listed companies traded at the Copenhagen Stock Exchange.
[12] The one-year Copenhagen Inter-Bank Offered Rates (CIBOR) can be obtained from the Danish Central Bank via the home page, www.nationalbanken.dk.

Table 1 provides summary statistics on option grants of the final sample. Panel A of Table 1 presents statistics on the number of option grants per year and shows that the use of options has increased during the sample period with a peak of 86 grants in 2001. Panel A also shows that between 1996 and 1998 all options in each grant had the same characteristics, whereas from 1999 firms have started to issue options with different characteristics, which is consistent with the empirical findings by Bechmann and Jørgensen (2004). On the basis of Danish data from 1995 to 2003, Bechmann and Jørgensen (2004) show that only managers were granted options in the early 1990s. From the late 1990s firms started to include directors and employees in the OBC schemes. This complicates matters, since the option characteristics of each grant likely differ among the recipient groups (directors, managers and employees), which implies that each grant consists of several sub-grants with specific option characteristics. For example, in 2001 the 86 option grants were distributed among 62 firm specific grant dates, which clearly emphasizes the complexity of the outstanding OBC schemes.

Panel B of Table 1 provides the statistics on the number of option grants per month and shows that more than 50% of the OBC schemes are issued in January, February, March or December. This is also the period where most Danish companies announce their financial reports suggesting that most options are granted around the announcement date or in association with the annual general meeting.

[Insert Table 2]

The Danish Rules at CSE require the firms to disclose the distribution of the option grants to directors, management, middle-management and other employees. However, Bechmann and Jørgensen (2004) find that firms tend to omit vital information about the distribution between middle-managers and other employees. Table 2 follows the classification criteria by Bechmann and Jørgensen (2004) and defines three recipient groups: board of directors, management and employees, where employees consists of both middle-managers and other employees.

Table 2 reports the per grant aggregated statistics in the distribution on number of options, option values, risk incentives and option characteristics to the board of directors, the management, and all employees. We use the BS model to calculate the option values and we define the risk incentives as the option value sensitivity for a 1% change in the underlying annualized stock return volatility. All monetary values are reported in U.S. dollars to make our statistics comparable to related U.S. studies. [13] For the management the mean (median) option value is $532,558 ($73,809), and mean (median) vega is $8,969 ($1,331). Comparing the use of OBC between Danish and U.S. companies, we immediately see that (1) the option component of the total remuneration scheme is much larger for S&P 500 executives compared to Danish executives, and (2) the average total pay level for S&P 500 executives are significantly

[13] The monetary values in U.S. dollars are based on the exchange in footnote 8.

greater than observed among Danish executives. The higher average pay levels and greater risk incentives from OBC for S&P 500 executives are likely to influence our later empirical results that are based on managerial risk incentives of OBC in Danish companies (see e.g., Guay (1999), Knopf et al. (2002), Rajgopal and Shevlin (2002), Bechmann and Jørgensen (2004), Jensen and Murphy (2004), and Coles et al. (2006)).

The mean and median price-to-strike ratio is 0.98, which is similar to findings in U.K. and U.S. studies (see e.g., Murphy (1999), and Stathopoulos et al. (2004)). However, differently from the U.S. we observe a minimum and maximum price-to-strike ratio of 0.16 and 8.86, respectively. Furthermore, unreported summary statistics of the 1st, 5th, 95th, and 99th percentiles are 0.38, 0.58, 1.15, and 1.28, respectively. The substantial variation in grant date price-to-strike ratios are not only observed in Denmark. On the basis of U.K. data from January 1996 to January 1999, Stathopoulos et al. (2004) report that the moneyness of the 1st, 5th, 95th, and 99th percentiles are 0.66, 0.71, 19.5, and 37.5, respectively. In U.S., on the other hand, we mainly find at-the-money option grants due to tax reasons and accounting rules. The observed moneyness in U.S. option grants may very well change since U.S. companies are currently being investigated for deliberately moving their stock option grants back in time to a period with lower stock prices. The practice is called backdating and several CEOs in large U.S. companies are facing civil or criminal fraud charges and have been forced to resign. If U.S. companies will be forced to reset their option grant dates, it is likely that we will observe more variation in grant date moneyness allowing for future research on the relation between moneyness and managerial risk incentives.

The average time-to-maturity of an option grant is 5.23 years, while the median time-to-maturity is 5 years. This contrasts sharply to the practice in the U.S. with a typically maturity of 10 years, whereas the maturity of U.K. option grants range between 7 and 10 years (e.g., Jensen and Murphy (2004)). This may result in more risky and short-term financing and investment decisions by Danish executives.

Table 2 also shows that there is considerable variation in the distribution of option grants to the three recipient groups. The median option grant to the management and employees are very similar in size, value and risk incentive. On the other hand, the directors are awarded a much lower proportion of the total option grant, which is inconsistent with the analysis by Bechmann and Jørgensen (2004), who find a steep increase in the proportion of firms that grant options to directors from 1996 to 2001. The Nørby Committee's report on Corporate Governance from December 2001 is a plausible explanation for the decline in option grants to directors after 2001, since the report recommends that OBC should no longer be part of the directors' compensation schemes.[14]

[14] More information on "The Nørby Committee's report on Corporate Governance - recommendations for good corporate governance in Denmark" is found via the

3.2 Firm risk

As mentioned above, it is generally assumed that OBC value is increasing in the underlying stock return volatility. Hence, we expect that OBC will encourage greater managerial risk-taking. So far, the empirical studies have primarily focused on whether OBC risk incentives explain future changes in stock risk (see e.g., DeFusco et al. (1990), Guay (1999), Cohen et al. (2000), Rajgopal and Shevlin (2002), Lewellen (2006), and Coles et al. (2006)).

When examining the impact from OBC risk incentives on firm risk, it is also interesting to fully understand how managers change stock risk in order to increase the option value. Changes in stock return volatility may come from asset risk changes but also from leverage changes that leave asset risk unchanged. To a great extent, previous studies have focused on the effect from leverage and ignored the effect from asset risk. The paper by Rajgopal and Shevlin (2002) is, however, an exception. Based on a sample of oil and gas firms, they examine whether executive stock options provide incentives to take future risky projects. They use the variation of future cash flows from exploration activity as a proxy for asset risk and find a positive relation between option risk incentives and asset risk.

In this paper the volatility restriction (VR) method and Moody's KMV method will be used to estimate the unobservable asset risk, σ_V, allowing us to study risk-shifting in stock risk and examine whether these changes may come from changes in asset risk. Both methods are based on the contingent-claim approach by Merton (1974), where the market value of equity is viewed as a residual claim on the value of the firm's assets after all debt obligations are met.[15] We think this paper is the first to investigate changes in asset risk in a broader cross-section of firms and industries.

When implementing the structural model by Merton (1974), we follow the existing literature and define the face value of debt, D, as the short-term debt plus half the long-term debt, and the maturity of D is assumed to be one year (e.g., Crouhy et al. (2000), Crosbie and Bohn (2003), and Vassalou and Xing (2004)). The daily market values of equity, E, are computed as the number of

home page, www.corporategovernance.dk

[15] The Merton (1974) model assumes no corporate taxes or bankruptcy costs and default can only occur if the firm is unable to pay back the debt at the date of expiry T. The Merton (1974) model has, however, been extended in several ways to weaken some of the restrictive assumptions made in the original model by Black and Scholes (1973) and Merton (1974). Black and Cox (1976) allow for default before debt maturity by introducing a constant lower boundary, and Longstaff and Schwartz (1995) model a more complex debt structure. Tax advantages of debt and bankruptcy costs were introduced by Leland (1994) and refined in Leland and Toft (1996). A more detailed description of the Merton (1974) model is given in Appendix B.

shares outstanding multiplied by the closing prices.[16]

Following the existing work of Ronn and Verma (1986), Agrawal and Mandelker (1987), and Ericsson and Reneby (2005), we estimate the asset risk, $\widehat{\sigma}_V^{\mathrm{VR}}$, using the VR method, where the instantaneous relationship between equity volatility and asset volatility is obtained by Itô's lemma.[17]

Recent theoretical work points out that the VR method has several weaknesses. Duan (1994) emphasizes that the equity volatility is assumed to be constant in the instantaneous relationship. Yet, the equity volatility is a function of the asset value, V_N, and time t_N, which is assumed to follow a geometric Brownian motion process. Another disadvantage of the VR method is that if a firm has a high default probability (i.e. the firm value is close to the face value of debt), $\widehat{\sigma}_V^{\mathrm{VR}}$ becomes very sensitive to small changes in leverage. Furthermore, when the estimation period overlap two financial calender years, the leverage is likely to change causing $\widehat{\sigma}_V^{\mathrm{VR}}$ to be biased.[18] Despite the obvious disadvantages we include $\widehat{\sigma}_V^{\mathrm{VR}}$ in our empirical analysis and compare $\widehat{\sigma}_V^{\mathrm{VR}}$ with asset variance estimates applying the iterative procedure of Moody's KMV.

In the credit risk literature, the Moody's KMV method, described by Crosbie and Bohn (2003), has become a popular algorithm for estimating the unobserved σ_V based on a time series of asset values. Compared to the VR method, Lando (2004) finds that this approach is more robust to changes in the leverage. Duan et al. (2004) show that the KMV method is numerically efficient under the Merton (1974) model. By using a large sample of U.S. firms, Vassalou and Xing (2004) apply a similar approach to compute the firms' default probabilities.

Following the implementation of the KMV method by Vassalou and Xing (2004), we estimate the asset volatility, $\widehat{\sigma}_V^{\mathrm{KMV}}$, before and after the OBC grants, where the iterative scheme converges only after a handful of iterations.[19]

---

[16] When firms have dual class shares, the market value of equity is defined as the sum of the market value of class A- and class B-shares.

[17] Agrawal and Mandelker (1987) study the association between OBC and managerial investment decisions, and they use the VR method to test for risk-shifting in the asset variance. Marcus and Shaked (1984) and Ronn and Verma (1986) apply the VR method to find the level of deposit insurance premiums in the U.S. banking market and Ericsson and Reneby (2005) examine different estimation techniques such as the VR method, when implementing structural bond pricing models. A more detailed derivation is found in Appendix B.

[18] Assuming that the debt level falls (increases) over the estimation period, the leverage in the instantaneous relation is assumed to be too low (high) at time t_N and does not represent the actual leverage in the entire estimation period. This causes E_N^{obs}/V_N to be upward (downward) biased which eventually leads to a higher (lower) $\widehat{\sigma}_V^{\mathrm{VR}}(D_{t_N})$ compared to $\widehat{\sigma}_V^{\mathrm{VR}}(D_{t_1})$.

[19] One disadvantage of the iterative algorithm is that it does not provide standard errors of $\widehat{\sigma}_V^{\mathrm{KMV}}$ and thereby does not allow for statistical inference. However, Duan et al. (2004) find that $\widehat{\sigma}_V^{\mathrm{KMV}}$ in a Merton (1974) framework is identical to the transformed-data maximum likelihood estimates of the asset volatility developed

We follow the approach in Skinner (1989) and define a variance ratio $\widehat{\sigma}^2_{t+1}/\widehat{\sigma}^2_t$, where $\widehat{\sigma}^2_{t+1}$ and $\widehat{\sigma}^2_t$ are the estimated variances over a period of 250 days after and 125 days before the option grant date, respectively. Consistent with DeFusco et al. (1990) and Brookfield and Ormrod (2000) we form a market-adjusted variance ratio to filter out market-wide factors where the variances are divided by the variance of the market index before forming the variance ratios.[20] The market-adjusted risk-shifting measure could easily be criticized for not adjusting for industry effects. Our data do, however, not allow for such an adjustment since the Danish stock market is characterized by relatively few stocks in each industry peer with low liquidity. This makes an industry-adjusted measure less reliable and we therefore leave the use of the industry-adjustment method open for future exploration on larger stock markets.

As examined by DeFusco et al. (1990) and Brookfield and Ormrod (2000), we investigate whether OBC grants increase the underlying stock return volatility (i.e. we examine whether the variance ratios are larger than one) and let SVR and MSVR denote the stock return variance ratio and the market-adjusted stock return variance ratio, respectively.

To better understand how the manager changes the stock risk we extend the analysis by examining whether OBC encourages the manager to change the asset risk. When estimating the asset variance, we implement both the VR and KMV method and form variance ratios, where AVR denotes the asset variance ratio and MAVR denotes the market-adjusted asset variance ratio.

Before jumping to the conclusion that the managers change the stock risk by changing the asset risk, we need to control for *Changes-in-leverage*, where leverage is defined as market value of total debt to market value of equity.[21]

In the regression analysis we follow the existing literature and use *Market-to-book* and *Firm size* as control variables, where *Market-to-book* is the ratio between market and book value of total assets and *Firm size* is the natural

by Duan (1994). A more detailed description of our implementation of the KMV method is provided in Appendix B.

[20] The all-share index (KAX) on CSE is used for the estimation of the market variance. A full description of the main indices on Copenhagen Stock Exchange (CSE) is found via the home page, www.cse.dk.

[21] Note that the leverage depends on the market value of total debt. Hence, leverage depends on the estimation method used to compute the asset variance. Later we emphasize that similar empirical results are obtained when using alternative leverage specifications.

logarithm of total assets.[22]

[Insert Table 3]

Table 3 provides summary statistics for the key variables. The changes in the stock risk in our study are similar to related studies, such as DeFusco et al. (1990) and Brookfield and Ormrod (2000). We find that the median SVR and MSVR is 1.028 and 1.128, respectively. When comparing the asset variance ratios using either the VR or the KMV method, we immediately notice that the two methods provide very different mean and median ratios. As mentioned above, our focus will be on the more efficient KMV method and compare these ratios with the less robust VR method used in earlier studies (see e.g., Ronn and Verma (1986), and Agrawal and Mandelker (1987)).

The table also shows that the leverage does not change much for the median firm. The minimum and maximum *Changes-in-leverage*$^{\text{KMV}}$ are, however, 0.004 and 25.379, respectively, suggesting that some firms in our sample experience large changes in the leverage during the estimation period. Later we investigate whether *Changes-in-leverage* may have an impact on changes in stock risk. Furthermore, the mean (median) *Market-to-book*$^{\text{KMV}}$ is 1.685 (1.140), while the mean (median) *Firm size* is 21.329 (21.311).

[Insert Table 4]

Table 4 reports the correlations between the key variables. As expected we find that MSVR is positively correlated with both MAVR and *Changes-in-leverage* using both the VR and KMV method. Table 4 also shows a correlation close to one between *Changes-in-leverage*$^{\text{VR}}$ and *Changes-in-leverage*$^{\text{KMV}}$, while the correlation between VR and KMV estimated market-adjusted asset variance ratios is much smaller, suggesting that the asset variance is more sensitive to the estimation method than the market value of total debt.

4 Empirical results

In this section, we document (1) the impact of option grants on firms' risk shifting, (2) how changes in asset risk and/or leverage cause changes in stock risk, and (3) whether the grant date price-to-strike ratios have an impact on changes in stock risk. Throughout the empirical analysis, we only use the market-adjusted asset variances to investigate for risk-shifting after option grants.

[22] Later we will be distinguishing between *Market-to-book*^{VR} and *Market-to-book*^{KMV} since *Market-to-book* depends on the market value of total assets.

4.1 Risk-shifting following option grants

We first test for risk-shifting in stock and asset risk. In addition, we examine whether changes in asset risk or changes in leverage are related to changes in stock risk.

4.1.1 Changes in stock and asset risk

In the following, we test our first hypothesis that option grants encourage managerial risk-taking by examining changes in stock and asset risk. We use the Wilcoxon signed-rank test to examine the null hypothesis that the sample median of the variance ratios are identical. In other words, we test whether the variances are the same before and after the option grant date. [23]

[Insert Table 5]

Table 5 reports the results from testing for risk-shifting in the variances after the firm issues OBC. In Panel A, we examine risk-shifting after the first option grant. When focusing on changes in stock risk, the results support our predictions that options increase the stock return variance. Consistent with related studies, such as DeFusco et al. (1990) and Brookfield and Ormrod (2000), we find that MSVR is highly significant above one at the 1% level.

As mentioned in the introduction, our primary contribution to the literature is the implementation of estimation methods which allow us to test for risk-shifting in the unobservable asset risk. In Panel A, we find no significant change in the market-adjusted asset risk using the VR method. On the other hand, we find highly significant positive changes in the market-adjusted asset variance when the variances are inferred using the KMV method. Focusing on the results using the KMV method, our results indicate that managers increase stock risk by increasing the asset risk.

In Panel B, we test for risk-shifting after all option grants. Overall, the results are consistent with the results reported in Panel A, indicating that repeated option grants still provide the manager with enough risk-taking incentives to increase the future asset and stock risk.

Table 5 also shows very different results when comparing the market-adjusted asset variances $MAVR^{VR}$ to $MAVR^{KMV}$. This indicates that the choice of estimation method in studies like ours has a considerable impact on the results emphasizing the importance of implementing efficient estimation methods like the KMV method.

Although not reported in tables, we analyze how sensitive the results are

[23] The advantage of the Wilcoxon signed-rank test is that the test accounts for the magnitude of each variance ratio's deviation to one by ordering the absolute deviations according to their magnitudes before the rank is assigned.

to the choice of estimation period following the option grants. Overall, when reducing the post estimation period, less support of risk-shifting is found, suggesting that it takes time for the manager to invest in new and more risky projects. Furthermore, we obtain similar results when testing for risk-shifting using variance ratios not adjusted for market risk.

4.1.2 The impact from changes in leverage and asset risk on changes in stock risk

In the previous section we documented positive and highly significant changes in stock risk as well as in asset risk. We interpreted these results in favor of our first hypothesis that options indeed increase managerial risk-taking through more risky investments. This may, however, not be the entire truth since managers could use leverage as an instrument to increase the underlying stock risk and thereby the value of the option grant. Lewellen (2006) studies the association between compensation and financing decisions and finds that greater risk incentives increase the manager's appetite for higher leverage.

In order to control for the leverage effect on stock risk, we regress the changes in stock risk on changes in asset risk and leverage. Because of limited observations the following analysis are based on the sample containing all option grants.

[Insert Table 6]

Table 6 reports estimates from regressing changes in stock risk on either changes in asset risk or changes in leverage. Finally, we regress changes in stock risk on both instruments controlled by the manager. In all the regressions we include the market-to-book ratio and firm size to control for growth opportunities and size effects, respectively. Furthermore, we include year dummies and indicator variables for all 2-digit Global Industry Classification Standard (GICS) industries in our sample to control for year effects and industry fixed effects, respectively. The reported t-statistics are tabulated in parentheses and are based on either Newey-West heteroscedasticity and autocorrelation consistent standard errors or robust standard errors clustered by firm (see e.g., Petersen (2007)).

Panel A of Table 6 reports the results using the VR method to estimate the asset risk. In Model (1), we regress changes in stock risk on changes in asset risk plus firm specific control variables. The coefficient estimate on changes in asset risk is positive and strongly significant. Considering Model (2), we find that the coefficient on changes in leverage is positive but insignificant. On the other hand, in Model (3) we find that both the coefficients on changes in asset risk and leverage are strongly positive and significant. Furthermore, in Model (4) to (6) we address the econometric problems that may bias our results since we allow firms to have multiple option grants. We follow Petersen (2007) and cluster by firm to account for firm fixed effects and find that our results are qualitatively similar to the regression results reported in Model (1) to (3). Finally, in all six regressions we control for growth opportunities, firm size, year effects, and industry fixed effects.

In Panel B, we apply the KMV method to estimate the asset variance. Consistent with our predictions, we find that both changes in asset risk and leverage are positive and highly significantly associated with stock risk changes. We obtain stronger significance on the MAVR coefficient estimates once we use standard errors clustered by firm while we loose some significance on the changes in leverage coefficient estimates. In all six regressions neither *Market-to-book*$^{\text{KMV}}$ nor *Firm size* are significantly related to changes in stock risk.

In sum, consistent with the existing literature we find that managers increase stock risk by increasing leverage. Furthermore, we contribute to the existing literature by showing that risk incentives from option grants encourage managers not only to increase leverage but also increase the asset risk. Hence, our results suggest that option grants affect both financing and investment decisions.

4.1.3 Further robustness checks

In order to ensure that our results are robust to alternative variable specifications and estimation periods, we check the results in several ways. First, we examine how sensitive the results are to an estimation period of 125 and 200 days following the option grant. In all cases, we find a positive and significant relation between changes in stock risk and asset risk, while the coefficient of *Changes-in-leverage*$^{\text{KMV}}$ is insignificant. We also check for robustness in the results if we include alternative leverage specifications. Following Rajgopal and Shevlin (2002) we define leverage as book value of total debt divided by market value of equity. In all cases, the results are similar to the findings reported in Table 6. [24]

4.2 Additional evidence on risk-shifting: Does grant date moneyness matter?

In Section 3.1.1 we reported that our unique sample has a high dispersion in grant date price-to-strike ratios, which allows us to empirical investigate recent theoretical predictions that risk-taking incentives vary across moneyness (see e.g., Carpenter (2000), and Brisley (2006)). In order to examine whether the option's moneyness has an impact on future managerial risk-taking we need to define our measure of moneyness. This may seem as a trivial task at first, but in our case most option grants consist of several sub-grants with

[24] In addition, we regress our models using leverage defined as book value of short-term debt to market value of equity and book value of long-term debt to market value of equity. In all cases, we obtain similar results to those reported in Table 6.

very different characteristics, such as price-to-strike ratios. We therefore immediately rule out the average price-to-strike ratio across all sub-grants since the option payoff is highly nonlinear. To capture the nonlinearity we define the moneyness per grant as the weighted price-to-strike ratio of all sub-grants with respect to both the option value and risk incentive. [25] The value weighted measure will, by definition, distribute most weight on in-the-money options whereas the incentive weighted measure distributes most weight on options granted out-of-the-money or at-the-money. When analyzing the moneyness' impact on risk-shifting in stock risk, we expect to find a positive relation for options granted out-of-the-money and at-the-money, while we predict decreasing changes in stock risk for in-the-money option grants. We follow Huddart and Lang (1996) and include *Moneyness* and *Moneyness-squared* in our regressions to capture the expected concave relation between risk-shifting and the option's moneyness.

[Insert Table 7]

Table 7 reports estimates from regressing changes in stock risk on *Moneyness* and *Moneyness-squared* using either the value or the incentive weighted measure of moneyness. Furthermore, we include changes in asset risk and leverage as we earlier found that managers change stock risk by changing both asset risk and firm leverage. Finally, we control for growth opportunities, size effects, year effects and industry fixed effects in all regression specifications.

Panel A (Panel B) of Table 7 reports the results using value (incentive) weighted moneyness in the regressions. Consistent with our predictions we find in Model (1) and (3) (Model (5) and (7)) the coefficient on *Moneyness* is positive and highly significant, while the coefficient on *Moneyness-squared* is negative and highly significant, suggesting that there is a concave association between the grant date price-to-strike ratios and risk-shifting behavior. Furthermore, the concave relation is still significant after controlling for changes in asset risk and leverage. The statistical significance is, however, reduced once we use robust standard errors clustered by firm (CL-Firm).

The significant coefficients on *Moneyness* and *Moneyness-squared* reported in Table 7 allow us to illustrate the partial effect on changes in stock risk across moneyness.

[Insert Figure 2]

Figure 2 plots the partial effect of *Moneyness* and *Moneyness-squared* on MSVR. Model (1) (Model (5)) is the partial effect using the value (incentive) weighted moneyness, whereas Model (2) (Model (6)) is the partial effects using the value (incentive) weighted moneyness after controlling for changes

[25] We follow Guay (1999) and use the Black and Scholes (1973) model to find the option value and define the risk incentive measure as the option value sensitivity to a 1% change in the annualized stock return volatility.

in asset risk and leverage.[26] Consistent with our predictions we obtain a concave relation between moneyness and risk-shifting in stock risk. We also find that including MAVR^{KMV} and $\textit{Changes-in-leverage}^{\text{KMV}}$ in our regressions do not have any considerable impact on our results, while the relation between moneyness and changes in stock risk becomes more concave when using incentive weighted moneyness instead of value weighted moneyness. In addition, we find that the partial effect starts to drop at a very high level of moneyness, suggesting that managers in our sample are less risk averse and undiversified than we expected. The results seem at first to be inconsistent with related work by Hall and Murphy (2002) and Lewellen (2006). However, their analysis are based on parameters corresponding to sample medians of U.S. firms, where the option component of the total compensation scheme account for more than three times the size of a median Danish option component in 2002 (see e.g., Bechmann and Jørgensen (2004), and Jensen and Murphy (2004)). We therefore would expect different risk-shifting behavior by Danish managers compared to U.S. managers since a smaller option component reduces the downside risk but still maintain a substantial upside potential.

In sum, the unique sample used in this paper allows us to examine risk-shifting across moneyness of option grants. Consistent with theoretical predictions we find empirical evidence of a concave relation between moneyness and risk-shifting in stock risk. We think this contributes to the existing literature about optimal compensation structure since our results may help the compensation committee to choose a strike price that causes the intended changes in firm risk.

4.2.1 Further robustness checks

We check our results in several ways. First, we implement the VR method to estimate the asset risk and perform the same regression analysis as before. In all regression specifications, we obtain highly significant positive and negative coefficients on *Moneyness* and *Moneyness-squared*, respectively. In addition, the estimated coefficients have the same magnitude as the coefficients reported in Table 7. Secondly, we also check for robustness in our results when measuring leverage as book value of total debt divided by market value of equity. Lastly, we analyze whether outliers in our key variables may bias our results. We fix outliers by winsorizing *Moneyness* and *Moneyness-squared* at the 1st and 99th percentiles. In all cases, the results are qualitatively similar to the findings reported in Table 7 and are available upon request.

[26] We would obtain a similar figure if we used our regression results with robust standard errors clustered by firm instead of Newey-West standard errors.

5 Conclusion

This paper investigates the relation between managerial risk-shifting incentives from OBC and firm risk in a broad sample of firms and industries. In particular, we provide empirical evidence of how changes in asset risk and leverage affect changes in stock risk after option grants.

We carefully derive our hypothesis by analyzing the option risk incentives obtained from the Black and Scholes (1973) model and from an expected utility model. Consistent with the existing literature, we predict that option grants increase managerial risk-taking. In addition, we follow the recent theoretical conjectures and predict that risk-shifting varies across price-to-strike ratios.

In our empirical investigation we use the approach outlined in Skinner (1989) to compute market-adjusted variance ratios and examine whether option grants have a positive impact on firm risk. The empirical results suggest a positive increase in the stock risk after option grants, which is consistent with the findings by DeFusco et al. (1990) and Brookfield and Ormrod (2000). In addition, we extend the existing literature by analyzing whether the increased stock risk is caused by changes in asset risk and/or leverage, where the unobservable asset risk is estimated using the volatility restriction method and Moody's KMV algorithm in a Merton (1974) framework. The empirical results provide support for the hypothesis that managers increase stock risk by increasing asset risk and leverage. Furthermore, these results remain unchanged after controlling for growth opportunities, firm size, year effects and industry fixed effects.

Our unique sample also provides us with the opportunity to test for risk-shifting across grant date price-to-strike ratios. We find empirical evidence of a concave relation between option moneyness and risk-shifting in stock risk, suggesting that out-of-the-money option grants cause the manager to increase risk-taking, while deep-in-the-money option grants reduce managerial risk-taking. These results support recent theoretical predictions that the compensation committee's moneyness policy may have a considerable impact on managerial risk-shifting behavior.

Overall, consistent with previous studies we find that option grants have a positive impact on both stock risk and leverage. In addition, this paper makes two significant contributions to the literature. First, and perhaps foremost, we examine risk-shifting behavior in the unobservable asset risk and find that managers indeed increase stock risk by increasing the risk in future investment decisions. Furthermore, our unique data allows us to empirical investigate risk-shifting across grant date moneyness. Consistent with recent theoretical work we show that the option's price-to-strike ratio has a substantial impact on managerial risk-taking behavior.

A Appendix: The certainty-equivalent framework

Hall and Murphy (2002) express the expected utility approach as

$$\int U(Wealth_T) f_{P_T}(P_T) dP_T = \int U(Wealth_T^{\mathrm{CE}}) f_{P_T}(P_T) dP_T.$$

We will now show how to rewrite the expected utility for one side of the equality only,

$$\int U(Wealth_T) f_{P_T}(P_T) dP_T, \tag{A.1}$$

where the continuously compounded logreturns are determined by the Capital Asset Pricing Model (CAPM). We assume that the nondividend paying stock price, P_t, is lognormal distributed and follows a geometric Brownian motion process $dP_t = \alpha P_t dt + \sigma P_t dW_P$ with an instantaneous drift α, an instantaneous stock volatility σ and a standard Brownian motion W_P. It is now straightforward to show that $\ln(P_T/P_0) \sim N\left(\left(r + \beta\left(r_m - r\right) - \sigma^2/2\right) T, \sigma^2 T\right).$

If we standardize $\ln\left(\frac{P_T}{P_0}\right)$ we are able to write P_T as a function of the standard normal random variable z,

$$P_T = P_0 \exp\left\{\left[r + \beta\left(r_m - r\right) - \sigma^2/2\right] T + \sigma\sqrt{T} z\right\}. \tag{A.2}$$

Assuming that $P_T(z)$ is a strictly monotonic function with a continuous derivative $P_T'(z)$, we are able to rewrite equation (A.1) to

$$\int U(Wealth_T) f_{P_T}(P_T(z)) dP_T(z). \tag{A.3}$$

We know from the rules of differentiation that

$$\frac{dP_T(z)}{dz} = P_T'(z) \iff dP_T(z) = P_T'(z) dz, \tag{A.4}$$

and this enables us to rewrite our numerical integration term in equation (A.3) as,

$$\int U(Wealth_T) f_{P_T}(P_T(z)) P_T'(z) dz. \tag{A.5}$$

If we use the *change of variables formula* and let $z = g(P_T)$ be a smooth differentiable mapping with a one-to-one relation, hence $P_T = g^{-1}(z)$. Then the probability density function of z can be obtained from the probability density function of P_T,

$$f_z(z) = f_{P_T}(g^{-1}(z)) \left|\frac{dg^{-1}(z)}{dz}\right| = f_{P_T}(P_T) \left|\frac{dP_T}{dz}\right| = f_{P_T}(P_T) P_T'(z). \tag{A.6}$$

By using equation (A.6) this enables us to rewrite (A.5) and integrate over a standard normal distribution factor z,

$$\int U(Wealth_T(z))f_z(z)dz. \tag{A.7}$$

B Appendix: The Merton (1974) model and estimation of asset risk

The Merton (1974) model is given as,

$$E = VN(d_1^E) - D\exp(-r(T-t))N(d_2^E), \tag{B.1}$$

where the value of a firm's assets V is lognormal and follows a geometric Brownian motion process $dV = \mu_V V dt + \sigma_V V dW_V$ with an instantaneous drift μ_V, an instantaneous asset volatility σ_V, and a standard Brownian motion W_V. D is the face value debt with maturity date T, and r is the risk-free interest rate. $d_1^E = \left[\ln(V/D) + \left(r + \sigma_V^2/2\right)(T-t)\right]/\sigma_V\sqrt{(T-t)}$, $d_2^E = d_1^E - \sigma_V\sqrt{(T-t)}$ and $N(\cdot)$ is the standard normal distribution function.

The VR method:

The VR method applies the Itô's formula to find the instantaneous relationship between equity volatility and asset volatility,

$$E_N^{obs} = E\left(V_N, t_N; \sigma_V\right), \tag{B.2}$$

$$\widehat{\sigma}_E^{\mathrm{VR}} = \frac{V_N}{E_N^{obs}}\frac{\partial E\left(V_N, t_N; \sigma_V\right)}{\partial V}\sigma_V, \tag{B.3}$$

where $\partial E\left(V_N, t_N; \sigma_V\right)/\partial V = N\left(d_1\right)$, $\widehat{\sigma}_E^{\mathrm{VR}}$ is the estimated equity volatility using historical daily equity observations, E_i^{obs} for $\mathbf{i} = 1, ..., N$ and t_N is the point in time in years. We use the Newton's Method for solving the nonlinear system of equations numerically and estimate $\widehat{V}_N$ and $\widehat{\sigma}_V$ given the starting values $V_N^0 = E_N^{obs} + D$ and $\sigma_V^0 = \widehat{\sigma}_E^{\mathrm{VR}}\frac{D}{D+E_N^{obs}}$ defined by Ronn and Verma (1986).

The KMV algorithm:

In a Merton (1974) framework, $E_i^{obs} = E\left(V_i, t_i; \sigma_V\right)$, the KMV method computes the value of assets at each time point $\mathbf{i} = 1, ..., N$ given an initial guess of σ_V^0, which is assumed to be the historical estimated equity volatility. From the time series of $V_1\left(E_1^{obs}, t_1; \widehat{\sigma}_V^k\right), ..., V_N\left(E_N^{obs}, t_N; \widehat{\sigma}_V^k\right)$, we reestimate

$\widehat{\sigma}_V^{k+1}$ and use $\widehat{\sigma}_V^{k+1}$ as the input parameter in the next iteration step. We repeat the iterative procedure until $\left|\widehat{\sigma}_V^{k+1} - \widehat{\sigma}_V^{k}\right| \leq 10E - 4$.

References

Aboody, D., Barth, M. E., Kasznik, R., 2004. SFAS no. 123 stock-based compensation expense and equity market values. The Accounting Review 79 (2), 251–275.

Aggarwal, R. K., Samwick, A. A., 2003. Performance incentives within firms: The effect of managerial responsibility. The Journal of Finance 58 (4), 1613–1649.

Agrawal, A., Mandelker, G. N., September 1987. Managerial incentives and corporate investment and financing decisions. The Journal of Finance 42 (4), 823–837.

Amihud, Y., Lev, B., Autumm 1981. Risk reduction as a managerial motive for conglomerate mergers. The Bell Journal of Economics 12 (2), 605–617.

Bechmann, K. L., Jørgensen, P. L., 2004. The value and incentives of option-based compensation in danish listed companies. Journal of Derivatives Accounting 1 (1), 91–109.

Bettis, J. C., Bizjak, J. M., Lemmon, M. L., 2005. Exercise behavior, valuation, and the incentive effects of employee stock options. Journal of Financial Economics 76, 445–470.

Black, F., Cox, J. C., 1976. Valuing corporate securities: Some effects of bond indenture provisions. The Journal of Finance 31 (2), 351–367.

Black, F., Scholes, M., 1973. The pricing of options and corporate liabilities. The Journal of Political Economy 81 (3), 637–654.

Brisley, N., 2006. Executive stock options: Early exercise provisions and risk-taking incentives. Journal of Finance 61 (5), 2487–2509.

Brookfield, D., Ormrod, P., 2000. Executive stock options: Volatility, managerial decisions and agency costs. Journal of Multinational Financial Management 10, 275–295.

Carpenter, J. N., 1998. The exercise and valuation of executive stock options. Journal of Financial Economics 48, 127–158.

Carpenter, J. N., 2000. Does option compensation increase managerial risk appetite? The Journal of Finance 55, 2311–2331.

Cohen, R. B., Hall, B. J., Viceira, L. M., 2000. Do executive stock options encourage risk-taking? Unpublished working paper, Harvard Business School.

Coles, J. L., Daniel, N. D., Naveen, L., 2006. Managerial incentives and risk-taking. Journal of Financial Economics 79 (2), 431–468.

Crosbie, P., Bohn, J., December 2003. Modeling default risk. Moody's KMV, 1–31.

Crouhy, M., Galai, D., Mark, R., 2000. A comparative analysis of current credit risk models. Journal of Banking and Finance 24, 59–117.

DeFusco, R. A., Johnson, R. R., Zorn, T. S., 1990. The effect of executive stock option plans on stockholders and bondholders. The Journal of Finance 45 (2), 617–627.

Duan, J.-C., 1994. Maximum likelihood estimation using price data of the derivative contract. Mathematical Finance 4 (2), 155–167.

Duan, J.-C., Gauthier, G., Simonato, J.-G., 2004. On the equivalence of the KMV and maximum likelihood methods for structural credit risk models. Working Paper.

Ericsson, J., Reneby, J., 2005. Estimating structural bond pricing models. Journal of Business, Forthcoming 78 (2).

Feltham, G. A., Wu, M. G. H., 2001. Incentive efficiency of stock versus options. Review of Accounting Studies 6, 7–28.

Garvey, G. T., Mawani, A., 2005. Risk-taking incentives of executive stock options and the asset substitution probem. Accounting and Finance 45, 3–23.

Graham, J. R., Lang, M. H., Shackelford, D. A., 2004. Employee stock options, corporate taxes, and debt policy. Journal of Finance 59 (4), 1585–1618.

Guay, W. R., 1999. The sensitivity of CEO wealth to equity risk: An analysis of the magnitude and determinants. Journal of Financial Economics 53, 43–71.

Hall, B. J., Murphy, K. J., 2002. Stock options for undiversified executives. Journal of Accounting and Economics 33, 3–42.

Haugen, R. A., Senbet, L. W., June 1981. Resolving the agency problems of external capital through options. The Journal of Finance 36 (3), 629–647.

Hirshleifer, D., Suh, Y., 1992. Risk, managerial effort, and project choice. Journal of Financial Intermediation 2, 308–345.

Holmström, B., 1979. Moral hazard and observability. The Bell Journal of Economics 10 (1), 74–91.

Huddart, S., Lang, M., 1996. Employee stock option exercises an empirical analysis. Journal of Accounting and Economics 21, 5–43.

Ingersoll, J. E., 2002. The subjective and objective evaluation of incentive stock options. Yale ICF Working Paper 79 (No. 02-07).

Jensen, M. C., Meckling, W. H., 1976. Theory of the firm: Managerial behavior, agency costs and ownership structure. Journal of Financial Economics 3, 305–360.

Jensen, M. C., Murphy, K. J., 2004. Remuneration: Where we've been, how we got to here, what are the problems, and how to fix them. Unpublished working paper, Harvard Business School.

Johnson, S. A., Tian, Y. S., 2000a. The value and incentive effects of nontraditional executive stock option plans. Journal of Financial Economics 57, 3–34.

Johnson, S. A., Tian, Y. S., 2000b. Indexed executive stock options. Journal of Financial Economics 57, 35–64.

Johnson, S. A., Tian, Y. S., 2004. Risk-averse executives, multiple common risks, and the efficiency and incentives of indexed executive stock options.

Journal of Derivatives Accounting 1 (1), 11–28.
Jørgensen, P. L., 2002. American-style indexed executive stock options. European Finance Review 6, 321–358.
Ju, N., Leland, H., Senbet, L. W., 2002. Options, option repricing and severance packages in managerial compensation: Their effects on corporate risk. Unpublished working paper, University of Maryland.
Knopf, J. D., Nam, J., Thornton, J. H., 2002. The volatility and price sensitivities of managerial stock option portfolios and corporate hedging. Journal of Finance 57 (2), 801–813.
Lambert, R. A., 1986. Executive effort and selection of risky projects. Rand Journal of Economics 17 (1), 77–88.
Lambert, R. A., Larcker, D. F., Verrecchia, R. E., Spring 1991. Portfolio considerations in valuing executive compensation. Journal of Accounting Research 29 (1), 129–149.
Lando, D., 2004. Credit Risk Modeling: Theory and Applications. Princeton University Press.
Leland, H. E., 1994. Corporate debt value, bond covenants, and optimal capital structure. The Journal of Finance 49 (4), 1213–1252.
Leland, H. E., Toft, K. B., 1996. Optimal capital structure, endogenous bankruptcy, and the term structure of credit spreads. The Journal of Finance 51 (3), 987–1019.
Lewellen, K., 2006. Financing decisions when managers are risk averse. Journal of Financial Economics 82, 551–589.
Longstaff, F. A., Schwartz, E. S., 1995. A simple approach to valuing risky fixed and floating rate debt. The Journal of Finance 50 (3), 789–819.
Marcus, A. J., Shaked, I., November 1984. The valuation of FDIC deposit insurance using option-pricing estimates. Journal of Money, Credit and Banking 16 (4), 446–460.
May, D. O., 1995. Do managerial motives influence firm risk reduction strategies. The Journal of Finance 50 (4), 1291–1308.
Merton, R. C., May 1974. On the pricing of corporate debt: The risk structure of interest rates. The Journal of Finance 29 (2), 449–470.
Murphy, K. J., 1999. Executive Compensation. In Handbook of Labour Economics, O Ashenfelter and D Card (Eds). Vol. III. Amsterdam: North-Holland.
Nohel, T., Todd, S., 2004. Stock options and managerial incentives to invest. Journal of Derivatives Accounting 1 (1), 29–46.
Oyer, P., 2004. Why do firms use incentives that have no incentive effects? The Journal of Finance 59 (4), 1619–1649.
Parrino, R., Poteshman, A. M., Weisbach, M. S., 2005. Measuring investment distortions when risk-averse managers decide whether to undertake risky projects. Financial Mangement, 21–60.
Petersen, M. A., 2007. Estimation standard errors in finance panel data sets: Comparing approaches. Working Paper, Kellog School of Manangement.
Rajgopal, S., Shevlin, T., 2002. Empirical evidence on the relation between

stock option compensation and risk taking. Journal of Accounting and Economics 33, 145–171.

Rogers, D. A., 2002. Does executive portfolio structure affect risk management? CEO risk-taking incentives and corporate derivative usage. Journal of Banking and Finance 26, 271–295.

Rogers, D. A., 2005. Managerial risk-taking incentives and executive stock option repricing: A study of US casino executives. Financial Management Spring, 95–121.

Ronn, E. I., Verma, A. K., 1986. Pricing risk-adjusted deposit insurance: An option-based model. The Journal of Finance 41 (4), 871–895.

Ross, S. A., 2004. Compensation, incentives, and the duality of risk aversion and riskiness. The Journal of Finance 59 (1), 207–225.

Skinner, D. J., 1989. Options markets and stock return volatility. Journal of Financial Economics 23, 61–78.

Smith, C. W., Stulz, R. M., December 1985. The determinants of firms' hedging policies. Journal of Financial and Quantitative Analysis 20 (4), 391–405.

Stathopoulos, K., Espenlaub, S., Walker, M., 2004. U.k. executive compensation practices: New economy versus old economy. Journal of Management Accounting Research 16, 57–92.

Tufano, P., September 1996. Who manages risk? an empirical examination of risk management practices in the gold mining industry. The Journal of Finance LI (4), 1097–1137.

Vassalou, M., Xing, Y., April 2004. Default risk in equity returns. The Journal of Finance 59 (2), 831–868.

Fig. 1. Managerial Risk-Shifting Incentives

This figure shows the option value sensitivities over a range of price-to-strike values. The legend is as follows: 'BS' is the Black-Scholes option value sensitivity to stock return volatility. 'CE, 14,330 options' denotes the cetainty-equivalent risk sensitivity for managers holding 14,330 options and paid \$391,082 in salary. 'CE, 42,990 options' denotes the cetainty-equivalent risk sensitivity for managers holding 42,990 options and paid \$256,714 in salary. The base-case parameters are: The exercise price is \$17.68, the time-to-maturity is 5 years. The continuously compounded logreturns are determined by the CAPM, where the continuous risk-free interest rate is 4%, the equity risk-premium, $r_m - r$, is 3%, the stock return volatility is 20%, and beta is 0.65. The relative risk-aversion is 2 and the non-firm-related manager wealth is \$583,440.

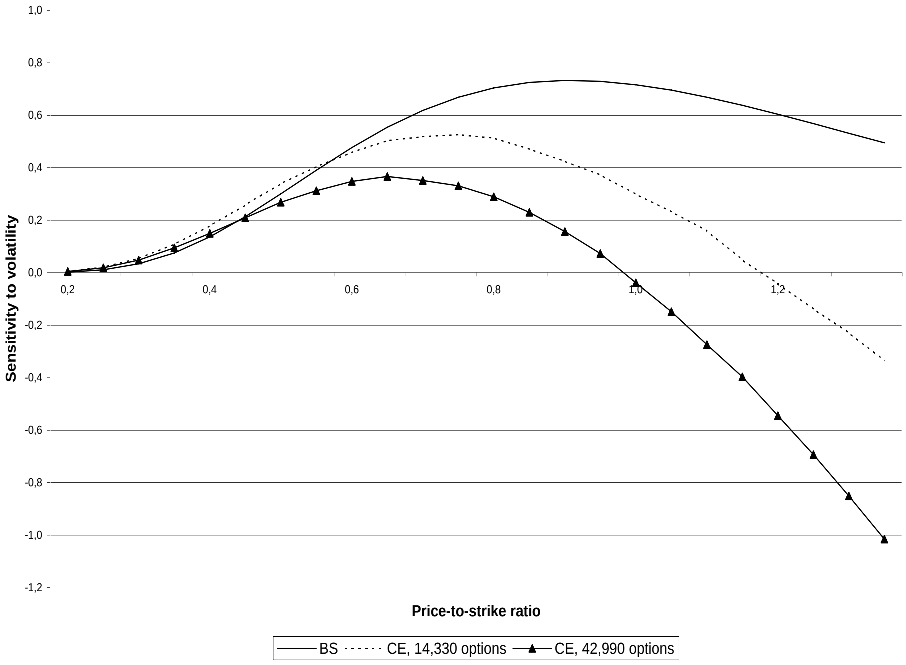

Fig. 2. The Impact of Price-to-Strike Ratio on Risk-Shifting

This figure shows the partial effect of *Moneyness* and *Moneyness-squared* on risk-shifting in MSVR where the statistical significant coefficient estimates on *Moneyness* and *Moneyness-squared* used in this illustration are reported in Table 7. The legends are as follows 'Model 1' and 'Model 5' denote the partial effect on MSVR from coefficients on value and incentive weighted moneyness, respectively. 'Model 2' and 'Model 6' denote the partial effect on MSVR from coefficients on value and incentive weighted moneyness, respectively, after controlling for changes in asset risk and leverage.

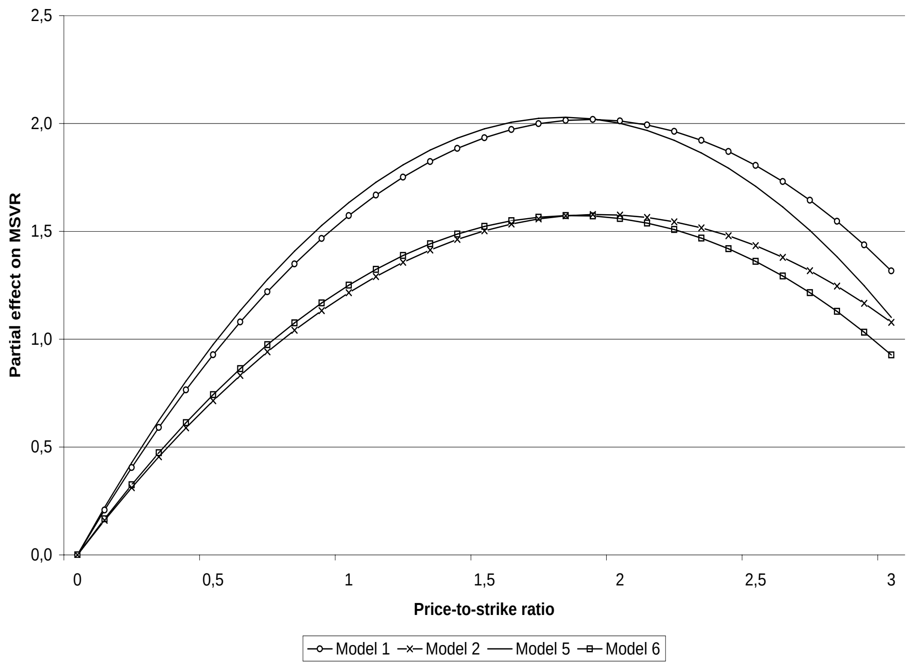

Table 1
Distribution of Option Grants Across Years and Months

This table provides summary statistics for option grants in Denmark over the sampling period between December, 1996 and May, 2004. The second column reports the number of grants of all firms and the third column reports the number of firm specific grant dates.

	No. of grants	No. of firm specific grant dates
Panel A: Option grants for each year in the sample period.		
1996	1	1
1997	2	2
1998	18	18
1999	32	23
2000	84	40
2001	86	62
2002	76	58
2003	76	49
2004	4	4
All years	379	257
Panel B: Option grants across months in the sample period		
January	37	30
February	27	21
March	92	53
April	29	18
May	21	18
June	25	20
July	12	11
August	30	20
September	24	16
October	19	14
November	23	14
December	40	22
All months	379	257

Table 2
Summary Statistics of Option Grants

This tables provides summary statistics for 77 firms with 379 grants at 257 firm specific grant dates over the sampling period between December 1996 and May 2004. The summary statistics are presented for three recipient groups (board of directors, management and employees) and for the total grant. The number of options denote how options are distributed among directors, managers and employees. The Black-Scholes formula is used to compute the option value and risk incentive of each grant. All values are reported in U.S. dollars based on the exchange rate on 9 May, 2007, where 100 DKK = 17.68 USD = 13.20 EUR. Each grant is often divided into sub-grants with different time-to-maturity, strike price, among other factors. The value of the grant is computed as the sum of sub-grant values, $\sum_{j=1}^{J} n_j \left[S_t N\left(d_1^j\right) - X_j \exp(-rT_j) N\left(d_1^j - \sigma\sqrt{T_j}\right)\right]$, where $d_1^j = \left[\ln(S_t/X_j) + (r+\sigma/2)T_j\right]/\sigma\sqrt{T_j}$. n_j is the number of options in sub-grant j, S_t is the underlying stock price at the grant date, X_j is the strike price of the option in sub-grant j with the time to maturity T_j. σ is the annualized stock return volatility computed as the standard deviation of the daily logreturns from 125 trading days prior the grant date multiplied by $\sqrt{250}$. The continuous risk-free interest rate, r, is equal to $\ln(1+R)$, where R is the one year Copenhagen Inter-Bank Offered Rates (CIBOR). Risk incentive of each option is defined by Guay (1999) as the option value sensitivity to a 1% increase in the annualized stock return volatility. The risk incentive for the grant is then given as the sum of the risk incentive of each sub-grant j, $\sum_{j=1}^{J} n_j S_t \sqrt{T_j} N'\left(d_1^j\right) * 0.01$, where N' is the normal density function. Moneyness of each sub-grant is S_t/X_j.

	Mean	Standard deviation	Minimum	Median	Maximum
Board of directors:					
No. of options	5,867	41,139	0	0	500,000
Option value (in USD)	78,712	603,181	0	0	10,514,869
Risk incentive (in USD)	870	5,096	0	0	62,752
Management:					
No. of options	46,719	144,896	0	10,200	2,328,000
Option value (in USD)	532,558	1,380,123	0	73,809	10,514,869
Risk incentive (in USD)	8,969	23,095	0	1,331	262,192
Employees:					
No. of options	96,627	303,546	0	9,983	2,394,092
Option value (in USD)	1,541,778	5,506,191	0	94,177	71,471,985
Risk incentive (in USD)	21,998	70,337	0	1,877	834,297
Total option grant:					
No. of options	149,477	357,734	210	50,000	3,000,000
Option value (in USD)	2,157,896	6,022,989	1,078	443,443	71,471,985
Risk incentive (in USD)	31,976	76,357	0	7,300	834,297
Moneyness	0.98	0.51	0.16	0.98	8.86
Time to maturity (in years)	5.23	2.42	0.83	5.00	17.83

Table 3
Summary Statistics on Key Variables

This table provides descriptive statistics of the key variables. SVR and MSVR denote the stock return variance ratio and the market-adjusted stock return variance ratio, respectively. AVR is the asset variance ratio and MAVR is the market-adjusted asset variance ratio, where the ratios are depicted using both the VR and KMV method. *Changes-in-leverage* is the market value of total debt to market value of equity and *Market-to-book* is the ratio between market and book value of total assets, where the ratios are depicted using both the VR and KMV method. *Firm size* is natural logarithm of total assets.

	Mean	Standard deviation	Minimum	Median	Maximum
SVR	1.501	1.952	0.132	1.028	21.281
MSVR	1.477	1.535	0.091	1.128	14.311
AVR^{VR}	1.162	1.042	0.016	0.984	10.063
MAVR^{VR}	1.332	1.297	0.015	0.942	9.433
AVR^{KMV}	1.711	2.488	0.049	0.958	18.140
MAVR^{KMV}	1.745	2.346	0.029	1.086	20.539
$\textit{Changes-in-leverage}^{\text{VR}}$	1.495	1.547	0.003	1.018	15.441
$\textit{Changes-in-leverage}^{\text{KMV}}$	1.584	2.078	0.004	1.089	25.379
$\textit{Market-to-book}^{\text{VR}}$	1.692	1.931	0.348	1.152	24.459
$\textit{Market-to-book}^{\text{KMV}}$	1.685	1.892	0.348	1.140	23.911
Firm size	21.329	1.512	17.251	21.311	24.567

Table 4. The Correlations Between Key Variables

This table provides the correlations between the key variables. SVR and MSVR denote the stock return variance ratio and the market-adjusted stock return variance ratio, respectively. AVR is the asset variance ratio and MAVR is the market-adjusted asset variance ratio, where the ratios are depicted using both the VR and KMV method. *Changes-in-leverage* is the market value of total debt to market value of equity and *Market-to-book* is the ratio between market and book value of total assets, where the ratios are depicted using both the VR and KMV method. *Firm size* is natural logarithm of total assets.

Variable	1	2	3	4	5	6	7	8	9	10
1. SVR										
2. MSVR	0.8090									
3. AVR^{VR}	0.5379	0.4839								
4. $MAVR^{VR}$	0.1942	0.5580	0.6157							
5. AVR^{KMV}	0.2200	0.1434	0.4657	0.1972						
6. $MAVR^{KMV}$	0.0998	0.2888	0.3632	0.5269	0.7672					
7. *Changes-in-leverage*^{VR}	0.0969	0.0530	-0.1923	-0.2486	0.0058	-0.0549				
8. *Changes-in-leverage*^{KMV}	0.0850	0.0528	-0.1906	-0.2298	-0.0191	-0.0661	0.9288			
9. *Market-to-book*^{VR}	-0.0268	-0.0809	-0.0815	-0.1524	0.0007	-0.0560	0.1441	0.2205		
10. *Market-to-book*^{KMV}	-0.0268	-0.0808	-0.0870	-0.1561	-0.0026	-0.0585	0.1516	0.2293	0.9996	
11. *Firm size*	0.0094	0.0030	0.0536	0.0489	0.0928	0.0912	-0.2499	-0.2543	-0.0917	-0.0953

Table 5
Risk-Shifting Following Option Grants

This table reports statistics on changes in stock and asset risk adjusted for market risk following option grants. In Panel A, we consider risk-shifting after first option grant. In Panel B, we consider risk-shifting after all option grants. MSVR is the market-adjusted stock return variance ratio. $MAVR^{VR}$ and $MAVR^{KMV}$ denote the market-adjusted asset variance ratio using the VR and KMV method, respectively. Z denotes the Wilcoxon signed-rank statistics. *** and ** indicate the one-tailed statistical significance at the 1% and 5% levels, respectively.

	MSVR	$MAVR^{VR}$	$MAVR^{KMV}$
Panel A: First Option Grant			
55 grants			
Mean	1.431	1.244	2.041
Std	0.987	1.003	2.497
Maximum	5.801	5.302	11.942
Q3	2.076	1.685	2.264
Median	1.175	0.942	1.319
Q1	0.763	0.657	0.623
Minimum	0.091	0.136	0.029
Firms with Ratio > 1	56.4%	45.5%	58.2%
Z	2.656***	0.452	2.564***
Panel B: All Option Grants			
257 grants			
Mean	1.477	1.332	1.745
Std	1.535	1.297	2.346
Maximum	14.311	9.433	20.539
Q3	1.718	1.551	1.858
Median	1.128	0.942	1.086
Q1	0.679	0.644	0.554
Minimum	0.091	0.015	0.029
Firms with Ratio > 1	54.9%	46.7%	54.9%
Z	3.729***	1.503	3.253***

Table 6. Risk-Shifting Following Option Grants: Stock Risk, Asset Risk and Leverage

This table reports OLS regression results with market-adjusted stock return variance ratio (MSVR) as the dependent variable. Panel A and Panel B show the regression results for asset variances inferred using the VR and KMV method, respectively. MAVR is the market-adjusted asset variance ratio, *Changes-in-leverage* is the market value of total debt to market value of equity, *Market-to-book* is the ratio between market and book value of total assets and *Firm size* is natural logarithm of total assets. The t-statistics are reported in parentheses and are based on either Newey-West (NW) heteroscedasticity and autocorrelation consistent standard errors or robust standard errors clustered by firm (CL-Firm). ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively. Coefficients on industry and year dummies are not reported.

Panel A: VR estimated asset risk

Model	(1)	(2)	(3)	(4)	(5)	(6)
Independent variables						
Intercept	0.115	0.156	-1.222	0.115	0.156	-1.222
	(0.110)	(0.138)	(-1.258)	(0.109)	(0.116)	(-1.165)
MAVR	0.702***		0.746***	0.702***		0.746***
	(4.373)		(4.569)	(4.217)		(4.456)
Changes-in-leverage		0.089	0.191**		0.089	0.191**
		(0.990)	(2.044)		(0.971)	(2.099)
Market-to-book	0.009	-0.021	-0.001	0.009	-0.021	-0.001
	(0.440)	(-1.000)	(-0.069)	(0.400)	(-1.044)	(-0.054)
Firm size	0.009	0.058	0.061*	0.009	0.058	0.061
	(0.220)	(1.191)	(1.722)	(0.221)	(0.946)	(1.521)
Industry Dummies	YES	YES	YES	YES	YES	YES
Year Dummies	YES	YES	YES	YES	YES	YES
Standard Errors	NW	NW	NW	CL-Firm	CL-Firm	CL-Firm
Number of observations	257	257	257	257	257	257
Adjusted R^2	0.332	0.043	0.366	0.332	0.043	0.366

Table 6. (continued)

Panel B: KMV estimated asset risk

Model	(1)	(2)	(3)	(4)	(5)	(6)
Independent variables						
Intercept	1.220	0.251	0.644	1.220	0.251	0.644
	(0.987)	(0.222)	(0.556)	(0.958)	(0.191)	(0.501)
MAVR	0.159***		0.159***	0.159***		0.159***
	(2.763)		(2.802)	(2.884)		(2.918)
Changes-in-leverage		0.080*	0.082**		0.080	0.082*
		(1.799)	(2.078)		(1.536)	(1.725)
Market-to-book	-0.015	-0.030	-0.031	-0.015	-0.030	-0.031
	(-0.657)	(-1.258)	(-1.416)	(-0.761)	(-1.249)	(-1.331)
Firm size	0.003	0.055	0.027	0.003	0.055	0.027
	(0.050)	(1.111)	(0.544)	(0.047)	(0.912)	(0.467)
Industry Dummies	YES	YES	YES	YES	YES	YES
Year Dummies	YES	YES	YES	YES	YES	YES
Standard Errors	NW	NW	NW	CL-Firm	CL-Firm	CL-Firm
Number of observations	257	257	257	257	257	257
Adjusted R^2	0.092	0.046	0.100	0.092	0.046	0.100

Table 7. Risk-Shifting Following Option Grants: Does Moneyness Matter?

This table reports OLS regression results with market-adjusted stock return variance ratio (MSVR) as the dependent variable. Panel A and Panel B show the regression results for value and incentive weighted price-to-strike ratios, respectively. *Moneyness* denotes the option's weighted price-to-strike ratio at the grant date and *Moneyness-squared* is the squared weighted price-to-strike ratio. MAVR is the market-adjusted asset variance ratio, *Changes-in-leverage* is the market value of total debt to market value of equity, *Market-to-book* is the ratio between market and book value of total assets and *Firm size* is natural logarithm of total assets. The t-statistics are reported in parentheses and are based on either Newey-West (NW) heteroscedasticity and autocorrelation consistent standard errors or robust standard errors clustered by firm (CL-Firm). ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively. Coefficients on industry and year dummies are not reported.

	Panel A:Value weighted moneyness				Panel B: Incentive weighted moneyness			
Model	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Independent variables								
Intercept	0.235	0.185	0.235	0.185	0.154	0.132	0.154	0.132
	(0.194)	(0.172)	(0.190)	(0.138)	(0.126)	(0.122)	(0.123)	(0.098)
Moneyness	2.140***	1.644**	2.140***	1.644*	2.267***	1.721**	2.267***	1.721*
	(2.607)	(2.000)	(2.630)	(1.916)	(2.606)	(2.048)	(2.623)	(1.923)
Moneyness-squared	-0.567**	-0.428**	-0.567**	-0.428*	-0.633**	-0.471**	-0.633**	-0.471*
	(-2.505)	(-2.005)	(-2.523)	(-1.782)	(-2.423)	(-1.993)	(-2.441)	(-1.750)
$MAVR^{KMV}$		0.149**		0.149***		0.149**		0.149***
		(2.245)		(2.774)		(2.244)		(2.778)
$Changes\text{-}in\text{-}leverage^{KMV}$		0.081**		0.081*		0.081**		0.081*
		(2.012)		(1.731)		(2.016)		(1.734)
$Market\text{-}to\text{-}book^{KMV}$	-0.019	-0.034	-0.019	-0.034	-0.019	-0.034	-0.019	-0.034
	(-0.769)	(-1.435)	(-0.928)	(-1.484)	(-0.754)	(-1.430)	(-0.911)	(-1.480)
Firm size	-0.017	-0.008	-0.017	-0.008	-0.016	-0.007	-0.016	-0.007
	(-0.295)	(-0.194)	(-0.299)	(-0.151)	(-0.279)	(-0.172)	(-0.282)	(-0.134)
Industry Dummies	YES	YES	YES	YES	YES	YES	YES	YES
Year Dummies	YES	YES	YES	YES	YES	YES	YES	YES
Standard Errors	NW	NW	CL-Firm	CL-Firm	NW	NW	CL-Firm	CL-Firm
Number of observations	257	257	257	257	257	257	257	257
Adjusted R^2	0.052	0.104	0.052	0.104	0.052	0.104	0.052	0.104