Strike Prices of Options for Overconfident Executives

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Oded Palmon and Itzhak Venezia

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Abstract

We explore via simulations the impacts of managerial overconfidence on the optimal strike prices of executive incentive options. Although it has been shown that, optimally, managerial incentive options should be awarded in-the-money, in practice most firms award them at-the-money. We show that the optimal strike prices of options granted to overconfident executive are directly related to their overconfidence level and that this bias brings the optimal strike prices closer to the institutionally prevalent at-the-money prices. Our results thus support the viability of the common practice of awarding managers with at-the-money incentive options. We also show that overoptimistic CEOs receive lower compensation than their realistic counterparts and that the stockholders benefit from

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their managers bias. The combined welfare of the firm's stakeholders is, however, positively related to managerial overconfidence.

The Monte Carlo simulation procedure described in Sect. 55.3 uses a Mathematica program to find the optimal effort by managers and the optimal (for stockholders) contract parameters. An expanded discussion of the simulations, including the choice of the functional forms and the calibration of the parameters, is provided in Appendix 1.

Keywords

Overconfidence • Managerial effort • Incentive options • Strike price • Simulations • Behavioral finance • Executive compensation schemes • Mathematica optimization • Risk aversion • Effort aversion

55.1 Introduction

The optimal structure of executive compensation has intrigued academic researchers as well as practitioners for a long time. Most principal-agent models dealing with this issue yield rather complex payment schedules, making it quite challenging to test their predictions. In practice there is a widespread use of simple compensation schemes such as linear or piecewise linear (stock option) contracts. An important question that arises in this case is what are the optimal parameters for these simple schemes? In particular what are the optimal strike prices for incentive option schemes? Unfortunately, this important issue has received only little attention. Institutional and tax factors could be to blame for this neglect. Before the 2006 changes in the US tax rules, the "intrinsic value" of executive options was taxed, and this discouraged firms from granting their executives in-the-money options. Granting out-of-the-money options seemed unfair and there is no empirical or theoretical evidence for advantages to such practice (Mahajan 2002). Indeed, only a very small fraction of firms used such strike prices.[1] The virtual monopoly of at-the-money strike prices, their institutional appeal, or some other unknown factors might have discouraged academics from studying the merits and demerits of this practice.

In their landmark paper, Hall and Murphy (2000, 2002) attribute the pervasiveness of granting at-the-money options to their property of being the most sensitive to changes in the stock price. Palmon et al. (2008), however, have shown that issuing the most sensitive options is not necessarily optimal when managers are risk and effort averse.[2] Within a model explicitly considering the choice of the contract parameters by stockholders and the resulting effort chosen by risk-averse and effort-averse managers, they show for a wide range of parameters that well describe

[1] According to Mahajan (2002), less than 1 % of firms used out-of-the-money strike prices. Furthermore, in his study firms did not benefit from awarding such options to their managers.

[2] Hall and Murphy (2000) did not show that at-the-money strike prices are optimal, just that they possess the highest sensitivity to stock prices. They did not assume effort aversion by managers either.

managers' risk and effort aversion, that in-the-money options provide are optimal. Such options provide managers a better risk-return trade-off and ultimately constitute a better form of compensation than either out-of-the-money or at-the-money options.[3] Palmon et al. further argue that the asymmetric tax treatment of options under the old (prior to 2006) tax system, which penalized the issuance of in-the-money options, may have driven firms to use at-the-money options.

Whereas most studies of the issue of optimal incentive contracts assumed that managers as well as stockholders are rational, there exists extensive literature that documents that managers often are overconfident. Of the few studies that explore the effect of cognitive biases on managerial compensation, none however explores the effect of overconfidence on the optimal strike prices for the incentive options. Gervais et al. (2011) investigate the optimal form of managerial compensation under overconfidence but define overconfidence in the sense of too-high-precision-of-estimates (calibration), and the managers in their model exert effort to obtain better information on the investment parameters. There is an abundant literature however that indicates the pervasiveness of overconfidence in the optimism or "better than average" sense rather than in the calibration interpretation (see, e.g., Malmendier and Tate 2005a, b, 2008; Roll 1986; Suntheim 2012).[4] Oyer and Schaefer (2005) and Bergman and Jenter (2007) also consider the effect of optimism, and other sentiments, on managerial compensation, but they do not consider the effect of these sentiments on the optimal strike prices or on the managers' effort.

In this paper we investigate the hitherto unexplored question of the effect of overconfidence on the optimal strike prices for risk-averse and effort-averse managers. We show that overconfidence leads to higher optimal strike prices of managerial incentive schemes, and that awarding overconfident CEOs at-the-money options mitigates the stockholders' vs. managers' agency problem, leading to higher managers' productivity. Our results thus provide support for the viability of the ubiquitous yet seemingly unoptimal practice of awarding CEOs with at-the-money incentive options.

Whereas the main focus of the paper is the interaction between overconfidence and the strike prices of managerial incentive options, it also sheds light on the effect of overconfidence on the firm's stakeholders (stockholders and managers). We predict, as empirically shown by Otto (2011), that overoptimistic CEOs receive lower compensation than their realistic counterparts. However, the stockholders benefit from their managers bias since they pay less and enjoy the productivity of the higher effort the overconfident manager exerts. We construct a measure of the combined welfare of managers and stockholders and demonstrate that it is

[3]Dittman et al. (2010) found that for a range of parameterizations, a principal-agent model with loss-averse agents generates convex compensation contract but did not investigate the parameters of the options to be used in the compensation package. Recently, however, Dittman and Yu (2011) found that in-the-money options are optimal.

[4]Glaser and Weber (2007) note that only overconfidence in the better than average sense affects trading.

positively related to managerial overconfidence, a result helping explain the persistence of this bias.[5]

The paper is constructed as follows. In Sect. 55.2 we present the model. In Sect. 55.3 we explain the simulation method, and in Sect. 55.4 we present the simulations' results. Section 55.5 concludes.

55.2 Overconfidence and the Optimal Exercise Prices of Executive Incentive Options

We consider a one-period Holmstrom (1979)-type model where a risk-neutral firm employs an overconfident, risk-averse, and effort-averse manager.[6] The cash flows, X, of the firm depend on the manager's effort and on exogenous stochastic factors. The manager is assumed to provide some effort which is the minimum necessary to run the firm and hence may be considered observable, but can provide also unobservable extra effort. The more extra effort the manager exerts, the higher will be the expected cash flows. Because stockholders cannot observe managers' extra effort, managerial compensation may depend on the firm's cash flows (which depend on effort), but cannot be determined directly based on extra effort.

We assume that the cash flows of the firm, X, are lognormally distributed with the following distribution function:

$$f(X) = \exp\left\{-0.5\{[\log(X) - \mu(Y)]/\sigma\}^2\right\}/\left(X\sigma\sqrt{2\pi}\right) \tag{55.1}$$

where Y denotes the managerial extra effort (a managerial choice variable) and $\mu(Y)$ and σ denote, respectively, the mean and the standard deviation of the underlying normal distribution of the natural logarithm of X. We assume that managerial effort increases cash flows and that overconfident managers overestimate the impact of their effort on cash flows. Formally, we use the following specification:

$$\mu(Y) = \mathrm{Ln}(\mu_0 + 500\lambda Y) - \sigma^2/2, \tag{55.2}$$

where λ denotes the degree of overconfidence. We assume that stockholders have realistic expectations, which are represented by $\lambda = 1$, and that managers use $\lambda > 1$ to form their expectations. Thus, f(X) can be written as f(X, λ), where f(X, $\lambda = 1$) represents the realistic cash flow distribution, while f(X, $\lambda > 1$)

[5]Palmon and Venezia (2012) explore the effect of managerial overconfidence on the firm's stockholders and show that overconfidence may improve welfare. However, that study does not investigate the optimal strike price of managerial incentive options.

[6]In our model we assume symmetry of information between the manager and the firm regarding the distribution of cash flows of the firm except for the different view of the effect of the manager's effort on cash flows.

represents the cash flow distribution as viewed by overconfident managers. For notation brevity, we suppress the λ in f(X, λ). By the known properties of the lognormal distribution, the mean and variance of X equal $e^{\left[\mu(Y)+0.5\sigma^2\right]}$ and $\left[e^{\left[2\mu(Y)+\sigma^2\right]}\left(e^{\sigma^2}-1\right)\right]$, respectively. Thus, it follows from Eq. 55.2 that a person with a λ overconfidence measure believes that the mean of the cash flows X is $e^{\mu(Y)+0.5\sigma^2}=\mu_0+500\lambda Y$ and that their coefficient of variation is approximately σ.[7] Since managers and stockholders differ in their perception of the distributions of cash flows, one must be careful in their use. In what follows we refer to the distribution of cash flows as seen by stockholders as the realistic distribution, and will make a special note whenever the manager's overconfident beliefs are used.

Except for her overconfidence, the manager is assumed to be rational and to choose her extra effort so as to maximize the expected value of the following utility function which exhibits constant relative risk aversion (CRRA) with respect to compensation:

$$U(I,Y)=\frac{1}{1-\gamma}NY^{\beta}+\frac{1}{1-\gamma}I^{1-\gamma} \tag{55.3}$$

In Eq. 55.3, I denotes the manager's monetary income, γ denotes the constant relative risk aversion measure, N is a scaling constant representing the importance of effort relative to monetary income in the manager's preferences, and the positive parameter β is related to the convexity of the disutility of effort.

Since stockholders cannot observe the manager's extra effort, they propose compensation schemes that depend on the observed cash flows, but not on Y. Stockholders, which we assume to be risk neutral, strive to make the compensation performance sensitive in order to better align the manager's incentives with their own. Stockholders offer the manager a compensation package that includes two components: a fixed wage (W) that she will receive regardless of her extra effort and of the resulting cash flows and options with a strike price (K) for a fraction (s) of the equity of the firm. We assume that stockholders offer the contract that maximizes the value of their equity.

The following timeline of decisions is assumed. At the beginning of the period, the firm chooses the parameters of the compensation contract (K, W, and s) and offers this contract to the manager. Observing the contract parameters, and taking into account the effects of her endeavors on firm cash flows and hence on her compensation, the manager determines the extra-effort level Y that maximizes her expected utility. At the end of the period, X is revealed, and the firm distributes the cash flows to the manager and to the stockholders and then dissolves. The priority of payments is as follows. The firm first pays the wages or only part of them if the cash flows do not suffice. If the cash flows exceed the wage, W, but not (K + W), then the

[7]More precisely the square of the coefficient of variation is $\left[e^{\sigma^2}-1\right]$ which can be approximated by σ^2 since for any small z, e^z-1 is close to z.

managers just receive their fixed wage. The managers are paid the value of the options s(X − K − W), in addition to W if X exceeds K + W. The manager therefore receives the cash flows I(X) defined by

$$I(x) = \begin{Bmatrix} X \\ W \\ W + s(X - W - K) \end{Bmatrix} \quad \text{when} \quad \begin{Bmatrix} X \le W \\ W \le X \le W + K \\ W + K \le X \end{Bmatrix} \tag{55.4}$$

The shareholders get the residual cash flows.

In the above cash flow formula, the first range covers the case where cash flows do not suffice to pay the entire wage. The second range covers the case where the options expire out-of-the-money, and the manager gets the promised wage. The third range represents cash flows that are large enough so that the options expire in-the-money. In addition to the wage, the manager receives a proportion, s, of the value of the firm above the threshold value of K. The expected utility of the manager E{U[I(X),Y]} which governs her behavior, and her expected compensation E[I(X)], can be obtained by integrating her utility U[I(X),Y] given in Eq. 55.3 and her compensation I(X), given in Eq. 55.4, respectively. We note that the manager chooses the effort level so as to maximize the expected utility using her perception of the distribution of the firm's final cash flows, while stockholders choose the parameters of the compensation contract using the realistic cash flow distribution to calculate the expected cash flows and managerial compensation.

Shareholders receive all cash flows that are not received by the manager. Since stockholders are risk neutral and rational, stockholders' equity value (SEV) is the expected value of these payments, using the realistic distribution function, and hence,[8]

$$SEV = E(\text{Cashflows}) - E[I(X)] = \int_0^\infty Xf(X)dX - E[I(X)] \tag{55.5}$$

While the derivation of the optimal contract for any set of exogenous parameters is conceptually straightforward, unfortunately, closed form solutions cannot be obtained in our integrative model. Hence, following Hall and Murphy (2000), we resort to simulations to evaluate the optimal contracts and analyze their properties. In addition, we cannot use the Black-Scholes model to evaluate the executive stock options since this model takes the values of the underlying asset as given, whereas a crucial aspect of the managerial incentive scheme of our model is that managerial extra effort and firm value are endogenously determined. We therefore introduce a model that simultaneously simulates the manager's optimal extra-effort level as well as the expected values of the executive stock options and shareholders' equity

[8]Discounting the cash flows by an appropriate risk-adjusted discount rate would yield a linear transformation of equity values. To simplify the presentation, and as is common in the literature, we abstract from that.

for each compensation package. We check the robustness of our results by using alternative parameters for the manager's utility function and the distribution functions of the cash flows.

55.3 The Simulation Procedures

We assume that managers have external employment opportunities and that stockholders offer managerial compensation packages that provide the managers with a comparable expected utility.[9] Without loss of generality (i.e., by an appropriate definition of the wage units), we assume that these external employment opportunities provide the manager an expected utility that equals the level of utility that is obtained from a fixed compensation of 100 in the absence of any extra effort. Thus, in all the simulations, we set the manager's expected utility to correspond to the level obtained from a fixed compensation of 100 (wage = 100 and no option grants) and no extra effort (which is the optimal extra-effort choice when no options are granted).[10] We then search over a grid of strike prices (using four-digit accuracy) and find for each strike price the percentage of options that should be awarded so that the manager's expected utility equals the expected utility target when the manager chooses the optimal extra-effort level. We identify the strike price that is associated with the highest equity level and refer to this contract as the optimal contract for the given set of parameters.

In calibrating the other parameters for the simulations, we try to approximately conform to Hall and Murphy (2000) and Hall and Liebman (1998); to studies that simulate decisions with effort aversion, such as Bitler et al. (2005); and to studies that explore the effect of overconfidence on corporate decisions, such as Malmendier and Tate (2005a, b, 2008).[11] Accordingly, we set the parameters in our base case as follows. The coefficient of variation, σ, equals 0.3, and thus, the standard deviation is 0.3E(X). Since the expected cash flows serve as numeraire, the volatility is determined solely by the coefficient of variation. In our base case, we set the managerial wage to equal 50.[12] The expected cash flows as viewed by an overconfident manager with an overconfidence measure of λ are $E(X) = 45{,}000 + 500\lambda Y$ (i.e., $\mu_0 = 45{,}000$). The risk aversion and effort aversion parameters are $\gamma = 4$ and $\beta = 3$, respectively.

[9]See Appendix 1 for more details.

[10]When the manager is overconfident, this expected utility is calculated according to the manager's expectations.

[11]See Appendix 1 for the explanation for the calibration of our model. To be on the safe side and in stride with explanations for the risk premium puzzle, we use higher values for the risk aversion parameter.

[12]It should be noted that although the wage level in our base case equals half of the fixed compensation that corresponds to the utility target, it equals only about 11 % of the expected compensation under the optimal contract when managers are realistic. When managers are overconfident, a wage of 50 consists of less than 11 % of total compensation according to the manager's expectations but more than 11 % according to the realistic expectations.

We consider overconfidence levels between $\lambda = 1$ (no overconfidence) and $\lambda = 2.5$ in 0.5 increments.

We examine the robustness of the results to deviations from the base case combination of parameters by simulating with several alternative sets of exogenous parameters. We repeat the analysis for many alternative sets of the exogenous parameters: the manager's risk and extra-effort aversion, γ and β, as well as the volatility measure of cash flows, σ.[13]

55.4 Results and Discussion

In Table 55.1 we present the impact of overconfidence on the strike price that stockholders choose to offer: the moneyness, the percentage of the firm given as options, the effort choice of managers, the stockholders' equity value, and the expected managerial compensation. The expected compensation is calculated both under the realistic distribution and under the subjective distribution of the manager.

One observes from Table 55.1 that the strike price, the options' moneyness, the optimal managerial effort, the value of the stockholders' equity, and the expected compensation according to the managers' expectations are directly related to overconfidence. The optimal strike price (in thousands of dollars; strike prices will be denoted in thousands of dollars in the rest of the study) for a rational manager is 40.71, with a 0.60 moneyness (which can be described as deep-in-the-money), but it rises to 63.74 with a 0.89 moneyness (closer to at-the-money) when $\lambda = 2.5$.[14] Managers also work harder the more overconfident they are (Y increases from around 47 when they are realistic to around 52 when $\lambda = 2.5$). Consequently, in order to hold the managers' expected utility fixed, their subjective expected monetary compensation must increase with overconfidence to compensate for the extra risk resulting from the higher strike price and for the additional effort they exert. The expected compensation the stockholders perceive they pay according to the realistic expectation, however, is inversely related to the overconfidence measure as they take advantage of managers' unrealistic expectations. The SEVs of the optimal contracts increase as managerial overconfidence increases (see column 5, the SEV rises from 68,099 when $\lambda = 1$ to 70,958 when $\lambda = 2.5$, an increase of about 6 %). That is, the stockholders benefit from the managers overestimating their powers.

This analysis suggests that stockholders are able to induce overconfident managers to exert higher effort levels even though the objective contract parameters they offer them are less favorable (the managers work harder but receive lower

[13]Because of scaling there is no need to conduct robustness checks for the expected cash flows.

[14]The moneyness measure depends on the strike price and the value of equity, which in turn depends on effort. Thus, the moneyness measure varies with overconfidence because effort varies with overconfidence, even when the strike price remains constant.

Table 55.1 Stockholders' equity values (SEV), strike prices (K), moneyness (K/S), effort levels (Y), and other parameters of interest. Base case: $\gamma = 4$ $\beta = 3$, $\sigma = 0.3$, wage = 50, N = 4,000

Overconfidence measure, λ	Strike price (K) in 1000s	Moneyness (K/S)	Percentage of firm given as options, (s)	Effort (Y)	Stockholders Equity Value (SEV)	Expected compensation, realistic valuation	Expected compensation, managers valuation	Sum of SEV and realistic expected compensation
	1	2	3	4	5	6	7	8
1	40.71	0.5944	1.40%	47.083	68099.42	441.89	441.89	68541.31
1.5	48.16	0.6891	1.35%	49.867	69580.04	353.41	513.34	69933.45
2	55.88	0.7910	1.35%	51.393	70417.74	278.65	598.49	70696.39
2.5	63.74	0.8962	1.38%	52.351	70958.63	217.12	698.06	71175.75

expected compensation). In particular the optimal strike prices of the options that stockholders award overconfident managers are increasing with their overconfidence. While realistic managers estimate that there is a substantial probability that options with an at-the-money strike price will be worthless regardless of their effort, overconfident managers may believe that their efforts will enhance the values of such options making them valuable.

In practice executive options usually are provided with at-the-money strike prices. When overconfidence or some other behavioral biases are not present, theory has shown (see, e.g., Dittmann et al. 2010; Dittmann and Yu 2011; Palmon et al. 2008), contrary to Hall and Murphy, that at-the-money prices are not optimal. Hall and Murphy argue that at-the-money prices are optimal because they provide maximum sensitivity to stock prices, but their argument does not hold when the managers are risk averse and effort averse. Managers must be adequately compensated for their efforts and for risk taking, and a balance must be reached between their efforts, risk taking, and their pay. As Palmon et al. have shown, the optimal balance is reached by issuing in-the-money options which do not necessarily provide maximum sensitivity to stock prices. If managers are overconfident, however, that makes them more amenable for stock price sensitivity, and hence, they will prefer higher strike prices which are closer to the at-the-money options usually awarded in practice.

We also note in Table 55.1 that managerial overconfidence increases stockholders' equity value. Given that the compensation is determined so as to equate the manager's expected utility to the target expected utility, it follows from Table 55.1 that consistent with the results of Palmon and Venezia (2012), the total welfare of both the managers and the stockholders improves with increased managerial overconfidence. The fixed-level expected utility of the manager is determined according to their subjective, overoptimistic perception. However, when evaluated according to the realistic view, expected managerial compensation falls with overconfidence. We note that, nonetheless, the difference between the monetary expected compensations according to the overoptimistic and realistic expectations is smaller than the monetary gains to stockholders from overconfidence, so that the sum of realistic compensation and SEV rises with overconfidence (see column 8). Thus, also in terms of realistic monetary values, the welfare of the stakeholders (stockholders and managers) increases with overconfidence.

In Table 55.2 we provide sensitivity analysis examining the effect of each of the parameters on the behavior of stockholders and managers. We present the results of only one or two changes in each of the exogenous parameters, but we conduct many other simulations, and all provide the same qualitative results.[15] In all the panels, higher overconfidence measure is associated with higher strike prices, moneyness levels, optimal managerial effort, value of the stockholders' equity, and expected compensation according to the managers' expectations. They also are associated

[15]The results of these simulations can be obtained from the authors upon request.

Table 55.2 Stockholders' equity values (SEV), strike prices (K), moneyness (K/S), effort levels (Y), and other parameters of interest. Departures from the base case

Overconfidence measure, λ	Strike price (K) in 1000s	Moneyness (K/S)	Percentage of firm given as options, (s)	Effort (Y)	Stockholders' Equity Value, SEV	Expected compensation, realistic stockholders' valuation	Expected compensation, managers' valuation	Sum of SEV and realistic expected compensation
	1	2	3	4	5	6	7	8
Panel A: wage = 25								
1	31.56	0.4490	1.25 %	50.63	69,807.58	508.76	508.76	70,316.34
1.5	37.49	0.5252	1.14 %	52.83	71,000.72	413.11	563.28	71,413.83
2	43.57	0.6053	1.08 %	54.01	71,670.56	334.41	622.54	72,004.97
2.5	49.74	0.6875	1.04 %	54.75	72,106.28	269.37	688.74	72,375.65
Panel B: wage = 75								
1	51.70	0.7859	1.63 %	41.71	65,518.91	336.51	336.51	65,855.42
1.5	60.61	0.8965	1.70 %	45.36	67,411.64	269.97	420.45	67,681.61
2	69.91	1.0186	1.82 %	47.42	68,498.86	211.05	522.88	68,709.91
2.5	79.42	1.1462	2.01 %	48.72	69,195.89	166.20	653.44	69,362.09
Panel C: σ = 0.2								
1	48.97	0.6935	1.80 %	51.33	70,225.15	441.49	441.49	70,666.64
1.5	58.39	0.8138	1.83 %	53.60	71,489.22	312.64	542.64	71,801.86
2	68.10	0.9412	2.02 %	54.82	72,198.16	209.92	692.03	72,408.08
2.5	77.94	1.0716	2.35 %	55.56	72,642.57	137.08	912.80	72,779.65
Panel D: σ = 0.4								
1	34.02	0.5090	1.19 %	43.77	66,438.75	444.93	444.93	66,883.68
1.5	40.00	0.5850	1.12 %	46.86	68,050.65	377.20	503.87	68,427.85
2	46.22	0.6675	1.09 %	48.59	68,975.32	317.47	566.82	69,292.79
2.5	52.58	0.7534	1.07 %	49.69	69,577.77	266.95	635.35	69,844.72

(continued)

Table 55.2 (continued)

Overconfidence measure, λ	Strike price (K) in 1000s	Moneyness (K/S)	Percentage of firm given as options, (s)	Effort (Y)	Stockholders' Equity Value, SEV	Expected compensation, realistic stockholders' valuation	Expected compensation, managers' valuation	Sum of SEV and realistic expected compensation
	1	2	3	4	5	6	7	8
Panel E: $\gamma = 3$								
1	45.70	0.6801	2.09 %	44.49	66,732.83	513.41	513.41	67,246.24
1.5	53.94	0.7839	2.14 %	47.71	68,445.70	411.53	639.26	68,857.23
2	62.52	0.8969	2.28 %	49.52	69,438.59	319.32	795.50	69,757.91
2.5	71.28	1.0142	2.49 %	50.66	70,086.17	243.48	992.82	70,329.65
Panel F: $\gamma = 5$								
1	36.91	0.5325	1.08 %	48.73	68,964.71	400.77	400.77	69,365.48
1.5	43.74	0.6198	1.01 %	51.24	70,295.63	323.30	449.43	70,618.93
2	50.78	0.7127	0.97 %	52.59	71,038.19	258.80	504.00	71,296.99
2.5	57.95	0.8085	0.96 %	53.44	71,515.08	206.66	567.94	71,721.74
Panel G: N = 2,000								
1	44.54	0.5886	1.36 %	61.44	75,242.70	477.96	477.96	75,720.66
1.5	54.10	0.7013	1.31 %	64.39	76,830.62	364.92	565.18	77,195.55
2	63.94	0.8204	1.32 %	65.98	77,714.30	274.85	672.50	77,989.15
2.5	73.93	0.9426	1.37 %	66.97	78,277.56	205.29	804.84	78,482.85
Panel H: N = 6,000								
1	38.87	0.5977	1.41 %	40.15	64,656.11	421.35	421.35	65,077.47
1.5	45.30	0.6826	1.36 %	42.83	66,067.86	346.87	486.08	66,414.74
2	51.97	0.7745	1.35 %	44.31	66,875.94	279.15	557.17	67,155.09
2.5	58.80	0.8701	1.38 %	45.25	67,401.85	223.48	643.22	67,625.33

with lower expected managerial compensation according to the realistic expectation. This indicates that the qualitative results obtained from the base case prevail also for a host of other parameters.

In panels A and B, we examine the effect of the fixed wages on the results. A higher wage level implies a lower value for the option component of the compensation. Imposing the use of lower-valued options, stockholders choose options that are more responsive to cash flow changes. This is obtained by an increase in the ownership percentage and in the strike price. In panels C and D, we set the coefficient of variation, σ, which equals 0.3 in the base case, to 0.2 and 0.4, respectively. We observe in panel D that facing a higher coefficient of variation, managers prefer a compensation that is less sensitive to firm cash flows, which is achieved by selecting a contract specifying a smaller ownership fraction and a lower strike price. Finally, in panels E and F, we observe the effects of varying risk aversion and in panels G and H those of varying effort aversion. Overall, higher risk aversion levels are associated with less risky compensations as they induce optimal contracts with a smaller option ownership percentage and a lower strike price. Higher effort aversion results in lower SEV and also in lower total monetary welfare.

The above sensitivity analysis shows that the effect of changing the parameters quite conforms to intuition, adding to the robustness of our results. We also note that regardless of the parameters considered, the effect of overconfidence on the qualitative behavior is the same as that observed from the base case. In particular, the higher the overconfidence, the higher the optimal strike prices and the closer they are to the at-the-money levels.

55.5 Conclusion

Our study suggests an explanation for the puzzling questions of why most incentive stock options are issued with at-the-money strike prices. This practice seems arbitrary and beyond its institutional appeal and its expired tax advantages; its main theoretical backing is that it provides the highest sensitivity to stock price. Several studies however have shown that in many cases it is inferior to awarding in-the-money options. Our analysis demonstrates that the optimal strike prices of incentive stock options when managers are overconfident are higher than the corresponding strike prices when managers are realistic, and are closer to the at-the-money strike prices awarded in practice. This makes at-the-money options more attractive to overconfident managers, and hence, given the ubiquity of overconfident managers, it provides support for the popularity of awarding such options. We also show that overoptimistic CEOs receive lower compensation than their realistic counterparts and that the stockholders benefit from their managers' bias. The combined welfare of the firm's stakeholders however is positively related to managerial overconfidence, hence providing support to the survival of managerial overconfidence.

Assef and Santos (2005) interpret the strike price as an intermediate instrument (between wages and stocks) in the incentive schemes for managers. Similarly one can interpret an in-the-money strike price as an intermediate instrument between a stock (zero strike price) and an at-the-money option. Since in practice, because of institutional reasons or inertia, firms are constrained to choose options with at-the-money strike price, they achieve their instrumental in-the-money strike price by choosing an appropriate weight of options relative to stock grants in their compensation contract. According to such an interpretation and from our results showing that higher overconfidence implies higher strike prices, it follows that the observable weight of options in the compensation contract may serve as a proxy for an unobservable degree of confidence.

Appendix 1

In this appendix we expand on the simulations we conduct. These simulations are intended to identify the contracts that yield the highest stockholders' equity value subject to manager's incentive compatibility and participation constraints. That is, the managers choose their effort optimally, and their resulting expected utility equals a predetermined level representing their alternative opportunities. Because we are studying the impact of overconfidence on the strike price, our calculations focus on the trade-off between the strike price and the fraction of the company that is awarded as options. For simplicity, we consider contracts that include only a fixed wage and options.

The first step in our simulation is the selection of the appropriate distribution of the company's cash flow as a function of managerial effort and the manager's utility as a function of managerial effort and compensation. In accordance with conventional assumptions in the options literature, we assume that the firms' cash flows, X, are lognormally distributed with the distribution function (55.1) where Y denotes the managerial extra effort (a managerial choice variable) and $\mu(Y)$ and σ denote, respectively, the mean and the standard deviation of the underlying normal distribution of the natural logarithm of X. We assume that managerial effort increases cash flows, that overconfident managers overestimate the impact of their effort on cash flows, and that the impact of effort on the mean of the natural logarithm of X is presented in Eq. 55.2.

We refer to Hek (1999) and Bitler et al. (2005) for the choice of the parameters and the shape of the manager's utility function that depends also on leisure.[16] We start with a base case of parameters and repeat the analysis for a large set of parameters around the base case. We chose the base case so that these parameters and the deviations around them that we also analyze cover the equivalent parameters used in similar studies. These simulations help verify that our results are robust to the choice of parameter values. They also are used to examine to what

[16]We found additional estimates of effort disutility (leisure utility) in the following papers: Dowell (1985), Kiker and Mendes de Oliveira (1990), and Prasch (2001). These estimates varied in the functional form as well as in the level of effort aversion.

extent the effects of changes in the parameter values on the outcomes coincide with economic intuition.

The parameter μ_0 serves as a numeraire for the other cash flows related parameters, and is chosen, without loss of generality, to equal 45,000. That, in the absence of managerial extra effort, the expected value of the company's cash flows is 45,000. Since the expected cash flows serve as numeraire, the ratio of the standard deviation of the cash flows per share to their expected value is a surrogate for the standard deviation of stock returns. Since Hall and Murphy (2000) used a standard deviation of 0.3, we chose this value also for our base case coefficient of variation.

The appropriate measure of risk aversion is harder to agree upon. Early estimates of risk aversion put this variable at around two (see, e.g., Mehra and Prescott 1985), but they are based on aggregate data and not on CEO compensation data.[17] In our study, in line with more advanced econometric methods (see, e.g., Campbell et al. 1996), we prefer using a base case risk aversion measure of four, slightly higher than the measure of three suggested by Malmendier and Tate (2008) and Hall and Liebman (1998). Our simulations (see, e.g., Glasserman 2003) and sensitivity analysis, of course, cover these parameters as well.

The next step in the simulation process is to identify, for each overconfidence level, the executive options' strike price that is optimal for stockholders. All the simulations were conducted using Mathematica. Because it is not possible to express the equity value as an explicit function of the strike price, we search for the optimal strike price by calculating the equity values that are associated with a set of discrete strike prices. Our search was facilitated by assuming that the stockholders know the manager's reservation expected utility. We assume that reservation utility to equal the utility obtained from a fixed salary of 100 with no extra effort.

For any given wage, the strike price and the fraction of the company awarded to the manager (which is a continuous variable representing the number of options the manager receives; we will henceforth use the latter expression) determine the value of the options to the managers and their cost to the stockholders. For each strike price and number of options, we then find the effort that the manager chooses to apply in order to maximize his/her expected utility Eq. 55.3. For each given strike price, the stockholders, well aware of the managers' reactions, will offer them the number of options that yield their reservation utility. We calculate the value of the stockholders' equity for each strike price (in thousands of dollars, using two digits beyond the decimal point) and identify the strike price that yields a maximum for stockholders' equity.

For each set of parameters for the cash flow distribution function and the managerial utility function, as well as for the several values of fixed salary (50 for the base case, 25 and 75 for the presented robustness simulations), we obtain the optimal effort, stockholders' equity value, and the expected managerial

[17]Similar estimates are provided in other contexts by Carpenter (2000), Constantinides et al. (2002), Epstein and Zin (1991), Friend and Blume (1975), and Levy (1994).

compensation according to the manager's overconfident view and the stockholders' realistic expectations. We repeat these simulations for several values of the overconfidence measure λ. Presented here however are just four such values: 1 for the realistic expectations and 1.5, 2, and 2.5 for increasing levels of overconfidence. We used quite a few simulations but choose to present a subset of the results as all showed the same qualitative results. In addition to verifying the robustness of the results to the choice of the parameter values, they also help examine to what extent the effects of changes in the parameter values on the outcomes coincide with economic intuition.

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