How Do Managers Behave in Stock Option Plans?

Clinical Evidence from Exercise and Survey Data

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Abstract

We use unique case study data to analyze the behavior of top managers in a distinct executive stock option plan. We gather extensive questionnaire data on the managers' traits (e.g. on their risk aversion, diversification, and volatility forecasts) and combine it with individual-level exercise data. Our results show that the managers in our sample expect very low volatilities (compared with historical estimates), are well diversified and modestly risk averse. This implies that the value-cost wedge of options can be smaller than usually assumed. Options are exercised very early and in large transactions. We provide results that suggest that exercise decisions vary with expected volatility, managerial wealth, and mental accounting. In particular, we find that managers who expect lower volatility exercise earlier. We show that this result is consistent with the predictions of expected utility models using our managers' survey parameters.

Keywords: Executive Stock Options, Exercise Behavior, Volatility, Individual Characteristics

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1 Introduction

Executive stock options (ESOs) have important financial implications at both the level of a company and the level of an individual. In many cases, the value of options granted to an executive represents a significant proportion of the total compensation (see Hall and Murphy, 2003). Despite its economic importance, little empirical research exists that examines the behavior of employees and managers in stock option programs. This lack of research is primarily due to the difficulty of obtaining data on individual-level behavior. As we will explain later, identifying the behavior of individuals in ESO programs is, however, of central importance if one is to adequately understand the implications of their use.

In this paper, we offer an empirical contribution to the understanding of managerial behavior in ESO plans and to the efficiency of stock option grants in general. We therefore study (i) how managers exercise stock options, (ii) how they dispose of company stock acquired in stock option programs, and (iii) which individual characteristics explain differences in observed exercise activity. In particular, we hereby study the volatility estimates of managers and how they affect their exercise behavior and the value-cost wedge of options. The value-cost wedge of options is the difference between the (subjective) value an executive assigns to his options and the cost of the options to the issuing company.

To investigate these issues, we use a unique and comprehensive data set on the behavior of senior top managers in the stock option plan of one of Germany's largest companies. We combine detailed information on individual-level stock option exercises of the company's top managers with extensive questionnaire information on a wide range of individual-specific characteristics, beliefs, and attitudes. We have further data concerning what the managers did with the shares they acquired on exercise, and whether or not they sold a stock investment that was required prior to the participation in the ESO program (the so-called required stock investment, abbreviated RSI).[1]

The uniqueness of our data stems from its disaggregated, individual-level observations and from the combination of exercise and survey data. Moreover, the data comes from senior top managers and hence from important decision makers in a very large firm. To our

[1] For every ten options they receive, option recipients must buy one share of company stock.

knowledge, this is the first empirical study in the academic literature on ESO programs that can link individual behavior with manager-level data on risk aversion, stockholdings, forecasted volatility or expected stock returns that are included in our sample. We use survey methodology, as this allows us to accurately address our research questions. As our study uses data on the stock option program of a single company, we are effectively doing a case study, which has obvious pros and cons. We therefore concentrate on individual-level determinants of behavior that show within-firm variation and do not study cross-sectional firm characteristics and their influence on behavior. The case study environment allows us to look inside the black box of a firm and to analyze finely tuned questions. That all managers in our study worked under the same organizational environment and within the same ESO plan is certainly an advantage of our research design, but it has the drawback that we need to be careful with generalizations of our results. This is also the reason why we consider our results as clinical evidence.

Our main findings can be summarized as follows. Consistent with the ESO literature, individuals in our data set exercise their stock options very early and in a few large transactions. Most option recipients sell the shares acquired on exercise. Also, most managers exercise for cash, thus reducing the exposure to company stock. Our survey data shows that the individuals in our sample expect very low volatilities compared with historical estimates. The average manager expects a company stock volatility of 6.8% over a seven-month forecasting horizon, while the estimate for this period based on historical data would be 30.3%. These low volatility estimates are remarkable, as they suggest that the usually assumed high volatility estimates in valuation models (often 30%) might lead to an overestimation of the size of the value-cost wedge. The overestimation of the wedge occurs as high volatility assumptions imply a high risk of the final distribution payoffs of the options leading to generally low subjective option values. Consistent with this intuition, we can show that the average option valuation using our managers' volatility estimates are in fact close to the Black-Scholes value. We can also document that the managers in our sample are only modestly risk averse and well diversified, further reducing the cost-value wedge.

We provide some interesting and new results that suggest that individuals' exercise decisions can be explained by differences in their expectations of future volatility. In par-

ticular, we offer evidence suggesting that managers who expect lower future stock price volatility exercise their options earlier. This result holds for volatility estimates of both company stock and the stock market as a whole. We show that this finding is consistent with the predictions of expected utility models using our managers' survey parameters as inputs. Overall, our findings imply that (low) volatility estimates are a main driver of early exercises.

With regard to other determinants of exercise decisions, we cannot detect that our measures of risk aversion and diversification (individuals' holdings of company stock) are related to exercise behavior. However, we have some indirect results for risk aversion. Consistent with Lambert et al. (1991) who model a manager's absolute risk aversion as a decreasing function of wealth, we find that wealthier individuals exercise their ESOs at later points in time compared to less rich ones. We also find some evidence that mental accounting partially matters for exercise decisions. We perform various robustness checks to account for non-response biases, liquidity and tax driven behavior as well as for herding and information based exercises.

Our documented results on behavior in option plans are of relevance for several reasons. First, understanding exercise decisions is important as they contain information on how managers subjectively value the stock options they are holding. A stock option will be exercised whenever an individual's utility from exercising prior to maturity is greater than the expected utility from continuing to hold the option. As discussed earlier, these subjective option valuations are important as they can cause a significant deadweight loss to the shareholders of the firm that is issuing the options (the value-cost wedge, see Hall, 2003).[2] Based on assumptions regarding managers' risk aversion, diversification, and future volatility, previous studies have shown that the deadweight loss can be up to 50% (see Hall and Murphy, 2000, 2002). If one wants to better understand the efficiency of granting stock options and the deadweight losses they can cause, one needs to better understand how individual traits (such as volatility estimates or risk aversion) affect option valuations and the corresponding exercise decisions.

Second, arguments for the widespread use of stock options generally rest on their as-

[2]The opportunity cost is the value an outside investor would be willing to pay for the option (usually the Black-Scholes value).

sociated incentive effects. The duration of these effects depends heavily on the actual *exercise behavior* of individuals. If options are exercised for cash very early (as shown in this study), these incentive effects quickly disappear. Moreover, they might not last long enough to justify the associated high economic costs of ESO programs to shareholders.[3] A better understanding of the determinants of individuals' exercise behavior can therefore be helpful in designing new stock option programs with robust incentive effects.

Third, theoretical models predict that the exercise behavior of an individual depends on his risk-aversion, wealth, and company stockholdings (see Lambert et al., 1991 or Hall and Murphy, 2000, 2002). However, due to data limitations it is still relatively unknown whether the predictions of these models hold in practice. To test these models, individuals' observed option exercises need to be linked with personal characteristics such as risk aversion or the degree of diversification (as it is done in this study). Empirical insights into the determinants of individuals' actual behavior could then help to assess existing theories and guide future modelling.

Fourth, from a practitioner standpoint, understanding the behavior of managers as well as employees in stock option plans is crucial for estimating the accounting costs of options. According to the Financial Accounting Standard (FAS) 123, companies expensing the cost of stock option plans need to estimate the *expected life* of issued options as an ingredient of classical option pricing models (see Hull and White, 2004). The expected life of ESOs depends on when option holders actually exercise their options. A precise estimation of the individual behavior can thus significantly reduce the accounting cost of ESO plans to the firms in question. In a recent paper, Bettis et al. (2005) show that the failure to adjust for observed exercise patterns can significantly overstate the cost of stock options.

Our study contributes to the more general literature on the efficiency of options grants and to a small number of empirical studies on executive and employee behavior in option plans. Core and Guay (2001) use aggregate exercise data and find that option exercises are higher when the realizable value of an option on exercise captures a greater percentage of the option's theoretical Black-Scholes value. Work by Bettis et al. (2005) documents that employees working for firms with higher stock price volatility exercise their options earlier

[3]See Marquardt (2002), Bettis et al. (2005) or Meulbroek (2001) for empirical evidence on how substantial the costs of stock option programs can be.

than those working for firms with lower volatility. In addition, more senior employees hold their options longer than less senior ones. Heath, Huddart and Lang (1999) and Huddart and Lang (1996) document that option holders exercise in a way which suggests that they believe that short-term price trends will reverse (mean reversion) and that long-term price trends will persist (trend extrapolation). The authors also find that exercise activity increases immediately when the stock price exceeds the maximum level attained during the previous year. Finally, Ofek and Yermack (2000) document that executives usually sell nearly all of the shares they acquired on exercise.

The remainder of this paper is organized as follows: Section 2 provides background on the behavior of individuals in ESO programs. The data, the ESO plan and the sample firm are described in Section 3. It also contains a definition of the variables we use. The results of our study are presented in Section 4 and 6. Section 7 provides robustness checks and Section 8 concludes.

2 Background on Individual Behavior in ESO Plans

This section provides (theoretical) background on the behavior of managers in ESO plans and derives individual-level variables that are likely to be related with managerial exercise behavior. In particular, it will sketch the effects of volatility estimates on subjective option valuations and exercises.

Manager can neither freely trade or sell their stock options nor hedge away the implied risks by short-selling company stock. Moreover, they are usually inherently undiversified with their entire human capital invested in the company. The inability to hedge the risk of stock options and the non-diversification will cause managers to value ESOs in a way that systematically differs from that of well-diversified outside investors. Therefore, the value managers assign to stock options will usually *not* equal the Black-Scholes value of a fully diversified investor. It is important to note that the value a person puts on his options is closely related to his exercise behavior. A stock option will usually be exercised whenever an individuals's expected utility from exercising prior to maturity is greater than the expected utility from continuing to hold the option (see Huddart, 1994, Carpenter, 1998 or Bettis et al., 2005).

Lambert, Larcker and Verrecchia (1991) and Hall and Murphy (2000, 2002) 2002 formally show that risk preferences and endowments of individuals affect the valuation of stock options. By using an expected utility framework, they define the value of an option as the lump-sum payment (certainty equivalent) that makes an individual indifferent between receiving this payment for certain and receiving the uncertain payoff that is induced by holding the option. They hereby point out that an individual's entire wealth structure and risk preferences affect this subjective option valuation and sh. In consequence, this implies that individuals who are more risk averse, who hold a larger fraction of wealth in company stock, and who are less wealthy will exercise their options earlier compared to less risk averse, better diversified and richer individuals. For the effect of wealth on exercise behavior, Lambert et al. (1991) assume that the level of absolute risk aversion is decreasing in managerial wealth.

It is well-established that stock price volatilities have a big impact on the value of stock options. The volatilities that are expected by participants in a stock option plan should

hence also affect their respective valuations and exercise decisions. In the context of ESOs, forecasted volatilities have two opposite yet simultaneous effects. On the one hand, a higher expected volatility *decreases* value and leads to an earlier exercise decision as it raises the firm-specific risk option holders are exposed to. But on the other hand, it also *increases* value and leads to a later exercise decision because of the convexity in the pay-off of a stock option. Ex ante, it is not clear which of the two effects should dominate as it depends on a variety of other factors such as, for example, the moneyness of the options or risk aversion (see Lambert et al, 1991). Whether the subjectively perceived stock price volatility overall leads to lower or higher values, and equivalently to earlier or later exercise decisions, thus remains an empirical question. As with forecasted volatilities, expected future stock returns are also likely to matter for the exercise behavior in ESO plans: more optimistic individuals who expect higher returns on company stock should assign higher values to their options and should therefore also exercise at later points in time compared to less optimistic individuals.

The firm-specific skills of a manager grow over time and have the positive effect of increasing the productivity at the employing firm (see, e.g., Becker, 1964). However, firm-specific skills are likely to be useless when the current job is terminated and when the manager moves to another company. Although the firm-specificity of human capital is not formally captured in ESO models, it is likely to affect exercise activity as well. More specifically, one can expect that individuals with a more firm-specific human capital generally exercise options earlier in order to diversify.

It has been documented that individuals use cognitive operations to organize and evaluate financial activities. Thaler (1980, 1999) denotes this kind of thinking as mental accounting. One aspect of mental accounting is that investors do not sufficiently integrate individual assets into the rest of their wealth and focus on narrowly defined gains and losses (cross-sectional narrow bracketing).[4] Massey (2003) argues that the more narrowly an individual brackets his ESOs (i.e. the less he integrates them into his total wealth), the lower his valuation of these assets will be. Individuals who suffer from narrow bracketing should hence exercise their options earlier compared to those who integrate their financial wealth.

[4]The valuation of gains and losses rather than absolute wealth levels is a central feature of prospect theory, see Kahneman and Tversky (1979).

An other aspect of mental accounting is that individuals often have myopic perspectives when evaluating assets (temporal narrow bracketing).[5] Benartzi and Thaler (1999) have shown that this kind of myopia can lead to more risk averse decision-making. In the context of stock options, this line of argument implies that individuals with more short-term perspectives concerning stock price changes will generally regard options as being less attractive. One can therefore expect that more myopic individuals will be more likely to exercise their ESOs at an earlier date.

Overall, the provided arguments suggests that a set of variables appears to be relevant in understanding individual-level behavior in ESO programs. Table 1 summarizes the predicted relationships between these variables and managerial exercise behavior. One possible approach to get a thorough understanding and explanation of actual exercise patterns is to ascertain these variables empirically. A tractable way to perform this is to distribute a questionnaire to option recipients of a particular ESO program. This is also the approach we use in this paper. We believe that conducting such a survey is a very promising way of effectively linking individual characteristics with personal-level exercise data given that most of the variables discussed above are per se difficult to observe. Our survey approach allows us to measure managerial characteristics directly without relying on much more noisy and indirect proxies of these variables.

[5] See Kahneman and Lovallo (1993).

3 The Institutional Set-Up and the Data

3.1 The Company and the Stock Option Program

Empirical research which looks inside firms to study individual behavior in stock option plans is rare. Existing studies primarily look at *aggregate* exercise decisions of option recipients in different corporations with different option plans and lack access to individual-specific information. To get a deeper understanding of managerial behavior in ESO plans, it is important to study the individuals acting in these plans in greater depth. Our objective is therefore to examine the behavior of managers in the ESO plan of *one* corporation in detail. In particular, we analyze how well our exercise data can be explained with measures of the variables that were outlined in the previous section. We essentially conduct a clinical study and, as a consequence, naturally concentrate on individual determinants of behavior which show *within-firm* variation rather than on cross-company determinants of behavior. This approach allows us to hold both firm and option plan characteristics constant (variables which are difficult to control for in studies across different firms and ESO plans).

Our data set contains information on the stock option exercises of the 70 most senior managers in one of the largest German corporations. The data set includes detailed records of all exercises of these individuals during the exercise period of the ESO plan (from May 2003 to September 2005). The stock options were granted between July and August 2000. All managers belong to the highest management levels of the firm and are important corporate decision makers. The company is one of the largest in its industry in Europe and employs more than 50,000 people worldwide. Its turnover exceeded 7 billion Euro in 2005 and its shares are publicly traded. The company supplied the data on the condition that it and its managers remain anonymous. During both the vesting and the exercise period, no extraordinary firm-specific events (like bankruptcy or financial distress) occurred, that might have triggered the exercise activity. Also, options on company shares were not traded.

To avoid conflicts of interests with regard to insider information, the company decided that the options were not exercisable on all days during the exercise period, but only within a

few exercise windows.[6] Each exercise window opened after the announcement of company earnings and lasted for approximately four weeks. The ESO program encompasses eight separate exercise windows in total. Initially, the strike price of the options was equal to the arithmetical average of the stock price 20 days prior to the option grant (15 Euro), with a conversion ratio of 1 (i.e. to buy one share of company stock at a price of 15 Euro, one option had to be delivered). To avoid adverse effects on the stock price resulting from a large number of option exercises with subsequent stock sales, the company reduced the strike price from 15 to 3 Euro, and lowered the conversion ratio from 1 to $\frac{S_t-15}{S_t-3}$ (i.e. a larger number of options had to be delivered to buy one share of company stock at a reduced price).[7] The program was designed such that the participants were allowed to exercise all options at the same time (cliff vesting). They were prohibited from conducting more than one exercise transaction per exercise window. Moreover, they were not allowed to sell the RSI during the vesting period. At the beginning of the exercise period, the stock price of the firm was 23 Euro.

3.2 Definition of Variables

As outlined above, we are able to combine our exercise data with comprehensive data on individual-specific characteristics, beliefs, and attitudes that was collected by means of a questionnaire. Furthermore, we have information on what each individual did with the shares he acquired on exercise and whether or not he sold the stock investment that was required prior to the participation in the ESO program. On May 14, 2004, between the third and fourth exercise window, all individuals participating in the ESO plan received a letter from us and were asked to participate in our questionnaire. 48 out of 70 option recipients returned the questionnaire which results a response rate of 68.6%. A copy of the questionnaire can be found in the Appendix. To avoid strategic and dishonest answers,

[6]Note that some firms grant new options just after executives have exercised existing options. This could potentially affect the incentive to exercise early. However, this was not the case in our sample firm and exercise decisions were therefore not affected by this granting practice.

[7]Ex post, the liquidity concerns of the firms were not justified. First, the shares of the sample firm belonged to the second largest German stock market index (MDAX) and were very liquid. Second, the shares of the firm were widely dispersed and showed no significant ownership concentration. Third, we have analyzed the share turnover data around the exercise dates and did not find any abnormal turnover rates. Moreover, the share price did not drop around the exercise dates. Fourth, even if the firm had kept its conversion ratio of 1, the turnover rate would remain within normal limits.

we guaranteed that survey responses are treated confidentially and will only be used for research purposes. In particular, we assured participants that neither the executive board of the company nor their human resources department will be able to access the individual answers.

3.2.1 Behavior Variables

The first three variables capture the behavior of a manager within the ESO plan. *Immediate exercise* is a binary variable that reflects the exercise behavior of an option holder and documents how early he exercised his options. It takes the value 1 if he exercised his ESOs during the first exercise window. Correspondingly, it takes the value 0 if he did *not* exercise during the first window.[8] The variable is based on the exercise data provided by the company.

When an individual exercises his ESOs, he acquires the underlying company stock and pays the strike price. An option recipient can then sell these shares immediately to log in the difference between the stock price at the exercise date and the strike price.[9] Alternatively, he may decide not to sell the acquired shares and keep them in his private stock portfolios. To characterize the stock selling behavior of an individual, we use a binary variable named *acquired stock*. It takes the value 1 if an individual sold his purchased shares before the day of filling in the questionnaire (either by paying the strike price and selling the shares or by cashless exercise), and 0 otherwise. The variable is based on self-reported information collected by our questionnaire.

A variable that is closely related to *acquired stock* is denoted *required stock investment*. Recall that before being granted his ESOs, each manager had to buy one share of company stock for every ten options he received. All individuals were thus prevented from selling these shares during the vesting period. From the inception of the vesting period onwards, they were free to trade their initial stock investments. *Required stock investment* is a binary

[8] If options were exercised in more than one window, the variable takes the value 1 if the majority of options were exercised in the first window.

[9] The immediate sale of shares can also be realized by 'cashless exercise', a procedure in which a brokerage firm delivers the difference between the strike price and the market price at exercise to the individual. As documented by Heath et al. (1999), cashless exercise is very common in stock option programs.

variable which takes the value 1 if an individual had already sold his stock investment (RSI) at the time of participating in our questionnaire, and correspondingly 0 if he retained it. This measure is also based on self-reported information.

3.2.2 Variables on Managerial Characteristics

We have data on a wide range of managerial characteristics. We argued that *risk aversion* can have a substantial effect on exercise decisions in ESO plans. We used a certainty equivalence method to elicit individuals' risk aversion (Question 9 in the attached Questionnaire). In this method, the participants were offered an uncertain prospect (a lottery) and were asked to indicate the amount of a sure payoff that they would consider to be equally attractive. The lottery was designed to have a 50% chance of winning an amount equal to the current wealth of a person, and a 50% chance of winning nothing. The certain payoff was a pre-specified and guaranteed change in wealth (e.g. a 30 or 40% increase in wealth). We transformed the certainty equivalents into a risk aversion parameter assuming a specific parametric form of the utility function. Following Lambert et al. (1991), we work with a power utility function of the form $u(x) = (1/(1-\alpha))x^{1-\alpha}$. In this parametric form, α is a measure of an individual's degree of relative risk aversion. Lower certainty equivalents imply higher values of α and thus a higher degree of risk aversion.

To measure individuals' exposure to firm-specific financial risk, we asked each option recipient for the percentage of their total wealth that they currently have invested in company stock.[10] *Stockholdings* consequently reflects the value of a manager's company stock holdings divided by his total wealth. Managers at higher levels in a company receive a larger number of stock options and also get a higher cash salary. They are therefore ceteris paribus wealthier and have more opportunities to diversify wealth. As described in Section 2, the value of an ESO is an increasing function of wealth. In our empirical analysis, we use the number of options granted to an individual (*options*) as a proxy for wealth.[11] This information is based on the transaction data set provided by the company.

[10] See Question 1 and 2. We combined the answers to both questions multiplicatively to get a measure of a manager's total wealth invested in company stock.

[11] Each non-board member (board member) could obtain up to 10,000 (50,000) options. For every ten options, one share of company stock had to be bought (see above). Given their personal financial constraints, individuals therefore had to decide how many options they actually wanted to receive. See Subsection 4.2 for descriptive data.

Following May (1995) and Degeorge et al. (2004), we use tenure as a proxy for the firm-specificity of human capital. *Tenure* is measured as the number of years a manager has been working for the company (Question 12).

To measure our main variable of interest, the future volatility that is expected by the individuals in our sample, we asked each option recipient to provide lower and upper bounds of 90% confidence intervals to two questions concerning stock index level forecasts and to one question concerning the future price of company stock over a seven-month horizon. Confidence interval questions are often used in the literature to elicit probability distributions and volatility estimates of future stock returns.[12] Following the widely used methodology suggested in Keefer and Bodily (1983), we transformed confidence intervals into volatility estimates.[13] As volatility benchmarks, we use historical volatilities of non-overlapping seven-month returns. Historical volatilities are often used as objective volatility benchmarks or as estimates for future volatility (see Graham and Harvey, 2002). Using historical volatilities as a benchmark is not without problems as they are calculated over different time periods and longer horizons. However, "optimal" volatility forecast benchmark hardly exist (see Poon and Granger, 2004) and other approaches such as looking at hit rates have other shortcomings (such as being ex post measures). Therefore, historical volatilities are considered the most reasonable volatility benchmark and are commonly used (see Glaser et al., 2007 or Graham and Harvey, 2002). Implied volatilities of exchange-traded options on company stock were not available.

We use two measures for the estimated volatility: *Forecasted volatility market* is used to measure the volatility an individual expects for the stock market as a whole.[14] *Forecasted volatility company* measures an individual's volatility forecast for the company stock only. Lower values of our volatility measures reflect tighter confidence intervals.

In order to investigate the impact of expected stock returns on managerial behavior, we asked each option recipient to provide a median forecast for the values of the two

[12] See, for example, Glaser and Weber (2005), Klayman et al (1999), Biais et al. (2005), and Soll and Klyman (2004).

[13] Keefer and Bodily (1983) show that the following approximation provides a good estimation of the forecasted volatility of a time series i: $\text{Volatility}_i = \frac{\text{r}(0.95)_i - \text{r}(0.05)_i}{3.25}$ with $i \in \{\text{DAX}, \text{Euro Stoxx 50}, \text{Company stock}\}$, r(0.95) being the upper and r(0.05) being the lower bound of the forecast (after transforming the level forecasts bounds into return forecasts bounds).

[14] It is constructed by calculating the arithmetic average over the volatility measures for the two market indexes DAX and Euro Stoxx 50. If only one measure was available, we used this forecast to represent the market forecast of an individual.

market indexes DAX and Euro Stoxx 50, as well as for the price of company stock (see Question 3). For each individual, we transformed these price/index forecasts into median return forecasts. We thereby constructed a measure of the general market optimism of an individual (*expected return market*), and a measure of his optimism concerning company stock (*expected return company*). *Expected return market* is calculated as the average over the forecasts for the DAX and Euro Stoxx 50. *Expected return company* is simply the expected return on company stock. All forecasts were made up to the end of the year 2004.

To assess the pervasiveness of mental accounting, we investigated whether the individuals in our sample think of their stock options in isolation (narrow bracketing) or as part of an overall investment strategy (asset integration). The resulting variable is denoted as *narrow bracketing* (see Question 5). To explore the second dimension of mental accounting, we also wanted to know how far ahead option recipients actually look when they consider their stock options and possible future prices of company stock. *Time horizon* is a discrete variable that takes the value 2 if a manager has a long-run perspective (two years or longer), 1 if he has a medium-run perspective (three months up to one year), and 0 if he has a short-run perspective (up to one month only) (see Question 7). In addition, we have information on the *hierarchy* levels of the managers in our data set (see Question 13). Due to the fact that all option recipients were men, we did not account for gender effects.

Table 2 summarizes the variables used in our empirical analysis and presents their respective data sources.

4 Descriptive Results

4.1 Descriptive Results on Exercise and Stock Selling Behavior

Summary statistics on the behavior of the managers in the ESO program are presented in Table 3. Panel A provides descriptive results on exercise patterns. It reports the number of individuals that exercised (the majority of) their stock options in each of the eight different exercise windows, the number of options exercised in the different exercise windows, and the total number of exercise transactions per manager. Consistent with other studies in the field, we find that early exercise is a pervasive and strong phenomenon in our sample.[15] A majority of the managers, 64%, exercised their options during the first window, reflecting a strong propensity to exercise early. Within this group of immediate exercisers, 71% (32 out of 45) actually exercised their options even within the first three trading days. Early exercise is also evident when we consider the fraction of options exercised in each of the eight exercise windows. We find that the vast majority, 83%, exercised their options in one large transaction.

Panel B reports statistics on the stock selling behavior. It shows that most individuals, 87%, sold the shares they acquired on exercise.[16] This finding is consistent with other results in the ESO literature (see, e.g., Ofek and Yermack, 2000). Having exercised their options, most individuals seem to be aware of their diversification problems and convert acquired shares into cash. To act consistently, individuals should also sell the shares they purchased for the required stock investment (RSI). However, Panel B shows that a significantly smaller percentage of managers, only 35%, did so. Hence a majority still ties a significant proportion of their financial wealth to the value of the firm by holding RSI shares.

Table 4 provides cross tables of the three transaction variables *immediate exercise*, *acquired stock*, and *required stock investment*. Panel A shows that, conditional on immediate exercise, 27 out of 30 option holders exercised for cash. Panel C again shows the differ-

[15] For similar evidence on early exercise, see, e.g., Bettis et al. (2005), Hemmer et al. (1996) or Huddart and Lang (1996).

[16] Shares were sold either immediately or up to the point in time when the questionnaire was returned. The vast majority, 91%, of shares was sold upon exercise.

ences in the disposition of acquired shares vis-a-vis RSI shares. This might be due to the fact that individuals regard shares acquired on exercise and RSI shares separately.

4.2 Descriptive Results on Questionnaire Data

Descriptive statistics on our questionnaire data are summarized in Table 5. Apart from *options*, all variables were calculated on the basis of the 48 returned questionnaires. The mean certainty equivalent for our presented lottery was a 25% increase in total wealth (median = 25%, std. dev. = 16.4%), leading to a mean value of *risk aversion* equal to 0.49 (median = 0.50, std.dev. = 0.23). Models such as Lambert et al. (1991) usually assume risk aversion parameters between 0.5 (not very risk averse) and 4 (very risk averse). This shows that the individuals in our sample are on average not very risk averse and close to risk neutral (which would be assigned a value of 0). The average manager has invested 2.9% of his total wealth in company stock (median = 1.75%, std.dev. = 3.04%), ranging from 0.25% to 12.75%. As a fraction of his overall *equity* holdings, the average option holder has put 25.3% into company stock (not reported in Table 5). This figure is in line with the findings of other studies. Benartzi (2001), for example, documents that employees invested 20-30% of their discretionary funds in company stock. Also note that our measures of risk aversion and diversification show quite a bit of variability within our sample (which is important for testing between group differences in managerial behavior). On average, managers received 10,520 options (median = 10,000, std.dev. = 11,435), and this number fluctuated between 1,000 and 50,000.[17] The average individual had been working for the company for 17.8 years (median = 15, std.dev. = 8.17).

We find that individuals' volatility forecasts vary across the managers sampled but, unexpectedly, are on average very low. Our measures suggest that the average manager in the company expects a market volatility of 5.8% over the next seven months and a volatility of only 6.8% for company stock. Table 6 presents further details on the volatility estimates. In particular, it compares these volatility estimates with historical volatilities. The table shows that in all three cases, estimated volatilities are significantly below historical

[17] On average, individuals received 76.6% of the options they could obtain at maximum (median = 100%). Recall that non-board members (board members) could obtain up to 10,000 (50,000) options, depending on personal financial constraints to fulfill the RSI.

averages. In the case of company stock, for example, the historical standard deviation of non-overlapping 7 month returns is 30.3%, while the executives in our sample expect on average a volatility of only 6.8%. There are two potential explanations for these findings. First, the managers' volatility estimates are very low by historical standards as they had information for this specific and relatively near-term period that allowed them more accurate forecasts. Consistent with this argument, Table 6 shows that the managers' bound estimates were relatively accurate when compared against actual stock price realizations.[18] Second, the low volatility estimates might also be consistent with results on miscalibration in the overconfidence literature (see, e.g., Glaser et al., 2006). This literature has shown that that individuals often underestimate future volatilities. Experimanetal studies have documented that executives, i.e. our group of survey participants, are particularly vulnerable to showing this kind of bias.[19]

Table 5 further documents that our managers expect a stock market year-end return of 6%, and that the average manager predicts a return of 7.37% for company stock. Most managers indicated that they think of their stock options in isolation (*narrow bracketing*), not taking other existing stock investments into account (mean = 1.78, median = 1.00, std.dev. = 1.56). This evidence for mental accounting is further reflected in the values of our second mental accounting variable (*time horizon*): most managers have myopic perspectives when evaluating company stock. Only three out of 46 top managers have a long-run view regarding stock price movements. Most managers only consider periods from between three months up a year in advance (35 individuals) or in some cases even less then three months (8 individuals). Finally, the *hierarchy* levels of the responding individuals look as follows: two belong to the management board, 19 to hierarchy level 2, 16 to level 3, seven to level 4 and three to hierarchy level 5.

[18] The very accurate inbound estimates might partially be due to the relatively low ex post volatility realizations over the forecasting horizon (as one can see based on a comparison of the historical volatilities with the realized ones).

[19] See Moore (1977), Kidd (1970), and Larwood and Whittaker (1977). Overall, the interpretation of these "inbound rates" is also limited as they are based on an ex post assessment of just one stock price/index realization.

5 The Effect of Volatility Forecasts on the Value-Cost Wedge and Option Exercises

5.1 Volatility Forecasts and Value-Cost Wedge Implications

The low volatilities estimates of the managers that were documented in the previous section have implications for the value-cost wedge and hence the general efficiency of stock option grants. Prior studies have shown that managers' subjective option values represent large discounts from Black-Scholes values. These studies almost always use some relatively high volatility estimates to calculate subjective option values. However, these high volatility estimates increase the risk of the final distribution of the option's payoff and cause a low certainty equivalent. These effects are particularly strong if managers are very risk averse and poorly diversified. Hall and Murphy (2000, p. 211), for example, document value-cost wedges of up to around 50% using a volatility estimate of 30%.[20]

To illustrate the effect of low volatility estimates on the value-cost wedge, we use the individual volatility forecasts of the managers in our sample together with their risk aversion, diversification and wealth parameters and calculate the implies subjective option values.[21] To compute these values, we apply the expected utility framework of Hall and Murphy (2000, 2002). Besides the individual characteristics of the managers, we added the time to maturity of the option, the exercise price, the market price of company stock, and estimates of the risk free rate, the firm's beta, and the equity risk premium as additional model inputs. Using these parameters, the expected utility model predicts an average (median) subjective option value of Euro 9.79 (Euro 9.91). The values are report in Panel A of Table 7. These values are surprisingly close to the Black-Scholes value which equals Euro 10.06 and is computed based on historical volatility. Using the (median) subjective values, these figures imply a value-cost discount of only 2.7% (1.5%) which is below what is usually assumed in the literature. In fact, recent evidence by Sautner and Weber (2008)

[20] In this specific example, a risk aversion parameter of 2 is assumed, and the the manager invests 66% of his wealth in company stock. The corresponding subjective option value is USD 7.49 and the Black-Scholes value USD 16.55. This leads to a value-cost discount of 54.7%.

[21] We measure the values for May 2003, the month when the exercise period started. In order to have a practical measure of managerial wealth, we assumed that managers that received more options are also richer and for 10,000 options a managerial wealth of 1,000,000 Euro. This implies that the average manager in our sample has a net wealth equal to 1,052,000 Euro.

suggests that subjective option values can even exceed the Black-Scholes values under certain conditions.

Overall, our results show that low volatility estimates, paired with modest risk aversion and a reasonable diversification, can have the effect of significantly reducing the value-cost wedge of ESOs and make them look more efficient from a shareholder's perspective than traditionally assumed.

5.2 Volatility Forecasts and Exercise Behavior

In a next step, we investigate to what extent the heterogeneity in forecasted volatility can explain the differences in the observed exercise behavior across the individuals in our sample.[22] Table 8 compares individual-level variables for the group of managers that immediately exercised their ESOs with those from the group that did not exercise immediately (or that did not sell acquired shares). Recall that almost all of the managers who exercised early did so right at the beginning of the first exercise window. We compare the mean and median values the estimated volatility of the two groups and perform a non-parametric Wilcoxon rank-sum test (Mann-Whitney test) to test the hypothesis that the values of the two sample medians are identical (the table also reports variables which will be referred to later). This enables us to discriminate between the two groups and allows us to investigate whether volatility differences or differences in other variables can explain the heterogeneity in individuals' actual exercise decisions.[23] The way we construct the two groups stems from the high immediate exercise activity in the first window. Overall, this categorization works against us rather in favor with regard to finding significant between group differences. Non-significant between group differences therefore do not necessarily indicate that the insignificant variables do not matter but could also signal simply a lack of power in our employed statistical tests.

The table shows that the group of immediate exercisers is forecasting significantly lower volatility levels compared to the second group. The average manager in the immediate-

[22] In the next section, we will also look at the effects of differences in risk aversion, company stockholdings, and the other variables that were described previously.

[23] Because of the limited size of our sample, we do not perform multivariate analyzes such as discriminant analysis or probit/logit regression models that require much stronger distributional assumptions.

exercise group estimates a company stock volatility of 6.19% while the average manager in the latter group expects 7.66%. Our findings seem to be robust as our volatility measures for the stock market as a whole show similar between-group differences. Given the size of our sample, the significance levels are also relatively high.[24]

Theoretically, a higher expected stock price volatility has two simultaneous but opposing effects on subjective option values and exercises (e.g., see Lambert et al, 1991). On the one hand, it has a negative effect on option values and leads to earlier exercises as it increases the perceived firm-specific risk option holders are exposed to. But on the other hand, it also has a positive effect and leads to later exercises because of the convexity in the payoff of a stock option. Depending on the magnitude of the two effects, differences in forecasted volatility can lead to lower or higher option values and hence to earlier or later exercise decisions. In our data, the documented underestimation of volatility seems to have led to earlier exercises.[25] This evidence suggests that managers who expect lower volatilities put smaller values on the options' time value and exercise earlier compared to individuals who expect higher volatilities.

To complement these volatility findings, we directly calculated the subjective option values for the two groups using the managers' personal estimates of volatility and their other characteristics as input variables. To compute these option values, we again applied the expected utility framework of the valuation model by Hall and Murphy (2000, 2002). Hereby, we used two slightly different approaches to calculate the implied option values of the managers in the two groups.

In the first approach, we conducted the valuations using the median values of risk aversion, diversification, and wealth for each of the two respective exercise groups. The other option parameters are used as before. Then we calculated the implied subjective option values using the mean volatility forecast of both the group of early and late exercisers.[26] Using

[24]The correlation between both volatility measures and our proxy for wealth is -0.03 and highly insignificant, so we can exclude the possibility that wealth is the driving causal factor behind our volatility result.

[25]The fact that the managers in our sample are only modestly risk averse and relatively well diversified is one of the reasons why the convexity effect dominates the risk effect.

[26]We used this first approach as several individual parameters were missing for some managers in the two respective group. Our results do not change if we use median forecasts instead. However, the difference in option values becomes a bit smaller.

this valuation approach, we find that the resulting subjective option value is 9.83 Euro for the group of immediate exercisers and 10.14 Euro for the other group. The corresponding time values were 1.83 Euro and 2.14 Euro, respectively. The numbers are reported in Panel B of Table 7. We document the time values as they reflect the money the option holders discard by exercising pre-maturely.

In the second approach, we calculated the implied option values for each manager individually. Despite the fact that this reduces the number of usable observations (21 individuals in the first and 17 in the second group), we still find that the average subjective option value of the managers that exercised immediately is lower than the value of those who exercised later (9.73 Euro versus 9.84, respectively). The corresponding median values are now 9.91 Euro and 9.95 Euro. However, we cannot detect a statistical difference between the values of the two groups which might be due to the small number of available observations.

In summary, the calculated option values support the previous analysis of the observed exercises and further suggest that the undervaluation of volatilities induced earlier exercises. Through this mechanism, expected volatilities are also related to value-cost wedge. The fact that the subjective option values are relatively close to each other is consistent with phenomenon that the exercise behavior in the firm's option plan is generally clustered in the first few exercise windows.

6 Effects of Risk Aversion, Diversification and Other Variables on Option Exercises

Having focused in the previous section on the effect of volatility forecasts on option exercises, we now study the effects of other variables such as risk aversion or diversification. As described earlier, models like those by Lambert et al. (1991) or Hall and Murphy (2000, 2002) predict that the group of instantaneous exercisers should exhibit a higher degree of risk aversion (i.e. a higher value of α) and larger holdings of company stock (i.e. a larger fraction of wealth invested in company stock). In our sample, we can neither detect significant between-group differences in the degree of risk aversion (median value of 0.50 vs. 0.50; p-value = 0.4208) nor in the holdings of company stock (median value of 2.25% vs. 1.25%; p-value = 0.5933). This result is surprising given that the vesting period has forced risk averse and non-diversified individuals to postpone their exercises leading to an accumulation in exercise activity at the end of the vesting period. The non-significance of our risk aversion and diversification variables, however, might partially be due to the generally low levels of these variables for our managers (see Section 4.2).

We argued that the amount of options granted to a manager can be considered as a proxy for labor income and wealth. Lambert et al. (1991) model a manager's absolute risk aversion as a decreasing function of wealth, and they thereby showed that option values are strictly increasing in wealth. Following this prediction, we expected wealthier individuals to exercise their ESOs at later points in time (compared to less rich ones). Consistent with this hypothesis, we find that the average number of granted options is significantly lower for the group of individuals that exercised their ESOs immediately compared to the group that exercised later (median value of 7,500 options vs. 10,000 options). The hypothesis that the two values are the same can be rejected at the 1%-level (p-value = 0.0050). We further used *tenure* as a measure for the firm-specificity of human capital. In general, we hypothesized that managers with more firm-specific human capital (i.e. with a longer job tenure) exercise their options earlier to reduce their exposure to the value of the firm. Our data, however, cannot confirm this conjecture.

We predicted that exercise decisions can be affected by expected stock returns. We argued in Section 2 that option holders who are more optimistic about the movements in company

stock will place higher values on their options, and should therefore exercise less early. However, we are not able to confirm this empirically. We further predicted that mental accounting, proxied by *narrow bracketing* and *time horizon*, can also partially affect ESO exercises. We predicted that the less an individual integrates an ESO into his wealth, the earlier he exercises it. Inconsistent with this conjecture, we find no significant difference in the values of *narrow bracketing* between the two group of managers. However, the second aspect of mental accounting seems to have some explanatory power: we find that immediate exercisers have shorter perspectives with respect to price changes of company stock (mean value of 0.77 vs. 1.05).

7 Robustness Checks

The first part of this section is concerned with a possible non-response bias in our data. 22 out of 70 managers did not return our questionnaire. To investigate whether this subgroup of individuals shows systematic differences in its behavior, we compare the exercise activity of the responding subgroup with that of the non-responding one. In total, 38% of all granted options were given to the 22 non-respondents. Table 9 compares the distribution of exercises over the past five exercise windows for the 22 non-respondents with those of the 48 respondents. It documents that the group of non-respondents shows exercise patterns that are very similar to those of the responding group: exercise activity is also clustered in the first window and very few ESOs were exercised in windows 3 to 8 (the high fraction of options exercised in the windows 6-8 of the non-respondents is due to one person who exercised 30,000 options in window 7). In conclusion based on our available information, we have no indication that the exercise behavior of the responding individuals systematically differs from that of the non-responding ones.

Individuals might also exercise their ESOs because of tax considerations, or to satisfy liquidity needs. To account for the possibility that observed exercise patterns were actually driven by tax motivations, we asked all individuals to indicate to what extent the following statement provides a good description of their personal tax considerations: "Tax considerations play an important role with respect to my exercise decisions within an executive stock option program". Answers were measured on a seven-point scale ranging from 1 ("I totally disagree") to 7 ("I totally agree"), see Question 4. The mean answer to this question was 2 (median = 2.83, std.dev = 2.09), which suggests that tax deliberations are a secondary consideration only and can be disregarded as an explanation of the behavior in our data. Accounting for liquidity-motivated exercising is, however, more difficult. Individuals can rationally exercise their options because of liquidity needs if the time value sacrificed by exercising is less than the cost of a loan. Liquidity needs are obviously more severe for younger managers as they usually have lower salaries but higher expenditures (see Dittmann and Maug, 2007). Therefore, we tested whether the subgroup of immediate exercisers is significantly younger than the group that exercised at later points in time. The average individual in the first group is 48.88 years old, while the average manager in the second group is only slightly older (50.35 years). A non-parametric test

(Mann-Whitney test) further shows that the difference between the two groups is highly insignificant (p-value = 0.5053), indicating that liquidity-based exercising is probably also not a driving factor in our data.

Private information and herd behavior might have affected the exercise decisions of the individuals in our data set as well. Managers at lower levels might, for example, exercise their ESOs after the public disclosure of exercises by board members, believing that this group of individuals possesses superior information about the future performance of the firm. We therefore checked the possibility that people imitated the exercise behavior of board members and asked each individual to what extent his exercises were influenced by the decisions of management board members. More precisely, we presented the following pre-formulated question (see Question 6): "Knowing that board members have exercised stock options influenced the timing of my exercise decision". Answers again ranged from 1 ("I totally disagree") to 7 ("I totally agree"). The average answer to this question was 1.95 (median = 1, std.dev. = 1.64) which suggests that imitating board members' exercises was only of minor importance. Furthermore, we cannot detect any significant price drops in the days following extensive exercise activity. Such a price drop would be expected to take place if the managers in our sample exploited private information in a favorable way. In general, the structure of the ESO plan with a set of exercise windows that open only after the public disclosure of company news (e.g. quarterly earnings) seem to deter the profitable use of insider information.

8 Conclusion

Using a unique data set, we studied the exercise behavior of managers within a particular stock option plan, contributing to a deeper understanding of how individuals behave in these programs. Our data set is uniquely comprehensive and detailed, but our study is limited to one company, essentially making it a case study. We empirically addressed questions on the efficiency of option grants and on the exercise behavior in an ESO plan. All individuals in our data set are top managers and important decision makers in one of the largest German corporations.

Our findings showed that the individuals exercise their options very early. A large majority of option recipients sold the shares acquired on exercise. Our survey data documented that the managers expect very low volatilities compared with historical estimates. These low volatility estimates suggest that the usually assumed high volatility estimates in valuation models might lead to an overestimation of the size of the value-cost wedge.

We provide evidence suggesting that differences in the exercise behavior are related to differences in expected volatilities. In particular, we offer evidence implying that managers who expect lower future stock price volatilities assign lower values to their stock options and exercise earlier. The volatility results hold both for forecasts regarding company stock and the stock market as a whole. We show that this finding is consistent with the predictions of expected utility models using our managers' survey parameters as inputs. We cannot detect that the exercise activity in our data can be explained with differences in measures of risk aversion and diversification. We perform various robustness checks to account for non-response biases, liquidity and tax driven behavior as well as for herding behavior and information-based exercises.

Regarding generalizations of our results, we are aware that our evidence is based on a clinical analysis. The advantage is that we can hold the institutional and organizational set-up of the firm and of the option plan constant in order to look at the effects of variations in individual characteristics across managers. This is of particular relevance given the large differences in ESO plans across institutions. However, it has the drawback that implications of the documented effects for other firms and ESO plans must be formulated cautiously.

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Table 1: **Predicted Relationship Between Exercise Behavior and Individual Characteristics**

This table reports predicted relationships between various individual-level variables and exercise behavior. "+" means that an increase in the respective variable will result in a later exercise decision. Correspondingly, "-" means that an increase in the variable will result in an earlier exercise decision. "?" means that no prediction is possible.

Variable	*Exercise Behavior (Predicted Sign)*
Risk aversion	-
Stockholdings	-
Wealth	+
Firm-specificity of human capital	-
Forecasted volatility	?
Expected return	+
Mental accounting	-

Table 2: **Definition of Variables**

This table summarizes and defines variables used in the empirical analysis and presents their respective data sources.

Variable	Data Source	Description
Immediate exercise	Transaction data	Binary variable which takes the value 1 if an individual exercised his options in the first exercise window; and 0 if an individual did not exercise his options in the first exercise window. If an employee exercised his options in more than one window, the variable takes the value 1 if the majority of options was exercised in the first window.
Acquired stock	Questionnaire	Binary variable which takes the value 1 if an individual had already sold his acquired shares at the time of filling in our questionnaire; and 0 if he did not sell it yet.
Required stock investment	Questionnaire	Binary variable which takes the value 1 if an individual had already sold his required stock investment at the time of filling in our questionnaire; and 0 if he did not sell it yet.
Risk aversion	Questionnaire	Measures an individual's degree of risk aversion.
Stockholdings	Transaction data	The ratio of the value of an individual's company stock holdings to his total wealth.
Options	Transaction data	The number of stock options granted to an individual and a proxy for wealth.
Tenure	Questionnaire	The number of years an individual works for the company and a proxy for the firm-specificity of human capital.
Forecasted volatility market	Questionnaire	Measures an individual's forecasted volatility for the stock market index. It is measured using two questions concerning confidence intervals for the price levels of two market indices.
Forecasted volatility company	Questionnaire	Measures an individual's forecasted volatility for the price of company stock. It is measured using a question concerning the confidence interval for the price of company stock.
Expected return market	Questionnaire	Measures an individual's expected return for the entire stock market.
Expected return company	Questionnaire	Measures an individual's expected return for company stock.
Narrow bracketing	Questionnaire	Measures to what extent an individual integrates his stock options into his entire wealth.
Time horizon	Questionnaire	Variable which takes the value 2 if an individual has a long-run perspective concerning the firm's stock price movements (two years or longer); 1 if he has a medium-run perspective (three months up to one year); 0 if he has a short-run perspective (up to one month).
Hierarchy	Questionnaire	Reflects an individuals' hierarchy level in the firm (with the categories being "management board" (coded 1), "management level 2" (coded 2), "management level 3" (coded 3) and "management level 4" (coded 4) and "management level 5" (coded 5).

Table 3: **Descriptive Results on Executive Behavior**

This table summarizes descriptive results on individuals' exercise and stock selling behavior. Panel A presents statistics on the exercise behavior. It documents the number of employees that exercised (the majority of) their stock options in each of the eight exercise windows, the number of options exercised by managers in the eight distinct exercise windows, and the total number of exercise transactions executed by option holders. Panel B reports statistics on individuals' stock selling behavior. It shows whether or not the managers in the sample sold the shares they acquired on exercise and whether or not they sold the shares they had to acquire prior to the participation in the stock option program (RSI shares). In total, 70 managers participated in the stock option program and 48 of these returned our questionnaire. For a discussion of a potential non-response bias, see Subsection 7.

Panel A				
Exercise Behavior				
	Number of managers who exercised	Managers who exercised in window 1	45	(64.43%)
		Managers who exercised in window 2	16	(22.85%)
		Managers who exercised in window 3	4	(5.71%)
		Managers who exercised in window 4	3	(4.29%)
		Managers who exercised in window 5	0	(0.00%)
		Managers who exercised in windows 6-8	2	(2.86%)
	Number of options exercised	Options exercised in window 1	334,868	(52.54%)
		Options exercised in window 2	231,084	(31.38%)
		Options exercised in window 3	58,098	(7.89%)
		Options exercised in window 4	25,320	(3.44%)
		Options exercised in window 5	0	(0.00%)
		Options exercised in windows 6-8	35,034	(4.76%)
	Number of exercises	One exercise decision (♯ of empl.)	58	(82.86%)
		Two exercise decisions (♯ of empl.)	9	(12.86%)
		Three exercise decisions (♯ of empl.)	3	(4.38%)
Panel B				
Stock Selling Behavior				
	Acquired Stock	Shares sold (♯ of empl.)	41	(87.23%)
		Shares not sold (♯ of empl.)	6	(12.77%)
	Required Stock Investment	Shares sold (♯ of empl.)	31	(64.58%)
		Shares not sold (♯ of empl.)	17	(35.42%)

Table 4: **Cross Tables of Transaction Variables**

This table presents cross tables of the transaction variables *immediate exercise*, *acquired stock* and *required stock investment*.

Panel A

		Acquired stock sold		
		No	*Yes*	*Total*
Immediate	*No*	3	14	17
exercise	*Yes*	3	27	30
	Total	6	41	47

Panel B

		Required stock investment sold		
		No	*Yes*	*Total*
Immediate	*No*	7	11	18
exercise	*Yes*	10	20	30
	Total	17	31	48

Panel C

		Required stock investment sold		
		No	*Yes*	*Total*
Acquired	*No*	4	2	6
stock sold	*Yes*	12	29	41
	Total	16	31	47

Table 5: **Descriptive Statistics on Questionnaire Data**

This table reports descriptive statistics on managerial risk aversion, company stockholdings (percentage of total wealth invested in company stock), the number of options granted, the managers' tenure, their forecasted volatilities (see Section 3 for details), their expected stock returns (see Section 3 for details), their degree of narrow bracketing, their time horizon (see Section 3 for details) and their hierarchy level. Descriptive statistics are calculated on the basis of 48 returned questionnaires. The table contains means, medians, standard deviations, minimums and maximums of all variables as well as the number of observations of the respective variables (Obs.).

Variable	Mean	Median	Std.dev.	Min.	Max.	Obs.
Risk aversion	0.49	0.50	0.23	-0.16	0.77	43
Stockholdings (in %)	2.90	1.75	3.04	0.25	12.75	46
Options	10,520	10,000	11,435	1,000	50,000	70
Tenure (in years)	17.76	15.00	8.17	6.00	40.00	47
Forecasted volatility market (in %)	5.83	5.35	2.78	1.59	15.03	45
Forecasted volatility company (in %)	6.80	6.57	2.72	0.98	15.33	46
Expected return market (in %)	6.00	6.13	6.39	-12.86	19.71	43
Expected return company (in %)	7.37	6.76	4.87	-9.25	17.44	44
Narrow bracketing	1.78	1.00	1.56	1.00	7.00	46
Time horizon	0.89	1.00	0.48	0.00	2.00	46
Hierarchy	2.79	3.00	0.98	1.00	4.00	47

Table 6: **Volatility Forecasts**

This table presents volatility forecasts for the DAX and EuroStoxx 50 indexes and for the company stock. Volatility forecasts are calculated as described in Section 3. In addition, the table shows historical volatilities of non-overlapping 7 month returns, the realized volatilities over the forecasting horizon (May to December 2004), and the fraction of individual forecasts for which the realized values were outside the forecasted bounds. We calculated historical volatilities up to October 2004.

DAX	Volatility Forecast (Mean)	5.75%
	Number of Observations	45
	Historical standard deviation	17.94%
	(May 1987 - October 2004)	
	Realized Volatility	11.21%
	Realized Value Outside Bound	40.0%
EuroStoxx 50	Volatility Forecast (Mean)	5.78%
	Number of Observations	40
	Historical standard deviation	15.45%
	(May 1987 - October 2004)	
	Realized Volatility	9.94%
	Realized Value Outside Bound	27.5%
Company Stock	Volatility Forecast (Mean)	6.80%
	Number of Observations	46
	Historical standard deviation	30.32%
	(May 1987 - October 2004)	
	Realized Volatility	15.41%
	Realized Value Outside Bound	10.9%

Table 7: **Imputed Subjective Option Values and Volatility Forecasts**

Panel A of this table presents average and median subjective option values based on the volatility forecasts of the managers in the sample. For comparison, it also reports the Black-Scholes value (calculated based on a historical volatility estimate) and the value-cost wedge. Volatility forecasts are calculated as described in Section 3. Panel B presents subjective option values for the group of managers that immediately exercised their options and sold the acquired shares with the group of managers that showed no immediate exercise activity (or who did not sell acquired shares). We use two different methods to calculate the option values in this panel. In the first approach, we conducted the valuations using the median values of risk aversion, diversification, and wealth for each of the two exercise groups as inputs. As further model inputs, we added the time to maturity of the options, the exercise price, market price of company stock, an estimates of the risk free rate, the firm's beta, and the equity risk premium. Then we calculated the implied subjective option values using the mean volatility forecast the group of early and late exercisers, respectively. In the second approach, we calculated the implied option values for each manager individually. The table reports the mean option values (median values are 9.91 Euro and 9.95 Euro, respectively).

Panel A:
Value-Cost Wedge

Subjective Option Value	Mean	9.79 EUR
	Median	9.91 EUR
Black-Scholes Value		10.06 EUR
Value-Cost Wedge	Mean	2.79%
	Median	1.50%

Panel B:
Exercise Behavior

	Group of managers who immediately exercised and sold acquired shares	Group of managers who did *not* exercise immediately or who did *not* sell acquired shares
Approach 1		
Subjective Option Value	9.83 Euro	10.14 Euro
Subjective Time Value	1.83 Euro	2.14 Euro
Approach 2		
Subjective Option Value	9.73 Euro	9.84 Euro
Subjective Time Value	1.73 Euro	1.84 Euro

Table 8: **Between Group Differences: The Exercise Behavior of Executives**

This table compares descriptive statistics for the group of managers that immediately exercised their options and sold the acquired shares with the group of managers that showed no immediate exercise activity (or who did not sell acquired shares). The table contains means and medians of a large set of variables for the two groups. It further includes the number of observations of the respective variables (Obs.). The last column contains p-values of a two-sample Wilcoxon rank-sum test (Mann-Whitney test) comparing the median values of a certain variable for the two groups. The null hypothesis is that the two groups are from populations with the same medians. * indicates significance at 10%; ** indicates significance at 5%; *** indicates significance at 1%.

		Group of managers who immediately exercised and sold acquired shares	Group of managers who did *not* exercise immediately or who did *not* sell acquired shares	p-value
Forecasted volatility market	Mean	5.05%	6.95%	0.0092**
	Median	4.60%	6.33%	
	Obs.	24	20	
Forecasted volatility company	Mean	6.19%	7.66%	0.0771*
	Median	6.46%	6.57%	
	Obs.	24	21	
Risk aversion	Mean	0.52	0.47	0.4208
	Median	0.50	0.50	
	Obs.	23	20	
Stockholdings	Mean	2.79	3.17	0.5933
	Median	2.25	1.25	
	Obs.	26	19	
Options	Mean	8,419	11,190	0.0050***
	Median	7,500	10,000	
	Obs.	26	21	
Tenure	Mean	17.27	18.03	0.9119
	Median	15.00	13.50	
	Obs.	26	20	
Expected return market	Mean	5.75%	6.22%	0.7432
	Median	6.19	6.03	
	Obs.	22	20	
Expected return company	Mean	7.10%	7.68%	0.9033
	Median	7.65	6.76	
	Obs.	22	21	
Narrow bracketing	Mean	1.81	1.63	0.9663
	Median	1.00	1.00	
	Obs.	26	19	
Time horizon	Mean	0.77	1.05	0.0518*
	Median	1.00	1.00	
	Obs.	26	19	
Hierarchy	Mean	2.88	2.65	0.2359
	Median	3.00	2.00	
	Obs.	26	20	

Table 9: **Non-Response Bias: Respondents vs. Non-Respondents**

This table contains the distribution of the options that were exercised in the different exercise windows by the 22 non-respondents and compares it with the distribution of exercises for the 48 respondents of our questionnaire.

Exercise Window	*Respondents*	*Non-Respondents*
Options exercised in window 1:	53.47%	51.00%
Options exercised in window 2:	33.25 %	28.28%
Options exercised in window 3:	9.40%	5.41%
Options exercised in window 4:	2.80%	4.50 %
Options exercised in window 5:	0.00%	0.00%
Options exercised in windows 6-8:	1.09%	10.81%