What Determines How Top Managers Value their Stock Options?

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Abstract

What determines how top managers value their executive stock options? We explore this question empirically by using a unique survey data set which combines subjective option valuation data with a wide set of individual-level variables. Inconsistent with the predictions of theory, individuals in our data set substantially overvalue the options they receive. Optimism and overconfidence (miscalibration) measures are significantly related to option values, whilst measures of risk aversion show no relationship. When managers are very optimistic about company stock they attribute higher values to their options. This finding is consistent with the implicit assumption in Malmendier and Tate (2005, 2007) and Malmendier et al. (2007). These papers assume that managers who overestimate future stock prices value their options higher and exercise at later points. We also find that less overconfident (miscalibrated) managers put higher values on their options.

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1 Introduction and Motivation

Recent academic research has provided many theoretical and empirical insights relating to compensation with executive stock options (ESOs). Issues receiving attention in research have included the reasons for using stock options, the effects of ESOs on firm performance, the economic costs of options and whether stock options provide opportunities for manipulation or the use of insider information.[1]

Despite current progress in the understanding of how stock options work, there is still relatively little empirical evidence about how managers and employees subjectively value the stock options they are holding. Core, Guay and Larcker (2003) therefore conclude in their widely cited survey on equity-based compensation that "an interesting question for future research is to examine how executives actually value their stock options."[2] The lack of empirical research on ESO values is largely due to widespread data limitations. If one really wants to understand these valuations, one simultaneously needs information about subjective option values and about individual characteristics (such as risk aversion, loss aversion or stockholdings). Unsurprisingly, companies rarely give researchers the opportunity to ask their managers and employers questions about their personal option valuations and their individual traits (for instance, their forecasts regarding company stock). This dearth of data has regrettably meant that many of the potentially valuable theoretical and practical insights to be gained from studying subjective option valuations have remained hidden from view.

The accounting costs of stock option programs, for instance, crucially depend on how

[1] Reviews covering these topics are provided by Murphy (1999), Core et al. (2003).

[2] Core et al. (2003), p. 43.

individuals value and, as a consequence of this valuation, exercise their options.[3] Existing accounting rules allow firms to adjust the costs of stock options to account for early exercise decisions. Firms can employ, for example, modified valuation models that use, as an input parameter, the expected time until exercise instead of the original time to maturity for valuing granted options (see Hull and White, 2004). Ignoring undervaluations of options and early exercises would result in adverse effects on firms' reported earnings due to an overestimation of the ESO programs' accounting costs.[4] A precise estimation of an ESO's expected life therefore requires an understanding not only of how the workforce actually values granted options, but also to what extent these values vary with individual characteristics (and hence differ within an organization).

Economic models of stock option compensation assume that individuals understand how the incentive effects of stock options work and how the value of option packages is determined. But if option holders do not understand the basics underlying stock option plans (for example, if they systematically misprice options), then it is likely that the incentive effects of stock options will not work as intended (see Core et al., 2003). Heterogeneous and possibly incorrect option valuations have further ramifications for the general efficiency of stock options as a compensation device. If some individuals heavily discount option values while others value them highly, then efficient contracting suggests that individuals with low option valuations should rather be remunerated with other compensation forms that produce lower costs for the issuing firm. To assess the efficiency of option compensation, an estimate of individuals' subjective option values is therefore needed.

[3] Note that exercise decisions of individuals and their subjective option values are related as individuals that place lower values on their option holdings will also exercise at earlier points in time (see below for details).

[4] Recall that new accounting rules require firms to expense the costs of ESO plans. See IFRS 2 "Share-based Payment" for IAS/IFRS and FAS 123R for US-GAAP.

Understanding the link between subjective option valuation (and the resulting exercise behavior) and individual characteristics is also important from a corporate finance perspective. A recent literature, pioneered by Malmendier and Tate (2005, 2007) and Malmendier et al. (2007), uses the timing of option exercises as a proxy for managerial overconfidence (hereby defined as the overestimation of mean future stock prices). This measure of overconfidence is later used to explain corporate investment decisions, M&A activity and capital structure choices. The methodology used by Malmendier and Tate (2005, 2007) and Malmendier et al. (2007) implicitly assumes that managers who overestimate their abilities to increase the stock price will value their stock options higher. As a result of that, they will eventually also exercise at later points in time. Whether or not this assumption is justified, however, has not been tested yet due to a lack of data.

Recent research by Bergman and Jenter (2007) and Oyer and Schaefer (2005) incorporates excessive employee optimism into option compensation frameworks using sentiment stories. They predict that employees generally do not value their options as suggested by existing valuation models and argue that firms grant stock options when their boundedly rational employees are overoptimistic about the firm's stock price. Empirical research on whether overconfidence or optimism really affects the subjective valuation of options is, however, far from mature and survey-based research can be very helpful to understand the effects of managers' expectations on ESO values.

Using a unique survey data set based on a questionnaire distributed to senior top managers in one of Europe's largest corporations, we empirically investigate the option valuations of top managers. In particular, we study to what extent individual characteristics of these managers are correlated with their option valuations. We are not aware of other research papers that can use the kind of data that is available for our analysis. Our main findings

are as follows. We document a strong heterogeneity in the values managers place on their options. The average manager in our data set values his stock options substantially above the Black-Scholes value. On average, a manager assigns a value of about 31 Euro to an option with a fair (Black-Scholes) value of about 26 Euro. We find that option values are unrelated with different measures of risk aversion. Our results indicate that optimism and overconfidence (miscalibration) measures are significantly correlated with option values. More specifically, our evidence suggests that managers who are more optimistic about company stock and the stock market as a whole place higher values on their ESOs. Our results are consistent with the implicit assumption in recent corporate finance papers such as Malmendier and Tate (2005, 2007) and Malmendier et al. (2007). In these papers it is assumed that managers that overestimate future stock prices put higher values on their stock options and exercise at later points in time. Our finding is also consistent with the sentiment hypothesis presented by Oyer and Schaefer (2005) and Bergman and Jenter (2007). In addition, we find that more overconfident (miscalibrated) managers place a lower value on their options.

The findings of this paper should certainly not be taken as final and definite as they rely on a study of a single organization. Nevertheless, our analyzes and results are important as they provide a first attempt to narrow the existing gap between theoretical and empirical research on subjective option valuation. Moreover, they give support to a recent line of corporate finance research that assumes that option valuation/exercise decisions and the overestimation of stock prices by managers are related.

The remainder of this paper is organized as follows: Section 2 discusses the theoretical background and related empirical research that studies the values individuals place on their ESOs. The data set and the methodology are presented in Section 3. Section 4

contains descriptive results, defines the variables and presents summary statistics on individual characteristics. Section 5 studies the determinants of individuals' option values. Finally, Section 6 summarizes our results and concludes.

2 Theory and Related Literature

2.1 Stock Option Valuations: Theory and Predictions

It is well-known that standard option pricing models are not appropriate for determining the value individuals place on their stock options. Economic theory has shown that risk aversion, diversification, and wealth need to be taken into account to explain the option valuations of participants in ESO plans.[5] Several theoretical studies hereby explicitly model option values as a function of risk aversion, diversification, and wealth. Examples for these studies are the papers by Lambert, Larcker and Verrecchia (1991) and Hall and Murphy (2000, 2002) which suggest that subjective options values should be decreasing in individuals' risk aversion and company stockholdings but increasing in outside wealth. Important conclusions from these modelling approaches are (i) that risk averse, undiversified and less wealthy individuals should value their stock options significantly below the Black-Scholes value and (ii) that differences in personal characteristics can lead to significant heterogeneity in option valuations within an organization.[6] In line with these

[5]Note that option values and exercise decisions are linked as lower individual option values lead to earlier exercise decisions. A stock option will generally be exercised whenever an employee's expected utility from exercising is greater than the expected utility form holding the option for another time period (see Huddart, 1994, Carpenter, 1998 or Bettis et al., 2005).

[6]Bettis et al. (2005) and Hemmer et al. (1996) have shown that exercise decisions and hence also option values further depend on firm characteristics such as dividend payments or stock price volatilities. We disregard these aspects as we do not study a cross-section of firms but rather focus on heterogeneity in individual-level variables within one organization.

studies, Sautner and Weber (2006) argue that individuals with a highly firm-specific human capital will also discount option values more heavily as their human capital is less diversified.

Beyond these four variables, a set of other individual characteristics has also been linked to option valuations. Massey (2003), for example, argues that more loss averse individuals should exhibit lower option valuations. He argues that loss aversion causes employees to put more weight on potential losses than on potential gains.[7] As stock options can either appreciate or decrease in value relative to a certain reference point (e.g. relative to past exercise gains), more loss averse individuals will consider the lottery structure implied in options as less attractive and hence discount option values more heavily. ESO values may also vary across managers because of differences in the individual level of optimism (see Malmendier and Tate, 2005, 2007, Malmendier et al., 2007, Oyer and Schaefer, 2005 and Bergman and Jenter, 2007). Optimistic managers believe that future stock returns are higher than they actually are. As option valuations are an increasing function of the underlying stock price, overoptimistic managers should place higher values on their stock options compared to their less optimistic colleagues.[8]

Managers that are overconfident (miscalibrated) assign confidence intervals to their estimates of future stock prices (e.g. of the own firm) that are too tight. Overconfidence then has two simultaneous but reverse effects on option values. On the one hand, overconfidence reduces the subjective value put on an option as the convexity of an option's payoff is undervalued. On the other hand, it also increases value as the risk that is underlying an

[7] See Kahnemann and Tversky (1979).

[8] Evidence suggesting that people regularly believe that more favorable events occur more often than they actually do can be found in Weinstein (1980) or Ito (1990).

option is underestimated (see Henderson, 2005). Which of these two effects actually dominates and whether overconfidence overall has a positive or negative effect on subjective option values is therefore an empirical question.

Massey (2003) uses prospect theory to argue that narrow bracketing can also affect option values. He claims that an individual that does not integrate his stock options into his total wealth, i.e. suffers from narrow bracketing, will consider ESOs as less attractive and will therefore lower his subjective valuation of a given option package. Myopia is related to the concept of narrow bracketing as it can be considered as a form of narrow bracketing over time. One can therefore expect that individuals with very myopic perspectives concerning stock price changes will regard ESOs as less attractive compared to less myopic individuals. The frequency by which individuals observe potential exercise gains of their option holdings (e.g. on the firm's web page) reflects their attention towards ESOs and is also likely to be correlated with personal option values, even though the direction of this relationship is not clear ex ante.

Overall, economic arguments hence predict that subjective option valuations should significantly depend on individuals' risk aversion, stockholdings, wealth, firm-specificity of human capital, loss aversion, optimism, overconfidence (miscalibration), narrow bracketing, myopia, and the frequency by which potential exercise gains are supervised. Table 1 summarizes the predicted relationships between these characteristics and ESO values. Hereby, "+" means that a model or theory predicts an increase in the subjective option value with an increase in the respective variable. "-" likewise means that a model or theory predicts a decrease in the subjective option value with an increase in the variable. "?" means that no testable prediction is possible ex ante.

2.2 Related Empirical Literature on Stock Option Valuations

Surprisingly, only few studies empirically investigate how individual managers and employees actually value the stock options they are holding. This is mainly due to the prevalent reservation of most firms with respect to questionnaires on their own ESO plans. Existing studies therefore try to circumvent this problem by surveying students or newsletter readers with questions on non-existing and virtual stock options. Lambert and Larcker (2001), for example, base their study on a survey of 122 knowledge@wharton readers. They asked these readers how much their employing companies would have to offer them to return a fully vested but imaginary stock option (they hence asked for individuals' certainty equivalents). Their results show that individuals substantially overvalue options relative to the theoretical Black-Scholes value. Young readers working at low management grades hereby seem to show the highest upward bias in their option values. Lambert and Larcker further document that higher expectations for future stock prices (optimism) are also correlated with higher option values.

The research by Hodge et al. (2005) is based on a survey conducted with university students. In line with Lambert and Larcker, they asked their subjects how much money they would require to exchange an imaginary stock option. They also provide evidence suggesting that individuals value ESOs substantially above the Black-Scholes value. Most closely related to our work is a study by Massey (2003). He looks at the determinants of subjective option values for a real option program of a Fortune 100 firm. Massey finds that risk aversion and stock price expectations are significantly related to option values: more risk averse and less optimistic employees place lower values on their ESOs. Moreover, he documents that loss aversion and mental accounting are negatively correlated with

individuals' option values. Our paper differs from Massey (2003) in that we focus on top managers rather than employees in a broad-based stock option plan. Moreover, we are able to use a wider set of individual-level variables compared to Massey (we can use, for example, information on managerial overconfidence which is of particular interest in a study on top managers). A recent paper by Farrell et al. (2006) looks at the impact of educational training programs on option valuations and finds that perceived option values are positively affected by education on the functioning of stock options.

3 The Data Set and the Institutional Set-Up

Our data set contains individual-level certainty equivalents for real and unvested stock options that were granted in March 2003. Using confidential paper-based questionnaires, we directly asked all 182 top managers of our sample company on the value they subjectively put on one of these stock options. Our data set further comprises comprehensive information on a wide set of manager-specific characteristics such as risk aversion, tenure or stock price expectations. We received a total of 77 survey responses yielding in a response rate of 42.31%. The survey was conducted in March and April 2005 (with one reminder). To avoid strategic and untruthful answering, we assured that all survey responses are treated confidentially. In particular, we guaranteed that neither the executive board nor the human resources department of the firm will be able to access the individual survey responses.

The individuals in our data set comprise the second (n = 19), third (n = 51) and fourth (n = 112) management level of the sample firm.[9] Seven managers of the second, 23 of the

[9]The company did not enable us to contact the executive board members (i.e. the first management level).

third, and 47 of the fourth level returned the questionnaires. The company that provided the option data is a member of the blue chip index Euro Stoxx 50. It is one of the largest in its industry worldwide and employs more than 80,000 people. The vesting period of the options we investigate ended in May 2005, and the subsequent exercise period runs until June 2011. To avoid insider conflicts, the company designed four closed periods per year within which options are not exercisable at all. Closed periods were set around calendar dates were quarterly or annual earnings are published. Each closed period encompasses two to six weeks.

We are aware that studies using survey data have natural shortcomings such as potential non-responses biases, biases resulting from differences in the interpretations of questions, or the problem of not measuring actions but beliefs.[10] Given that executive stock options are not traded and prices non-existent, we, however, think that the use of survey data is a promising way to get a better understanding of subjective option valuations and their determinants. In particular, we think that the possibility to ask *senior* managers on how they personally value a fully-fledged *real* stock option provides an exciting basis to address our research questions and outweighs potential survey shortcomings.

[10] See Hodge et al. (2005) for a discussion of these issues in the context of ESO surveys.

4 Subjective Option Valuations and Individual Characteristics: Descriptive Results

4.1 Descriptive Results on Subjective Option Valuations

To get a general idea on how the managers in our data set value their option holdings, we asked each individual for the certainty equivalent of one of his outstanding and unvested stock options (see Question B in the attached questionnaire). Table 2 provides summary statistics of the subjective stock option values that were thereby ascertained (in Euro). The table further contains information on how many of the stated option values were below and above the fair option value (in %). In March 2005, i.e. when most individuals filled in our questionnaire, the Black-Scholes value of an option of this grant was equal to 26.13 Euro.[11] This option value was disclosed to the individuals neither by us nor by the company.

The table shows that individuals on average value their stock options substantially *above* the Black-Scholes value. More specifically, individuals assign a mean (median) value of 30.96 Euro (30.00 Euro) to an option with a Black-Scholes value of 26.13 Euro. Roughly two-thirds of the option holders valued their ESOs above this value. The entire distribution of the stated option values is plotted in Figure 1. The numbers show that, even though we observe a strong general tendency to overvalue options, there is a lot of heterogeneity within the organization. Interestingly, there is also evidence that suggests that some managers severely discount the value of their options. Overall, our finding is in line with related empirical research that also documents this overvaluation effect (see Lam-

[11] This is the market value of the stock option under the assumption that the option can be traded.

bert and Larcker, 2001, Hodge et al., 2005 and Massey 2003). Note that our evidence is highly inconsistent with prevalent economic models that suggests that individuals should value stock options significantly *below* its Black-Scholes value as they are inherently undiversified (see, e.g., Lambert et al., 1991). Our results on the large heterogeneity of the elicited option values are important from an efficient contracting view. Efficient contracting suggests that individuals with low option valuations should rather be remunerated with other compensation forms that produce lower costs for the issuing firm (holding the incentive effects constant). Our results therefore imply that the sample firm could lower its compensation costs by having a better understanding on how their managers value granted stock options.

4.2 Descriptive Statistics on Individual Characteristics

To identify the variables of interest that are related to subjective option values, we used the arguments and predictions that were derived in Section 2. These variables will later be linked with the ascertained option values. Table 3 summarizes and defines the variables that are used in the subsequent empirical analysis.

Risk Aversion 1 measures a manager's self-reported degree of risk aversion (see Question C1 in the attached questionnaire). Individuals had to divide a given amount of money, 1,000,000 Euro, between a risky lottery[12] and a risk-free investment (safe return of 3%). The response range was between 0% (if everything was invested in the safe asset) and 100% (if everything was invested in the risky lottery). Clearly, the lower the proportion of wealth that is invested in the risky asset, the higher the degree of individual risk aversion.

[12] 50% probability that the investment increases by 30% and 50% probability that it decreases by 20%.

For the subsequent analysis, we classify answers below (equal to and above) the median response as high (low). *Risk Aversion 2* captures a manager's degree of risk aversion based on the certainty-equivalent method (see Question C2).[13] The lower the elicited certainty equivalent, the higher the degree of risk aversion. We again classify answers below (equal to and above) the median response as high (low). *Stockholdings* is the ratio of the value of an individual's company stockholdings to his total wealth (answers in %) (see Question A1). Responses below (equal to and above) the median response are classified as low (high). *Wealth* measures a manager's total wealth. We proxy wealth by the management level of an employee in the corporation. We classify individuals at the second and third management level as high, and those at the fourth level as low. Following May (1995) and Degeorge et al. (2004), we use tenure as a proxy for the firm-specificity of human capital (see Question D). *Firm-specificity of Human Capital* is hence measured by the number of years an individual has been working for the option granting company. We classify answers below (equal to and above) the median response as low (high).

Loss Aversion reflects an individuals's degree of loss aversion based on a stated certainty equivalent for a mixed lottery (see Question C3). Lower certainty equivalents hereby imply a lower degree of loss aversion.[14] We categorized answers into groups ranging from 1 to 4, with lower values indicating a lower degree of loss aversion. Answers below the median response were classified as low (low degree of loss aversion), and those equal to and above the median response as high (high degree of loss aversion).

[13] We elicited certainty equivalents based on a lottery that provides a 50% chance of winning an amount equal to 1,000,000 Euro and a 50% chance of winning nothing.

[14] To measure loss aversion, individuals had to decide on the participation or non-participation in a set of pre-specified lotteries. These lotteries had a 50% chance of a loss equal to 100,000 Euro and a 50% chance of a gain equal to X. We varied X between 25,000 Euro and 300,000 Euro.

A person's degree of optimism about the firm's stock price is captured by *Optimism Company* (see Question A2). It is based on a forecasting question about the expected return for company stock over a five-year horizon (responses in %). We classify answers below (equal to and above) the median response as low (high). Note that this variable captures what Malmendier and Tate (2005, 2007) and Malmendier et al. (2007) consider as "overconfidence" (overestimation of future stock prices). We define overconfidence as miscalibration with regard to the firm's stock price. *Overconfidence Company* is measured based on a forecasting question about upper and lower bounds of the firm's share price level over a five-year horizon (see Question A2). Following DeBondt (1998), we use these bounds to calculate confidence intervals (the difference between the upper forecast bound and the lower forecast bound, divided by the stock price level at the date of forecast and multiplied by 100).[15] Answers below (equal to and above) the median response were herby classified as high (low). *Optimism Market* measures an employee's general degree of optimism and is based on a forecasting question about the expected return for the German stock market index DAX over a five-year horizon. We again classify answers below (equal to and above) the median response as low (high). *Overconfidence Market* reflects a manager's degree of overconfidence based on a forecasting question for upper and lower bounds of the index level of the DAX (once more over a five-year horizon). Confidence intervals were again calculated using the methodology suggested by DeBondt (1998). We classify answers below (equal to and above) the median response as high (low).

A manager's degree of wealth integration is captured by *Narrow Bracketing* (see Question A3). Individuals responded on a five-point scale with the endpoints "1 = no wealth inte-

[15] If the current stock price is, for example, 10 Euro and a manager expects an upper bound of 13 and a lower bound of 8, our overconfidence measure would be $(13 - 8)/10 * 100 = 50$.

gration" and "5 = high level of wealth integration" to a question about their degree of narrow bracketing. Higher values hereby imply a lower degree of narrow bracketing. We classify answers below three (equal to and above) as high (low). We further measured how far individuals look ahead with respect to stock price changes and option values (*Myopia*). They responded on a six-point scale with the endpoints "1 = less than a week" and "6 = more than two years" (see Question A4). Answers below (above) two years are classified as high (low). *Frequency Supervision* finally measures how often an employee checks the exercise gains he can realize by exercising.[16] The managers responded on a seven-point scale with the endpoints "1 = several times a day" and "7 = less than once a month" (see Question A5). We consider answers below (equal to and above) 5 as high (low).

Summary statistics on our set of individual characteristics are provided in Table 4. Apart from the variables defined above, the table also includes information on the fraction of total wealth invested in equity (*Ratio Equity*), and on the fraction of equity holdings invested in company stock (*Ratio Company Stock*). The table shows that the average individual invested 36.19% in the risky lottery (*Risk Aversion 1*). The mean certainty equivalent for a 50% chance of winning 1,000,000 Euro and a 50% chance of winning nothing was 258,571 Euro (*Risk Aversion 2*). On average, managers in our sample invested 7.51% of their total wealth in company stock (median = 5.25%, std.dev. = 7.86%). As a fraction of his overall equity holdings, the average option holder has a considerable investment in company stock (41.88%). This figure displays that most individuals in our data set are highly undiversified. Their investment strategies contrast the recommendations given by Markowitz (1952) and Sharpe (1964) who suggest that people should hold well-diversified

[16]The company offered a web page where all managers can regularly check the gains they would realize by exercising.

portfolios.[17] Most people have been working for the company for a period of more than 20 years, which even deteriorates their diversification problems. The mean (median) value of tenure, our proxy for the *Firm-specificity of Human Capital*, is 22.74 years (24.00 years). The people in our sample seem to be very loss averse on average: the mean value of our categorial variable for loss aversion is equal to 3.31.[18] The average individual predicted a company stock return of 22.67% over the five-year horizon, with responses varying heavily between -28.90% and 77.75% (*Optimism Company*). Expected returns for the market index DAX (*Optimism Market*) turned out to be of similar size, with a mean value of 23.84% and a minimum (maximum) of -31.46% (82.77%). The average confidence interval is 45.34% for company stock (*Overconfidence Company*) and 50.30% for the DAX (*Overconfidence Market*). Most managers suffer from *Narrow Bracketing* and do not integrate their financial wealth (median = 2.00, mean 2.37). The median option holder looks less than two years ahead with respect to stock price changes and option values (*Myopia*), and checks his potential exercise gains several times a month (*Frequency Supervision*).

Table 5 presents pairwise correlations between our collected individual characteristics. It shows that our measures of risk aversion are consistent in the sense that higher risk aversion in the self-reporting treatment is significantly associated with higher risk aversion in the certainty equivalent treatment. Furthermore, we find that a higher degree of risk aversion (according to both risk measures) is also associated with a higher degree of loss aversion.

[17] Recent research by Meulbroek (2002) has explicitly shown how considerable the costs of such an insufficient diversification can be. Further evidence for non-diversification by employees can be found in the 401(k) literature, see Benartzi (2001) or Huberman and Sengmüller (2004) among others.

[18] One individual had a loss aversion value equal to 1, 12 individuals a value of 2, 20 a value of 3, and 35 individuals a loss aversion value of 4.

5 Empirical Results on Determinants of Subjective Option Valuations

Having looked at the elicited option values and the individual-level variables in our data set, we now formally investigate the heterogeneity in option valuations within our data set. Table 6 therefore presents correlation coefficients (Spearman's Rho) between the available personal characteristics and the perceived option values.[19] It further includes the significance level of each correlation as well as the number of observations used in calculating the respective correlation coefficient (Obs.).

The correlation analysis provides only little evidence that risk aversion is related to option values: both measures of risk aversion are unrelated with the subjective option values we elicited. This finding is consistent with the results in Sautner and Weber (2006) who find no association between risk aversion and exercise decisions using individual-level data. Higher holdings of company stock are surprisingly associated with higher option values which is inconsistent with our hypothesized direction. The correlation with our proxy for wealth is insignificant.

Both our optimism and our overconfidence measures are significantly associated with the stated option values. More optimistic and less overconfident managers seem to place higher values on their options compared to less optimistic and more overconfident managers. The coefficients for optimism have the anticipated signs. Our results are consistent with the implicit assumption in the recent corporate finance literature Malmendier and Tate (2005, 2007) and Malmendier et al. (2007) where it is assumed that managers that overestimate

[19] Given the size of the data set and taking missing values into account, we passed on doing regression analysis.

future stock prices put higher values on their stock options and exercise at later points in time. Our results are also consistent with the sentiment hypotheses presented in Oyer and Schaefer (2005) and Bergman and Jenter (2007). Their theories suggested that excessive optimism causes individuals to overvalue stock options. Furthermore, our overconfidence results are in line with the findings in Sautner and Weber (2006) and indicate that overconfidence (measured as miscalibration) significantly affects option values. Even though, we do not perform multivariate analyzes, the correlation matrix in Table 5 do not suggest that our optimism and overconfidence results are driven by a third variable.

Contrary to our prediction, we find no evidence suggesting that narrow bracketing and myopia are related to option values. The coefficient estimate of the frequency by which individuals supervise their exercise gains is, however, significantly correlated with option valuations. The more heavily the managers in our data set checked their potential exercise gains, the higher they value their option packages.

Table 7 complements the results in Table 6 and records subjective option values partitioned by whether the realization of a certain individual variable is high or low. It further presents p-values of a two-sample Wilcoxon rank-sum test (Mann-Whitney test) comparing the mean values of a certain variable for the high and low realizations. The variables and their respective realizations (high/low) are defined in Table 3.[20] The findings reinforce our conclusion that our measures of risk aversion only poorly explain the observed variation in option values in our data. The difference is neither economically large nor statistically significant for the two risk aversion groups. Individuals who are optimistic about company stock value their option with 32.17 Euro, while less optimistic managers

[20]Note that the analysis in Table 7 uses less information than the correlation analysis in Table 6. It is therefore not surprising that some variables turned out to be significant in the correlation analysis but not in grouping analysis.

placed an average value of only 28.65 Euro on their ESOs. The results for our overconfidence variables confirm the general conclusions we drew on the basis of the correlation analysis in Table 6.

6 Conclusion

Stock option programs constitute an important economic concern for issuing companies and for their employees. Little is known, however, about how individuals value their stock option packages. The absence of research has been sustained by data limitations concerning individual-level subjective option values. We have studied how top managers personally value their options and what the determinants of these option valuations are. To perform these tasks, we were able to use a unique data set combining survey-based subjective option values and detailed personal characteristics on a wide set of economic variables.

Our main findings can be summarized as follows. When individuals were asked how they subjectively value a real stock option in their portfolio, they reported values that were substantially in excess of the Black-Scholes option value. The average manager assigned a value of about 31 Euro to an option with a fair value of roughly 26 Euro. Our survey data suggested that the managers in our data set are highly undiversified with almost 42% of their equity holdings invested in company stock. The average individual predicted a company stock return of 22.67% over a five-year horizon with responses varying heavily between -28.90% and 77.75%. Moreover, most of the managers suffered from narrow bracketing and were very loss averse.

As to how individual characteristics affect option values, we found no statistically signif-

icant relationship between option values and measures of risk aversion. We found that optimism and overconfidence measures were significantly related to option valuations. Managers that are very optimistic about company stock seem to place higher values on their ESOs. Our results are consistent with the implicit assumption in recent corporate finance papers such as Malmendier and Tate (2005, 2007) and Malmendier et al. (2007). These papers assume that managers who overestimate future stock prices put higher values on their stock options and exercise at later points in time. Our finding is also consistent with the sentiment hypothesis presented by Oyer and Schaefer (2005) and Bergman and Jenter (2007). Their models suggested that excessive optimism causes individuals to overvalue ESOs. Consistent with Henderson (2005) and Sautner and Weber (2006), we also found that more overconfident managers assign lower values to their stock options.

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Table 1: **Predicted Relationship between Subjective Stock Option Values and Individual Characteristics**

This table reports predicted relationships between various individual characteristics and subjective stock option values. "+" means that a model or theory predicts an increase in the subjective option valuation with an increase in the variable. "-" means that a model or theory predicts a decrease in the subjective option valuation with an increase in the variable. "?" means that no prediction is possible.

Variable	**Predicted Sign**
Risk Aversion	-
Stockholdings	-
Wealth	+
Firm-specificity of Human Capital	-
Loss Aversion	-
Optimism	+
Overconfidence	?
Narrow Bracketing	-
Myopia	-
Frequency Supervision	?

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Table 2: **Subjective Option Values**

This table provides summary statistics of the subjective stock option values that were reported in the questionnaires (in Euro). We asked individuals for their certainty equivalents of an outstanding and unvested option. The options were issued in 03/2003, vest in 07/2005, and expire in 06/2011. The table presents the mean, the median, the minimum, the maximum, and the standard deviation of the stated subjective option values. It further includes the number of observations that was available. The table also contains information on how many of the reported option values were below (above) the Black-Scholes option value (in %). In March 2005, i.e. when most individuals filled in the questionnaire, the fair value of the stock option was equal to 26.13 Euro.

Subjective Option Value **(in Euro)**			
Mean	30.96	Median	30.00
Min.	13.00	Max.	46.00
Std.dev.	8.60	Obs.	75
Stated Value $\leq$ Fair Value	36.00%	Stated Value $>$ Fair Value	64.00%

Figure 1: Distribution of Subjective Option Values in Euro

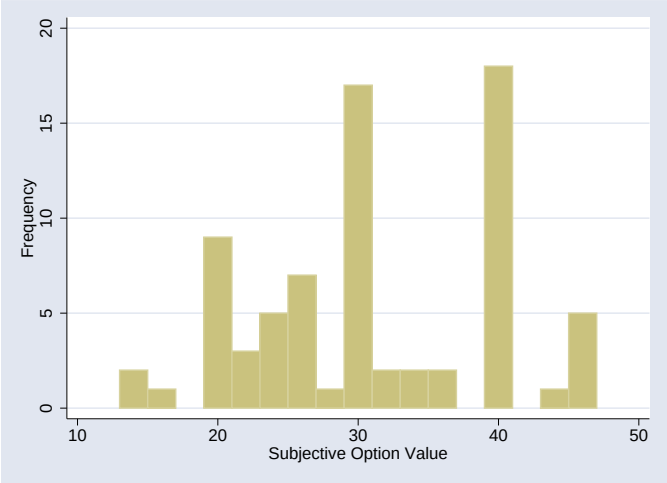


Table 3: **Definition of Variables**

This table summarizes and defines the variables used in the empirical analysis.

Variable	**Description**
Risk Aversion 1	Measures a manager's self-reported degree of risk aversion. We classify answers below (equal to and above) the median response as high (low).
Risk Aversion 2	Measures a manager's degree of risk aversion based on the certainty-equivalent method. We classify answers below (equal to and above) the median response as high (low).
Stockholdings	Is defined as the ratio of the value of a manager's company stockholdings to his total wealth. We classify answers below (equal to and above) the median response as low (high).
Wealth	Measures a manager's wealth. We proxy wealth by the grade of an employee in the company. We classify employees at the second and third management level as high, and those at the fourth level as low.
Firm-specificity of Human Capital	Measures a manager's firm-specificity of human capital. We proxy it by the number of years an employee has been working for the company. We classify answers below (equal to and above) the median response as low (high).
Loss Aversion	Measures a manager's degree of loss aversion based on a stated certainty equivalent for a mixed lottery. We classify answers below the median response as low (low degree of loss aversion), and those equal to and above the median response as high (very loss averse)
Optimism Company	Measures a manager's degree of optimism based on a forecasting question about the expected return of company stock over a five-year horizon. We classify answers below (equal to and above) the median response as low (high).
Overconfidence Company	Measures a manager's degree of overconfidence (miscalibration) based on a question concerning upper and lower bounds for the price level of company stock over a five-year horizon. Confidence intervals are calculated as the difference between the high forecast and the low forecast, divided by the stock price level at the date of forecast multiplied by 100. We classify answers below (equal to and above) the median response as high (low).
Optimism Market	Measures a manager's degree of optimism based on a forecasting question about the expected return for the German stock market index DAX over a five-year horizon. We classify answers below (equal to and above) the median response as low (high).
Overconfidence Market	Measures a manager's degree of overconfidence (miscalibration) based on a question concerning upper and lower bounds of the index level of the German stock market index DAX over a five-year horizon. Confidence intervals are calculated as the difference between the high forecast and the low forecast, divided by the index level at the date of forecast multiplied by 100. We classify answers below (equal to and above) the median response as high (low).
Narrow Bracketing	Measures a manager's degree of wealth integration. Managers responded on a five-point scale with the endpoints "1 = no wealth integration" and "5 = high level of wealth integration". We classify answers below three (equal to and above) as high (low).
Myopia	Measures how far a manager looks ahead with respect to stock price changes and option values. Employees responded on a six-point scale with the endpoints "1 = less than a week" and "6 = more than two years". We classify answers below (above) two years as high (low).
Frequency Supervision	Measures how often a manager checks the potential exercise gains of his stock options. Employees responded on a seven-point scale with the endpoints "1 = several times a day" and "7 = less than once a month". We classify answers below (equal to and above) 5 as high (low).

Table 4: **Descriptive Statistics on Individual Characteristics**

This table provides summary statistics on an extensive set of individual characteristics. Among other variables, it encompasses an individuals' degree of risk aversion, his stockholdings, his wealth, his firm-specificity of human capital, his optimism, and overconfidence. The variables are defined in Table 3. The table also includes information on the fraction of total wealth that is invested in equity (*Ratio Equity*). Moreover, it contains the percentage of equity holdings that is invested in company stock (*Ratio Company Stock*). The table contains means, medians, minimums, maximums, and standard deviations of all variables. It further includes the number of observations of the respective variables (Obs.). Summary statistics were calculated on the basis of 77 returned questionnaires (and on the basis of confidential information provided by the company (*Wealth*)).

Variable	**Mean**	**Median**	**Min.**	**Max.**	**Std.dev.**	**Obs.**
Risk Aversion 1 (in %)	36.19	30.00	0.00	100.00	28.08	77
Risk Aversion 2	258,571	250,000	50,000	650,000	157,648	70
Ratio Equity (in %)	20.45	15.00	5.00	65.00	13.43	77
Ratio Company Stock (in %)	41.88	25.00	5.00	95.00	29.61	77
Stockholdings (in %)	7.51	5.25	0.25	48.75	7.86	77
Wealth	3.51	4.00	2.00	4.00	0.68	182
Firm-specificity of Human Capital	22.74	24.00	10.00	35.00	5.59	77
Loss Aversion	3.31	4.00	1.00	4.00	0.82	68
Optimism Company (in %)	22.67	24.42	-28.90	77.75	20.84	68
Overconfidence Company (in %)	45.34	37.33	7.11	106.65	25.11	59
Optimism Market (in %)	23.84	25.66	-31.46	82.77	20.55	68
Overconfidence Market (in %)	50.30	45.69	9.14	159.93	31.34	60
Narrow Bracketing	2.37	2.00	1.00	5.00	1.33	75
Myopia	4.88	5.00	1.00	6.00	1.22	76
Frequency Supervision	5.13	5.00	2.00	7.00	1.53	76

Table 5: **Correlation Coefficients Individual Characteristics**

This table presents pairwise correlations between the set of individual-level characteristics. It further includes the number of observations used in calculating the correlation coefficient. * indicates significance at 10%, ** indicates significance at 5%, *** indicates significance at 1%.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
Risk Aversion 1 (1)	1.00														
	77														
Risk Aversion 2 (2)	0.58***	1.00													
	70	70													
Ratio Equity (3)	0.17	0.05	1.00												
	77	70	77												
Ratio Company Stock (4)	-0.09	-0.14	-0.26**	1.00											
	77	70	77	77											
Stockholdings (5)	0.04	-0.05	0.60***	0.45***	1.00										
	77	70	77	77	77										
Wealth (6)	-0.09	-0.11	-0.13	-0.03	-0.15	1.00									
	77	70	77	77	77	182									
Firm-spec. of HC (7)	-0.28**	-0.14	-0.35***	-0.03	-0.24**	0.26**	1.00								
	77	70	77	77	77	77	77								
Loss Aversion (8)	-0.40***	-0.67***	-0.09	0.02	0.00	0.03	0.09	1.00							
	68	66	68	68	68	68	68	68							
Optimism Company (9)	0.10	0.15	0.12	-0.01	0.07	0.16	-0.25**	-0.14	1.00						
	68	62	68	68	68	68	68	61	68						
Overconfidence Company (10)	0.11	0.20	0.11	-0.04	0.27**	0.06	-0.08	-0.06	0.54***	1.00					
	59	53	59	59	59	59	59	59	59	59	59				
Optimism Market (11)	0.11	0.13	0.13	-0.10	-0.07	0.14	-0.26**	-0.21	0.71***	0.36***	1.00				
	68	61	68	68	68	68	68	60	67	58	68				
Overconfidence Market (12)	0.13	0.29**	0.06	-0.03	0.07	0.15	-0.15	-0.17	0.47***	0.72***	0.55***	1.00			
	60	54	60	60	60	60	60	54	60	58	60	60			
Narrow Bracketing (13)	0.15	0.12	0.23**	-0.08	0.15	-0.10	-0.23**	-0.30**	0.01	0.30**	0.01	0.15	1.00		
	75	68	75	75	75	75	75	66	67	58	67	59	75		
Myopia (14)	0.16	0.26**	0.16	0.01	0.02	-0.07	-0.15	-0.33**	0.21*	0.17	0.12	0.02	0.24	1.00	
	76	70	76	76	76	76	76	67	67	58	67	59	74	76	
Freq. Supervision (15)	-0.15	-0.12	-0.03	-0.17	-0.13	-0.01	0.16	0.27**	-0.06	-0.35***	-0.18	-0.27**	0.06	-0.01	1.00
	76	69	76	76	76	76	76	67	68	59	68	60	74	75	76

Table 6: **Correlation Coefficients between Subjective Option Values and Individual Characteristics**

This table presents correlations (Spearman's Rho) between subjective option values for and an extensive set of individual-level characteristics. It further includes the significance level of each correlation coefficient as well as the number of observations used in calculating the correlation coefficient (Obs.). The variables are defined in Table 3. * indicates significance at 10%, ** indicates significance at 5%, *** indicates significance at 1%.

Variable	**Spearman's Rho**	***p*-value**	**Obs.**
Risk Aversion 1	0.0661	0.5729	75
Risk Aversion 2	0.1247	0.3112	68
Stockholdings	0.2450**	0.0341	75
Wealth	0.0183	0.8760	75
Firm-specificity of Human Capital	-0.1610	0.1675	75
Loss Aversion	-0.1806	0.1467	66
Optimism Company	0.2984**	0.0150	66
Overconfidence Company	0.3327**	0.0107	58
Optimism Market	0.1553	0.2130	66
Overconfidence Market	0.2573**	0.0491	59
Narrow Bracketing	0.0162	0.8918	73
Myopia	0.1752	0.1354	74
Frequency Supervision	-0.2887**	0.0126	74

Table 7: **Determinants of Subjective Option Values**

This table records the subjective option values partitioned by whether the realization of a certain variable is high or low. It further presents p-values of a two-sample Wilcoxon rank-sum test (Mann-Whitney test) comparing the mean values of a certain variable for the high and low realizations. The variables and their realizations (high/low) are defined in Table 3. The table further contains the number of observations (Obs.) for the respective variable realizations.

	Risk Aversion 1			*Risk Aversion 2*			*Stockholdings*		
	High	Low	p-value	High	Low	p-value	High	Low	p-value
Subjective Option Value	30.96	31.16	0.8195	30.04	31.18	0.6216	32.46	29.50	0.1256
Obs.	32	43		23	45		37	38	
	Wealth			*Firm-specificity of HC*			*Loss Aversion*		
	High	Low	p-value	High	Low	p-value	High	Low	p-value
Subjective Option Value	30.55	31.22	0.6831	30.20	31.88	40.28	29.97	32.63	0.2303
Obs.	29	46		33	28		34	32	
	Optimism Company			*Overconfidence Company*			*Optimism Market*		
	High	Low	p-value	High	Low	p-value	High	Low	p-value
Subjective Option Value	32.17	28.65	0.1058	28.38	32.70	0.0564	32.28	29.13	0.1449
Obs.	35	31		22	21		36	30	
	Overconfidence Market			*Narrow Bracketing*			*Myopia*		
	High	Low	p-value	High	Low	p-value	High	Low	p-value
Subjective Option Value	28.84	33.63	0.0357	31.06	30.76	0.9014	29.12	32.15	0.1337
Obs.	25	27		48	25		26	48	
	Frequency Supervision								
	High	Low	p-value						
Subjective Option Value	35.10	29.45	0.0186						
Obs.	21	53							

APPENDIX

Questionnaire

(translated into English)

Some General Questions

A1.) First of all, we would like to ask you some questions on the importance of equity holdings within your private investment portfolio.

What percentage of your total wealth (including savings, shares, mutual funds, bonds, life insurance, home equity etc.) is currently approximately invested in stocks and mutual funds including stocks? (please mark)

O 0 % O 1 – 10 % O 10 – 20 % O 20 – 30 % O 30 – 40 % O 40 – 50 %

O 50 – 60 % O 60 – 70 % O 70 – 80 % O 80 - 90 % O 90 – 100 % O I do not know

What percentage of your total wealth invested in stocks is currently invested in [Company Name] stocks? (please mark)

O 0 % O 1 – 10 % O 10 – 20 % O 20 – 30 % O 30 – 40 % O 40 – 50 %

O 50 – 60 % O 60 – 70 % O 70 – 80 % O 80 - 90 % O 90 – 100 % O I do not know

A2.) In the next questions, we would like you to make three statements concerning your forecasts of future stock market index levels/stock market prices.

The statements should be made such that the correct index level/market price (for instance in the first question, the value of the Deutsche Aktienindex DAX in five years) should...

… with a high probability (95%) not fall short of the Lower Bound (i.e. with 95% probability, it should be above your lower bound)

… should equally likely be above respectively below the Estimate (i.e. with a probability of 50% it should not be below your Estimate and with a probability of 50% it should not be above your Estimate)

… with a high probability (95%) not exceed the Upper Bound (i.e. with 95% probability, it should be below your Upper Bound)

	Estimate	Lower Bound	Upper Bound
Value of the DAX (Deutscher Aktienindex) in five years (17.02.2005: 4.377.05)			
Value of the EURO-STOXX 50 in five years (17.02.2005: 3,077.03)			
Stock price of the [Company Name] stock in five years (17.02.2005: X€)			

A3.) We would now like to ask you to provide an answer to the following statement:

"My activity within the executive stock option program is part of my overall investment strategy. Therefore, I try to make my private stock investments in a way that takes my positions in executive stock options into account" (please mark)

I totally disagree				I totally agree
1	2	3	4	5
O	O	O	O	O

A4.) In the subsequent questions, we are interested in how far you look into the future if you make estimates for the stock price of [Company Name] and how often you check potential exercise gains of your executive stock options.

If you consider your stock options and the future stock price of [Company Name], how far do you look ahead?

O less than one week	O one week	O one month	O three months
O 6 months	O 1 year	O 2 years	O more than 2 years

A5.) Please now fill in the following statement:

"To find a good moment to exercise my stock options, I check potential exercise gains on the webpage of the stock option program… ." (please mark)

O several times a day	O once a day	O several times a week	O once a week
O several times a month	O once a month	O less than once a month	

Question About Your Subjective Stock Option Valuation

Please now consider the stock options that you received within the executive stock option program [Name of the ESO program]. The exercise period of the options in this program starts on July 1, 2005 and terminates on June 30, 2011.

B.) How much does your company need to pay you <u>today</u> in order to return one of the options of this executive stock option plan? (please mark)

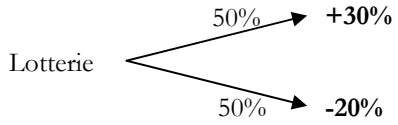
At least …	14 €	16 €	18 €	20 €	22 €	24 €	26 €	28 €	30 €	32 €	34 €	36 €	38 €	40 €	42 €	44 €	46 €
	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I

Some Questions About your Attitude towards Risk

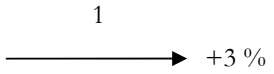
C1.) Question 1:

Please imagine the following situation:

You can invest money in a lottery (a risky investment). The invested amount of money can either increase in value by 30% or decrease in value by 20%. Both outcomes have a probability of 50%.



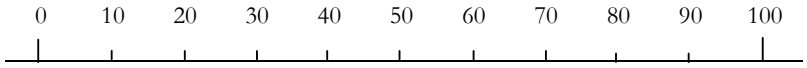
Alternatively, you can also invest your money in a risk-free asset. The money invested there will for sure appreciate in value by 3%.



You have 1,000,000 Euro to invest.

How much would you invest in such a situation in the lottery (risky investment) and how much in the risk-free asset?

Please indicate you answer on the following scale (from 0 to 100). Hereby, 0 means that you invest all the money in the risk-free asset and 100 means that you invest all the money in the lottery. (please mark)



C2.) Question 2:

In the following situation, you can choose between a lottery and a sure payment.

The lottery pays out either 1,000,000 Euro or 0 Euro. Each outcome has a probability of 50%.

The sure payment varies between 100,000 Euro and 900,000 Euro.

Please mark for each of the different values of the sure payment, whether you prefer the lottery or the sure payment

Lottery	Sure payment…	I prefer the sure payment	I prefer the lottery
	900,000 Euro	O	O
	800,000 Euro	O	O
	700,000 Euro	O	O
	600,000 Euro	O	O

Lottery: 50% → **1,000,000 Euro**; 50% → **0 Euro**	500,000 Euro	O	O
	400,000 Euro	O	O
	300,000 Euro	O	O
	200,000 Euro	O	O
	100,000 Euro	O	O

C3.) Question 3:

In the following situation, you can choose between participation and non-participation in a set of pre-specified lotteries.

In case of participation in the lottery, you lose 100,000 Euro with a probability of 50% and win an amount equal to X Euro with the same probability. The amount X varies between 25,000 Euro and 300,000 Euro.

In case of non-participation, your wealth does not change.

Please mark for all values of X whether or not you want to participate in the lottery (please mark).

Lottery	**Value of X in Euro**	**I participate in the lottery**	**I do <u>not</u> participate in the lottery**
Lottery: 50% → **+X Euro**; 50% → **-100,000 Euro**	300,000 Euro	O	O
	275,000 Euro	O	O
	250,000 Euro	O	O
	225,000 Euro	O	O
	200,000 Euro	O	O
	175,000 Euro	O	O
	150,000 Euro	O	O
	125,000 Euro	O	O
	100,000 Euro	O	O
	75,000 Euro	O	O
	50,000 Euro	O	O
	25,000 Euro	O	O

Question about You

D.) Finally, we have a question about you:

For how long have you been working for [Company Name]? (please mark)

_____ years