Stock Options and Employee Behavior:

Evidence from Exercise and Survey Data

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Abstract

Employee stock options (ESOs) are a widespread and economically highly significant phenomenon, both at a company and at an employee level. Despite its economic importance and due to data limitations, there exists very little empirical research that examines the behavior of employees in stock option programs. Our study empirically analyzes the behavior of option holders in a distinct ESO plan at a very large German corporation. Using individual-level option exercise data and very detailed questionnaire data, we study how top managers exercise their stock options and how they dispose of company stock acquired in the ESO plan. Moreover, we investigate which rational and behavioral factors explain differences in the observed exercise behavior. We find that individuals exercise their options very early and in a few large transactions. A large majority of option recipients sell the shares acquired on exercise. Furthermore, risk aversion and individuals' holdings of company stock, factors that are included in rational models of exercise, cannot explain the exercise behavior in our data. We provide some interesting and new results that suggest that individuals' exercise decisions depend on the psychological factors miscalibration and mental accounting.

Keywords: Employee Stock Options, Exercise Behavior, Stock Selling Behavior, Correlation of Economic and Psychological Variables

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1 Introduction

Employee stock options (ESOs) constitute an important economic domain both at a company and at an individual level. In many cases, the value of options granted to an individual adds up to a significant proportion of the total compensation (see Hall and Murphy, 2003). Despite its economic importance, very little empirical research exists that examines the behavior of employees in ESO programs. This lack of research is primarily due to pronounced data limitations on individual-level behavior. Understanding the behavior of individuals in ESO programs is, however, very important as the following paragraphs will show.

A major argument for the widespread use of stock options are the incentive effects associated with it. The duration of these effects depends heavily on the actual *exercise behavior* of employees. If options are exercised for cash very early, these incentive effects disappear very quickly. Moreover, they might not last long enough to justify the associated high economic costs of ESO programs to shareholders.[1] A better understanding of the determinants of individuals' exercise behavior can therefore be very helpful for the design of new stock option programs with powerful and long-lasting incentive effects.

Theoretical models predict that the exercise behavior of an employee depends on his risk-aversion, wealth, and stockholdings (see Lambert et al., 1991 or Hall and Murphy, 2000, 2002). Whether the predictions of these models hold in real life is, however, still relatively unexplored. To test theses models, employees' observed option exercises need to be linked with individual characteristics on risk aversion or diversification. Empirical insights into the determinants of employees' actual behavior could help modifying existing theories and guide future modelling.

Several studies document that individuals are prone to various behavioral biases when dealing with stocks (see Barberis and Thaler, 2003 for a survey). It is, however, much less understood whether and how psychological factors influence individual behavior in stock option programs (e.g. the decision to exercise). This is particularly astonishing given that an increasing body of literature assumes that employee behavior in ESO plans and

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

psychological biases are related (see, e.g., Oyer and Schaefer, 2005 and Bergman and Jenter, 2005). Studying individual behavior in the context of option plans is therefore a way to test if and how psychological biases affect economic activity in an important domain. It is well-known that behavioral biases are of particular importance in situations where subjects have a high degree of individual autonomy in their decisions and where large amounts of money are concerned (as it is the case in ESO programs). Linking judgement biases and individual transactions such as option exercises hence provides a way to test *which* biases actually influence economic behavior.

From a practitioner standpoint, understanding the behavior of employees in ESO plans is crucial for the estimation of the accounting costs of stock option programs. According to the Financial Accounting Standard (FAS) 123, companies expensing the costs 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 thereby significantly reduce the accounting costs of ESO plans to the granting firms. In a recent paper, Bettis et al. (2005) show that the failure to adjust for observed exercise patterns can overstate the costs of stock options significantly.

We try to provide a contribution to a better understanding of individual behavior in ESO plans by empirically studying the following set of research questions: How do employees exercise their stock options? How do employees dispose of company stock acquired in stock option programs? What rational and behavioral factors explain differences in observed exercise behavior? To investigate these issues, we are able to use comprehensive and unique data on individual behavior in the stock option plan of one of the largest German companies. We can combine detailed individual-level stock option exercise data of the senior managers of this company with extensive questionnaire information on a wide range of individual-specific characteristics, beliefs, and attitudes. We further have data about what the managers did with the shares 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).[2]

The uniqueness of our data set stems from the individual-level of our data set and from

[2]For every ten options they received, employees had to buy one share of company stock.

the possibility to combine exercise and survey data. To our knowledge, there exist no other empirical studies in the academic literature on ESO programs that also link individual behavior with employee-level data on economic and psychological variables like risk aversion, stockholdings, overconfidence or optimism which are included in our sample. As our study uses data on the stock option program of a single company, we are effectively doing a case study, which has natural benefits and costs. We therefore concentrate on looking at individual-level determinants of behavior which 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 firm and to analyze finely tuned questions. Also, all managers in our study worked under the same organizational environment. This is certainly an advantage of our research design, but has the drawback that we need to be careful with generalizations of our results. We use survey methodology as we believe that conducting a survey is the best way to address the research questions outlined above.

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. A large majority of option recipients sells the shares acquired on exercise. Most individuals exercise for cash and hereby reduce the exposure to company stock. However, we have evidence that employees suffer from mental accounting and violate the fungibility principle: they dispose differently over equity acquired on exercise and over equity bought for the RSI. Shares from the first source are much more likely to be converted into cash than those of the second one. Furthermore, risk aversion and individuals' holdings of company stock, factors that are included in rational models of exercise like those of Lambert et al. (1991) and Hall and Murphy (2000, 2002), cannot explain the exercise behavior in our data. We provide some interesting and new results that suggest that individuals' exercise decisions depend on the psychological factors miscalibration and mental accounting. In particular, we offer evidence that suggests that miscalibrated individuals put a too small value on stock options and therefore exercise too early. Our results supplement the findings by Heath et al. (1999) who also document that psychological factors can affect exercise decisions in ESO plans (in their study reference points and beliefs in trend extrapolation and mean reversion).

The remainder of this paper is organized as follows: Section 2 provides the theoretical

background for the behavior of employees in ESO programs. Section 3 surveys the existing empirical literature that studies individual behavior in option plans. The data sets and the design of our study are described in Section 4. Section 5 presents our methodology and describes the variables we use in the empirical analysis. The results of our case study are presented in Section 6. We hereby provide descriptive statistics and try to explain the differences in the observed employee behavior. Finally, Section 7 summarizes our results and concludes.

2 Theoretical Background

Employees can neither freely trade or sell their stock options nor hedge away the implied risks by short-selling company stock.[3] Moreover, employees are usually inherently undiversified with their entire human capital invested in the company. The inability to hedge the risk of stock options and their serious non-diversification will cause employees to value ESOs in a way that systematically differs from that of well-diversified outside investors. This implies that the concept of risk-neutral valuation can not be applied to the pricing of ESOs. Therefore, an employee's value of a stock option will usually *not* equal the Back and Scholes (1973) value of a fully diversified investor, and exercise decisions prior to maturity can be rational under certain circumstances.

It is important to note that the value an employee puts on his options is closely related to his exercise behavior. A stock option will usually be exercised whenever an employee'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). An individual's exercise decision therefore reveals information about the value he places on an option: the lower the value, the earlier he exercises it. If an employee exercises an option at a certain date prior to maturity, he obviously values it less than or equal to the amount of money he realizes from exercising (while continuing to hold the derivative reveals that he values it above its intrinsic value).

[3]Stock option programs usually forbid employees to bilaterally sell their options and to go short in the underlying company stock.

Rational Determinants of Behavior

Lambert et al. (1991) formally showed that risk preferences and endowments of individuals affect the valuation of employee 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 employee's entire wealth structure and his risk preferences affect his subjective valuation.[4] More specifically, Lambert et al. (and later also Hall and Murphy, 2000, 2002) show that the option value is lower for employees who are more risk averse, who hold a larger fraction of wealth in company stock, and who have less outside wealth.

It is well documented that an employee's firm-specific skills grow over time and increase 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 employee 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 employees with a more firm-specific human capital exercise options earlier in order to diversify.[5]

Behavioral Determinants of Behavior

There exists widespread and persistent evidence in the academic literature that psychological/behavioral factors affect individual decision making in economics and finance.[6] In what follows, we consider three psychological variables and their relationship to individual behavior in ESO programs.

Increasing empirical evidence shows that individual decisions are subject to the psychological bias overconfidence. Experimental studies have found that executives are particularly vulnerable to showing overconfidence and the concept of overconfidence therefore cur-

[4]For a typical power utility function, Lambert et al. report that an employee's valuation of a stock option can be less than 50% of the Black and Scholes (1973) option value if he invested 50% of his wealth in his firm's shares.

[5]Apart from these diversification issues, exercise decisions prior to maturity can be rational in cases where option holders urgently need liquidity. Early exercise is rational in such a case if the value sacrificed by exercising pre-maturely is less than the cost for a loan that might be taken out alternatively. See Subsection 6.4.

[6]See Rabin (1998) or Barberis and Thaler (2003).

rently receives increasing attention in the corporate finance literature.[7] Overconfidence can manifest itself in different forms like miscalibration, the better than average effect or in illusion of control (see Glaser and Weber, 2006). In what follows, we consider overconfidence as the tendency of individuals to assign confidence intervals to their estimates of quantities that are too tight (miscalibration). Several studies find that this kind of overconfidence is a robust phenomenon, especially when people judge items that are difficult.[8] As a consequence, overconfidence, defined as an individual's degree of miscalibration, is very likely to affect employee behavior in ESO programs as well. Miscalibrated employees assign confidence intervals to future stock prices that are too narrow and they thereby subjectively underestimate the volatility of future stock returns. In the context of stock options, this individual bias can result in a misvaluation of the time value imbedded in options. The subjectively perceived stock price volatility has two effects on option values: on the one hand, it *increases* value as it lowers the firm-specific risk employees are exposed to. But on the other, hand it also *decreases* value because of the convexity in a stock option's payoff. Whether overconfidence overall leads to earlier or later exercise decisions remains an empirical question.

People regularly believe that favorable outcomes occur more frequently than they actually do (see, e.g., Weinstein, 1980). This phenomenon is often called overoptimism or unrealistic optimism. As with overconfidence, managers are again particulary likely to be exposed to this behavioral bias. Overoptimistic managers believe that future stock returns of their own companies are greater than they actually are. In two recent studies, Bergman and Jenter (2005) and Oyer and Schaefer (2005) incorporate this form of unrealistic optimism into stock option compensation frameworks. Both papers show that companies will compensate their employees with options when employees are irrationally optimistic about company stock. Overoptimistic individuals put higher values on their options and will therefore exercise at later points in time compared to less optimistic individuals.

It is documented in numerous experimental studies that individuals use cognitive operations to organize and evaluate financial activities. Thaler (1980, 1999) denotes this

[7] See Moore (1977), Kidd (1970), and Larwood and Whittaker (1977) as well as Malmendier and Tate (2005) or Gervais et al. (2003).

[8] See Glaser and Weber (2006), Klayman et al. (1999) or Soll and Klayman (2004).

Table 1: **Predicted Relationship Between Exercise Behavior and Rational and Psychological Factors**

This table reports predicted relationships between various rational and psychological variables and ESO valuation/ESO exercise behavior. "+" means that a model or theory predicts that an increase in the respective variable results in an increase in the subjective option value and hence in a later exercise decision. Correspondingly, "-" means that a model or theory predicts that an increase in the variable results in a decrease in the subjective option value and hence in an earlier exercise decision. "?" means that no prediction is possible.

Variable	*Exercise Behavior (Predicted Sign)*
Rational Variables	
Risk Aversion	-
Stockholdings	-
Wealth	+
Firm-specificity of human capital	-
Psychological Variables	
Miscalibration	?
Optimism	+
Mental accounting	-

kind of thinking as mental accounting. Mental accounting violates the economic axiom of fungibility as individuals perceive economically identical assets in isolation (by assigning them to different mental accounts). 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).[9] Using prospect theory, Massey (2003b) 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 that suffer from narrow bracketing should hence exercise their options earlier compared to those that integrate their financial wealth.

A related aspect of mental accounting is that individuals often have myopic perspectives when evaluating assets (temporal narrow bracketing).[10] Benartzi and Thaler (1999) have shown that myopia of investors with respect to risky gambles can lead to more risk averse

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

[10] See Kahneman and Lovallo (1993).

decision-making. In the context of employee options, this line of argument implies that individuals with short-term perspectives concerning stock price changes will regard options as being less attractive. One can therefore predict that myopic individuals will be more likely to exercise their ESOs at early dates.

Overall, the economic literature thus suggests that a set of rational and psychological variables (risk aversion, company stockholdings, wealth, the firm-specificity of human capital, miscalibration, optimism, and mental accounting) appears to be relevant for the understanding of individual behavior in ESO programs. Table 1 summarizes the predicted relationships between the variables discussed above and exercise decisions. To get a thorough understanding and explanation of actual exercise patterns, one needs to ascertain these variables (or proxies for them) empirically. One way to do this is by distributing a questionnaire to option recipients of a particular ESO program. As most of the variables discussed above are unobservable, we believe that conducting a survey is a very good way to effectively link individual characteristics with employee-level exercise data.

3 Empirical Evidence on Employee Behavior in Stock Option Plans

Data on employee behavior in option plans is highly confidential and causes a lack of empirical studies in the field. The existing empirical findings suggest that employees generally exercise options in a few large transactions and that exercises take place well before expiration. Also, many employees exercise the maximum permissible number of options shortly after the first vesting anniversary.

Core and Guay (2001) find that option exercises are higher when the realizable value of an option on exercise captures a greater percentage of the options theoretical Black and Scholes (1973) value. This finding is considered evidence consistent with employees recognizing that it is costly to exercise options too early (because it involves sacrificing the time value of the option).[11]

[11] Heath et al. (1999) argue that exercise decisions of rational employees meeting liquidity needs or diversification goals are more likely when the ratio of the intrinsic value to the Black-Scholes value is relatively large.

Bettis et al. (2005) find that employees working for firms with high stock price volatility exercise their options earlier than those working for firms with low volatility. Furthermore, employees at higher grades hold their options longer than those at lower ones. They consider this finding as evidence suggesting that risk averse individuals exercise to reduce the exposure to firm specific risk.[12]

Heath et al. (1999) and Huddart and Lang (1996) were the first who tried to study how psychological factors influence exercise behavior. They show that option holders exercise in a way that suggests that they believe that short-term price trends will reverse (mean reversion) and that long-term price trends will persist (trend extrapolation). They also find that exercise activity increases immediately when the stock price exceeds the maximum level that was attained during the previous year.

Massey (2003a) matches data on exercise decisions of employees from a Fortune 100 company with a set of demographic characteristics provided by the company and with stock price characteristics. He finds that exercises are sensitive to behavioral factors (the short-term stock performance), the volatility of the option, the time-until expiration, and to an individual's experience with options. Demographic characteristics seem to have no impact on the exercise decision.

Even less explored is the question of how option recipients dispose of shares acquired in ESO plans. In a study on changes in stock and option ownership of top managers, Ofek and Yermack (2000) document that executives sell nearly all of the shares they acquired on exercise (regardless of their prior equity ownership).

4 The Company, the Data, and the Stock Option Program

The previous section has shown that empirical research which looks inside firms to study individual behavior in stock option plans is quite rare. Most existing studies look at *aggregate* exercise decisions of employees in different organizations and have no access to individual-specific information. However, to get a deeper understanding of managerial

[12] They hereby assume that lower level employees are more risk averse or have more of their financial and human capital invested in the firm.

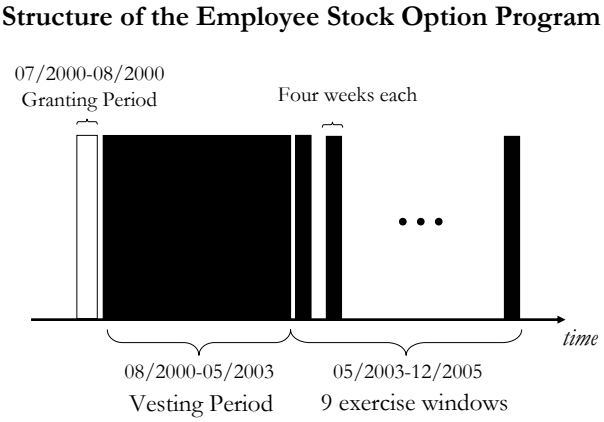
behavior in ESO plans one needs to study more detailed information about the individuals acting in these plans. Our objective is to examine in detail the behavior of managers in one corporation. In particular, we analyze how well the theoretical mechanism on exercise behavior outlined above fit our data. We thereby essentially conduct a clinical study and, as a consequence, concentrate on looking at individual determinants of behavior which show within-firm variation (rather than looking at cross-company determinants of behavior).This section describes the data we use and also summarizes institutional details on the investigated ESO program.

Our first data set contains stock option exercise transactions of all 70 top management employees from one of the largest German corporation. The data set includes detailed records of all exercises of these individuals between May 30, 2003 and September 16, 2004 (the "observation period"). All 70 managers belong either to the management board ("Vorstand") or to the first and second hierarchy level of the firm.

Stock options were granted between July and August 2000. The exercise period within which options are exercisable opened on May 30, 2003 and closes in December 2005. To avoid conflicts of interests with regard to insider information, the company decided that options are not exercisable on all days during the exercise period but only within a few so-called exercise windows. Each exercise window opens after the announcement of company earnings and last for approximately four weeks. The ESO program encompasses nine separate exercise windows in total. Our data set consists of exercises that took place within the first five exercise windows. Since more than 90% of all options were exercised during these five windows, we believe to have an accurate picture of the overall exercise activity. Initially, the strike price of the options was equal to the arithmetical average of the stock price 20 days prior to the option grant (15.00 Euro) with a conversion ratio of 1 (i.e. to buy one share of company stock at a price of 15.00 Euro, one option had to be delivered). To avoid adverse effects for the stock price resulting from a large number of option exercises with subsequent stock sales, the company decided to reduce the strike price from 15.00 Euro to 3.00 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). The program was designed such that employees were allowed to exercise all options at one point in time ("cliff vesting"). Individuals were prohibited from conducting

Figure 1: **Overview of the ESO Program Structure**

This figure documents the basic structure of the stock option program we study. It presents the granting period, the vesting period, and the various exercise windows.



more than one exercise transaction per exercise window. Moreover, they were not allowed to sell the RSI during the vesting period. Figure 1 provides a simplified overview of the structure of the ESO program.

The company is one of the largest in its industry in Europe and employs more than 50,000 people worldwide. Its turnover exceeded 5 billion Euro in 2003 and its shares are publicly traded. The company supplied the data on the condition that itself and its managers remain anonymous. Both during the vesting and during the exercise period, no extraordinary firm-specific events (like bankruptcy or financial distraction) occurred that might have driven the exercise activity. There used to be no traded options on company stock at the derivative exchange Eurex.

Our second data set consists of comprehensive data on individual-specific characteristics, beliefs, and attitudes and was collected by means of a questionnaire. It further includes 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 program received a mail and were asked to participate in the survey. 48 out of 70 option recipients returned our questionnaire resulting in a

response rate of 68.57%. To avoid strategic and untruthful answering, we guaranteed that survey responses are treated confidentially and used for research purposes only. In particular, we assured that neither the executive board of the company nor their human resources department will be able to access individual answers.

5 Methodology and Data Description

In this section, we present details on the methodology of our study and provide descriptions and summaries of the variables and measures we employ throughout our analysis.

Individuals were free in deciding when to exercise their stock options (the exercise windows being the only given restriction). *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 an employee exercised his ESOs during the first exercise window. Correspondingly, it takes the value 0 if he did *not* exercise during the first window. The latter contains both the case that an employee has not yet exercised any of his stock options and the case that options were exercised in the second, third, fourth or fifth window. If options were exercised in more than one window, the variable takes the value 1 if the majority of options was exercised in the first window. The variable is based on the exercise data provided by the company.

When individuals exercise their ESOs, they acquire the underlying company stock and pay the strike price. Option recipients can sell these shares immediately to log in the difference between the stock price at the exercise date and the strike price.[13] Alternatively, they may decide not to sell acquired shares and keep them in their private stock portfolios. To characterize the stock selling behavior of an individual employee, we use a binary variable named *acquired stock*. It takes the value 1 if an individual sold his purchased shares by 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 data collected by our questionnaire.

[13]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 employee. As documented by Heath et al. (1999), cashless exercise is very common in stock option programs.

A variable that is closely related to *acquired stock* is denoted *required stock investment*. Recall that before being granted their ESOs, managers had to buy one share of company stock for every ten options they received. Individuals were restricted from selling these shares during the vesting period. From the inception of the vesting period onwards, employees were free in trading their initial stock investments. *Required stock investment* is a binary variable which takes the value 1 if an employee sold his stock investment (RSI) by the day of participating in our questionnaire, and correspondingly 0 if he did not sell it. We use this measure based on self-reported information.

We argued that *risk aversion* can have a substantial effect on exercise decicions in ESO plans. Following Massey (2003b), we used a certainty equivalence method to elicit the degree of risk aversion of an individual. In this method, employees were offered an uncertain prospect (a lottery) and were asked to indicate the amount of a sure payoff that they consider equally attractive. The lottery was designed as a 50% chance of winning an amount equal to a subject's current wealth, 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 other studies in the decision analysis literature, we work with a power utility function of the form $u(x) = x^{\alpha}$ (see Tversky and Kahneman, 1992). In this parametric form, α reflects the concavity of the utility function and is a measure of an individual's degree of risk aversion. Higher certainty equivalents imply higher values of α and a smaller degree of risk aversion.

To measure individuals' exposure to firm-specific financial risk, we asked each option recipient for the percentage of total wealth that is currently invested in company stock.[14] *Stockholdings* consequently reflects the value of an employee's company stock holdings divided by his total wealth.

Managers at higher levels in a company receive a large number of stock options and

[14]We presented two questions. In the first question, we asked individuals about the percentage of *total wealth* (including savings, shares, mutual funds, bonds, life insurance, home equity etc.) that is currently approximately invested in stocks and mutual funds including stocks. The second question asked them about the fraction of their *total stockholdings* that is invested in company stock (including shares they received by exercising their options and shares resulting from the required and not yet sold RSI). We combined the answers to both questions multiplicatively to get a measure of an employee's total wealth invested in company stock. The questionnaire can be found in the Appendix.

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. We use the number of options granted to an individual (*options*) as a proxy for wealth.[15] This information is based on the transaction data set provided by the company. 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.

To measure the degree of miscalibration, we asked individuals to provide lower and upper bounds of 90% confidence intervals to two questions concerning index level forecasts (for the DAX and the Euro Stoxx 50), and to one question concerning the forecast of the price of company stock for the end of the year 2004.[16] Confidence interval questions are widely used in the literature to elicit probability distributions and variance estimations of stock returns.[17] Following the methodology suggested in Keefer and Bodily (1983), we transformed confidence intervals into volatility estimates and compared them with a volatility benchmark.[18] We use two measures of miscalibration: *Miscalibration market* is used as a measure to reflect an individual's degree of miscalibration with respect to general stock market trends.[19] *Miscalibration company* measures an individual's miscalibration of his volatility forecast for company stock. A lower value of our miscalibration measure

[15]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 6.1.2 for descriptive data.

[16]The lower bound was defined such that the correct index/market price level at the end of the year 2004 should not fall short of this bound with a probability of 95%. Similarly, the upper bound was defined such that correct index/price level at the end of the year 2004 should not exceed the bound with a probability of 95%.

[17]See, for example, Glaser and Weber (2005, 2006), Klayman et al (1999), Biais et al. (2005), and Soll and Klyman (2004).

[18]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. As volatility benchmarks, we use historical volatilities of non-overlapping 7 months returns. Historical volatilities are often used as objective volatility benchmarks or as estimates for future volatility (see Graham and Harvey, 2002 or Glaser and Weber, 2006). Implied volatilities of exchange-traded options on company stock were not available. Note that the forecast horizon in the questionnaire was approximately 7 months. By dividing the Keefer and Bodily (1983) measure through the corresponding historical values, we get a measure of an individual's degree of miscalibration.

[19]It is constructed by calculating the arithmetic average over the miscalibration measures for the two market indexes DAX and Euro Stoxx 50.

reflects tighter confidence intervals and implies a higher degree of miscalibration.[20]

In order to investigate the impact of stock market forecasts on employee behavior, we asked each option recipient to provide a median forecast for the values of the two indexes DAX and Euro Stoxx 50, as well as for the price of company stock at the end of 2004. For each individual, we transformed these price/index forecasts into median return forecasts. We thereby construct a measure of the general market optimism of an individual (*optimism market*), and a measure of his optimism concerning company stock (*optimism company*). *Optimism market* is calculated as the average over the market forecasts for DAX and Euro Stoxx 50. *Optimism company* is simply the expected return for company stock.

To asses the pervasiveness of mental accounting, we investigated whether individuals 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*.[21] To explore the second dimension of mental accounting, we wanted to know how far option recipients actually look ahead 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 an employee 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). In addition, employees provided information on their *education* levels by indicating to what category their highest degree belonged to.[22] Due to the fact that all option recipients were men, we did not have to account for gender effects.

Table 2 summarizes the variables used in our empirical analysis and presents their respective data sources. A copy of the questionnaire can be found in the Appendix.

To investigate the determinants of exercise decisions, we form two groups of individuals:

- a group consisting of people that immediately exercised stock options and decided to

[20] If the value of the miscalibration measure equals one, we call an individual well-calibrated. If the ratio is smaller than one, he is considered miscalibrated.

[21] More specifically, individuals were asked to indicate to what extend the statement "I try to make my private stock investments in a way that takes my positions in employee stock options into account" is consistent with their own behavior. They registered their answers on a seven-point scale ranging from "I strongly disagree" (1) to "I strongly agree" (7).

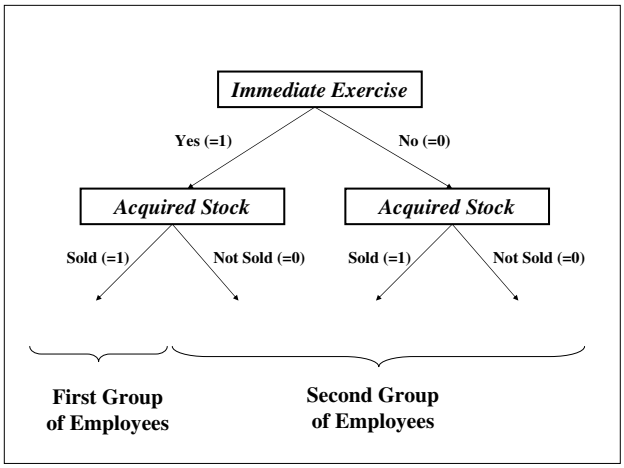
[22] With the categories being "traineeship in business" (coded 1), "university degree" (coded 2), "PhD" (coded 3) and "none of the above".

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 employee exercised his options in the first exercise window; and 0 if an employee 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 employee sold his acquired shares by the day of filling in our questionnaire; and 0 otherwise.
Required stock investment	Questionnaire	Binary variable which takes the value 1 if an employee sold his required stock investment by the day of filling in our questionnaire; and 0 if he did not sell it yet.
Risk aversion	Questionnaire	Measures an employee's degree of risk aversion.
Stockholdings	Transaction data	The value of an employee's company stock holdings to his total wealth.
Options	Transaction data	The number of stock options granted to an employee and a proxy for wealth.
Tenure	Questionnaire	The number of years an employee works for the company and a proxy for the firm-specificity of human capital.
Miscalibration market	Questionnaire	Measures an employee's degree of miscalibration with respect to two questions concerning confidence intervals of two market indices and is used as a proxy for overconfidence.
Miscalibration company	Questionnaire	Measures an employee's degree of miscalibration with respect to a question concerning the confidence interval of company stock and is used as a second proxy for overconfidence.
Optimism market	Questionnaire	Measures an employee's degree of optimism with respect to general stock market movements .
Optimism company	Questionnaire	Measures an employee's degree of optimism with respect to company stock.
Narrow bracketing	Questionnaire	Measures an employee's degree of wealth integration.
Time horizon	Questionnaire	Variable which takes the value 2 if an employee 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).
Education	Questionnaire	An employee's education level ("traineeship in business" (coded 1),"university degree" (coded 2), "PhD" (coded 3) and "none of the above").

Figure 2: Realizations of Transaction Variables



sell the shares acquired on exercise (i.e. a group that decided to reduced the entire risk instantaneously); and

- a group consisting of people that either decided not to exercise stock options immediately or not to sell shares acquired on exercise (i.e. a group that decided to kept some risk).

To clarify our classification, Figure 2 provides an overview of the possible realizations of the two transaction variables *immediate exercise* and *acquired stock*. The first group consists of people where the value of both *immediate exercise* and *acquired stock* are "1", while the second group consists of people where the value of either *immediate exercise* or *acquired stock* were "0".

Having partitioned the option holders, we investigate why the two groups reveal differences in the observed behavior. We therefore employ the information that was collected in our questionnaires. We compare the mean values of a certain variable (e.g. risk aversion) between the two groups and perform a Wilcoxon rank-sum test (Mann-Whitney test) to test the hypothesis that the values of the two sample means are identical. This enables us to discriminate between the two groups and allows us to investigate which factors are responsible for differences in individuals' actual exercise decisions. We thereby study to what extent the theories and predictions outlined in Section 2 are supported by our

data. Because of the limited size of our sample, we do not perform multivariate analyses like discriminant analysis or probit/logit regression models that require much stronger distributional assumptions.

6 Empirical Results

6.1 Descriptive Results

6.1.1 Descriptive Results on Exercise and Stock Selling Behavior

Table 3 presents summary statistics on the behavior of the management employees in the studied ESO program. Panel A provides descriptive results on exercise patterns. It reports the number of individuals that exercised their stock options immediately, the number of options exercised in the five different exercise windows, and the total number of per-individual exercise transactions that was executed. Consistent with other studies in the field, we find that early exercise is a pervasive and strong phenomenon in our sample.[23] A majority of all individuals, 64.43%, exercised their options during the first window reflecting a strong propensity to exercise early.[24] Early exercise is also evident when we consider the fraction of options that was exercised in each of the five exercise windows. After five out of nine windows, only 4.76% of all outstanding options have not yet been exercised. Interestingly, we find that a vast majority of individuals, 81.43%, exercised their options in one large transaction.

Panel B reports statistics on the stock selling behavior. It shows that most individuals, 87.23%, sold the shares they acquired on exercise.[25] This finding is consistent with other results in the ESO literature (see, e.g., Ofek and Yermack, 2000). Having exercised their options, most individuals therefore seem to be aware of the diversification problem and

[23] For similar evidence on early exercise, see, e.g., Bettis et al. (2005), Massey (2003a), Hemmer et al. (1996) or Huddart and Lang (1996).

[24] Within the group of immediate exercisers, 71.11% (32 out 45) exercised their options even within the first three trading days.

[25] Shares were sold either immediately or up to the point of time where the questionnaire was returned. Within the number of sold shares, the vast majority, 90.89%, was sold upon exercise.

Table 3: **Descriptive Results on Employee 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 their stock options immediately (an exercise decision is named early if it occurs within the first exercise window), the number of options exercised by employees in the five distinct exercise windows and the total number of exercise transactions that was executed by option holders. Panel B reports statistics on individuals' stock selling behavior. It shows whether or not employees 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 management employees participated in the stock option program and 48 employees returned our questionnaire. For a discussion of a potential non-response bias, see Subsection 6.4.

Panel A				
Exercise Behavior				
	Timing	Immediate exercise (♯ of empl.)	45	(64.43%)
		No immediate exercise (♯ of empl.)	25	(35.57%)
	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 not yet exercised	35,034	(4.76%)
	Number of exercises	One exercise decision (♯ of empl.)	57	(81.43%)
		Two exercise decisions (♯ of empl.)	10	(14.29%)
		Three exercise decisions (♯ of empl.)	2	(2.86%)
		Four or five exercise decisions(♯ of empl.)	0	(0.00%)
		No exercise decision (♯ of empl.)	1	(1.43%)
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

rationally convert acquired shares into cash. To act consistently, individuals should also sell the shares purchased for the required stock investment (RSI). However, Panel B shows that a significantly smaller percentage of option recipients, 35.42%, also sold these shares of company stock. A majority still ties a significant proportion of financial wealth to the value of the firm by holding RSI shares.

The observation that employees tend to reduce their option holdings very early is remarkable from an agency perspective. A major argument for the widespread use of stock options are the incentive effects associated with them. If options are systematically exercised for cash very early and at the beginning of the exercise period (as in our case), the incentive effects disappear much earlier than probably expected by the issuing companies (with the vesting period remaining the main incentive contracting mechanism).

Overall, our results document that most employees exercise a maximum number of options in a few large transactions at the beginning of the exercise period. Individuals exercise for

cash and hereby reduce their exposure to company stock. However, our evidence suggests that employees suffer from mental accounting and violate the fungibility principle: they dispose differently over shares acquired on exercise and over shares bought for the RSI. Equity from the first source is much more likely to be converted into cash than that of the second one.

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, 90% of the option holders exercised for cash (27 out of 30). This finding suggests that immediate exercisers are aware of their diversification problems and exercise to diversify (or to satisfy liquidity needs). However, Panel C again shows the differences in the disposition over acquired shares vis-a-vis RSI shares. According to economic theory, individuals should consider shares of company stock, independent of the source, as perfect substitutes. Our finding of a difference in the disposition over these shares might be due to the fact that employees regard shares acquired on exercise and RSI shares separately, and consider narrowly defined gains and losses for each source of equity. Prospect theory provides a behavioral explanation for this kind of behavior (see Kahneman and Tversky, 1979). Shares acquired on exercise and shares of the required stock investment differ with respect to their purchase prices: the strike price of an employee option was 3.00 Euro, while the purchase price of a RSI share was approximately 15.00 Euro.[26] At the end of the closed period, the stock price exceeded 22.00 Euro and did not decline below 20.00 Euro from this date onwards. Virtually, both sources of company stock differed in their purchase prices.[27] If purchases prices of employees act as their reference points then the disposition effect predicts that individuals sell shares acquired on exercise but not those resulting from the RSI (as selling the earlier implies realizing a higher gain).[28] Moreover, it is well-known that individuals are more risk averse on stocks with larger gains compared to those with smaller gains. This is due to the concavity of the value function and further suggests that acquired shares rather than RSI shares are sold. Overall, these behavioral

[26] During the time period in which the company asked individuals to buy the required stock investment, the average stock price was approximately 15.00 Euro.

[27] Note that from an economic point of view, funds from selling RSI shares are identical to those that result from selling shares acquired on exercise. From a tax perspective, individuals should rather sell the RSI shares.

[28] See, e.g., Odean (1998) for the assumption that purchase prices are used as reference points.

arguments provide an explanation why a significant number of employees sold the shares acquired on exercise but not those of the RSI. Supporting evidence for our interpretation is provided by Grinblatt and Keloharju (2001) on trading decisions of individual and institutional investors in Finland. They empirically document that shares with larger past return are more likely to be sold by investors.

An alternative explanations for our finding might be that RSI shares were considered as an implicit contract to hold some minimum amount of stock. Also, the difference in the holding periods of the respective shares might explain our finding. Shares from the RSI were bought at least three years ago and individuals got accustomed to the fluctuations in its value (compared to acquired shares which were purchased at the date of exercise). RSI shares therefore more likely became part of an employee's perceived "total wealth", leading to a reduction in the propensity to sell these assets quickly.

6.1.2 Descriptive Results on Questionnaire Data

Table 5 summarizes descriptive statistics on our questionnaire data. Apart from *options*, all variables were calculated on the basis of the 48 returned questionnaires. The parameters listed are means, medians, minimums, maximums, standard deviations, and the number of observations of the each variable (Obs.).

The mean certainty equivalent for our presented lottery was a 25% increase in total wealth (median = 25%, std. dev. = 16.42%), leading to a mean value of *risk aversion* equal to 0.55 (median = 0.50, std.dev. = 0.37). The average employee 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 25.31% into company stock (not reported in Table 5).[29] On average, managers received 10,520 options (median = 10,000, std.dev. = 11,435), and this number fluctuated between 1,000 and 50,000.[30] The average individual has been working for the company for 17.76

[29] 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.

[30] 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.

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

This table reports descriptive statistics on risk aversion, company stockholdings (percentage of total wealth invested in company stock), the number of options granted to employees, employees' tenure, their degree of miscalibration (see Section 5 for details), their degree of overoptimism (see Section 5 for details), their degree of narrow bracketing, their time horizon (see Section 5 for details), education and age. 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	0.55	0.50	0.37	0.23	1.16	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
Miscalibration market (in %)	0.35	0.30	0.17	0.10	0.90	45
Miscalibration company (in %)	0.22	0.22	0.09	0.03	0.51	46
Optimism market (in %)	6.00	6.13	6.39	-12.86	19.71	43
Optimism 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
Education	2.12	3.00	0.61	1.00	4.00	47

years (median = 15.00, std.dev. = 8.17).

We find that individuals' probability estimates are generally not well-calibrated, both regarding the market and the company forecast (mean value of *miscalibration market* = 0.35, mean value of *miscalibration company* = 0.22). However, these findings are consistent with results on miscalibration in the overconfidence literature (see, e.g., Glaser et al., 2006). Table 5 further documents that individuals expect a stock market year end return of 6.00% (median = 6.13%, std.dev. = 6.39%), and that the average employee predicts a return of 7.37% for company stock (median = 6.76%, std.dev. = 4.87%).

Table 6 presents further details on the volatility forecasts for the two indexes and for company stock. Volatility forecasts are calculated as described on page 15 and the table compares these estimates with historical volatilities. It shows that in all three cases,

Table 6: **Volatility Forecasts**

This table presents volatility forecasts for the stock market indexes DAX and EuroStoxx 50 and for company stock. Volatility forecasts are calculated as described in Section 5. In addition, the table shows historical volatilities of non-overlapping 7 month returns. We calculated historical volatilities until October 2004.

DAX	Mean	5.75%
	Number of Observations	45
	Historical standard deviation	17.94%
	(May 1987 - October 2004)	
EuroStoxx 50	Mean	5.78%
	Number of Observations	40
	Historical standard deviation	15.45%
	(May 1987 - October 2004)	
Company Stock	Mean	6.80%
	Number of Observations	46
	Historical standard deviation	30.32%
	(May 1987 - October 2004)	

volatilities are heavily underestimated. In the case of company stock, for example, the historical standard deviation of non-overlapping 7 month returns is 30.32%, while individuals expect a volatility of only 6.80% on average.[31]

Returning to Table 5, we find that mental accounting is also a very pronounced phenomenon in our sample. Almost all employees 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). Evidence for the presence of mental accounting is further reflected in the values of the second mental accounting variable (*time horizon*): individuals have very myopic perspectives when evaluating company stock. Only three out of 46 management employees have a long-run view regarding stock price movements. Most employees look forward only three months up to one year (35 indi-

[31] Note that the miscalibration measure in Table 5 (e.g. for company stock) results from dividing the mean value of the volatility forecast by the historical standard deviation (see Table 6).

viduals) or even less then three months (8 individuals). Given recent public discussions on short-termist behavior of corporate officers, this finding is particularly striking. Finally, the education levels of the responding individuals look as follows: four employees have a traineeship in business, 35 hold a masters degree, six a PhD, and two have any other degrees.

Correlations for the variables gathered by our questionnaire can be found in the Appendix (Table 9).

6.2 Between Group Differences in Individuals' Exercise Behavior

This subsection investigates to what extent variables like risk aversion, company stock-holdings, miscalibration or mental accounting can explain the differences in the observed exercise behavior across the individuals in our data set.

Table 7 compares individual variables for the group of employees that immediately exercised their ESOs with those from the group that did not exercise immediately (or that did not sell acquired shares). For each of the two groups, the table contains means and medians of the respective variables as well as the number of observations used in calculating each variable (Obs.). The last column presents p-values of a two-sample Wilcoxon rank-sum test (Mann-Whitney test) comparing the respective median values. The null hypothesis is that the two groups are from populations with the same medians.

Rational valuation 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). These general models should also apply to our data. But surprisingly, we find that the latter group neither shows a significantly higher degree of risk aversion (median value of 0.50 vs. 0.50; p-value = 0.4208) nor significantly larger holdings of company stock (median value of 2.25% vs. 1.25%; p-value = 0.5933). These results are puzzling from a standard ESO valuation point of view. Moreover, they suggest that individual behavior in our data might be driven by factors not included in

Table 7: **Between Group Differences: The Exercise Behavior of Employees**

This table compares descriptive statistics for the group of employees that immediately exercised their options and sold the acquired shares with the group of employees 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 mean values of a certain variable for the two groups. The null hypothesis is that the two groups are from populations with the same means. * indicates significance at 10%; ** indicates significance at 5%; *** indicates significance at 1%.

		Group of employees who immediately exercised and sold acquired shares	Group of employees who did *not* exercise immediately or who did *not* sell acquired shares	p-value
Risk aversion	Mean	0.48	0.53	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	
Miscalibration market	Mean	0.30	0.41	0.0113**
	Median	0.28	0.38	
	Obs.	24	20	
Miscalibration company	Mean	0.20	0.25	0.0771*
	Median	0.21	0.22	
	Obs.	24	21	
Optimism market	Mean	5.75	6.22	0.7432
	Median	6.19	6.03	
	Obs.	22	20	
Optimism 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	
Education	Mean	2.15	2.10	0.9771
	Median	2.00	2.00	
	Obs.	26	20	

rational models of exercise.[32]

We argued that the amount of options granted to an employee can be considered as a proxy for labor income and wealth (see Section 5). Lambert et al. (1991) model a manager's absolute risk aversion as a decreasing function of wealth, and they thereby show that option values are strictly increasing in wealth. Following this prediction, we expected that wealthier employees 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 second group (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), providing support for the argument of Lambert et al. (1991).

We further used *tenure* as a measure for the firm-specificity of human capital. In general, we hypothesized that rational employees with more firm-specific human capital (i.e. with a longer job tenure) exercise their options earlier to reduce the risk exposure that is related to the value of the firm. Our data, however, contradicts this conjecture: we do not find that immediate exercisers show a significantly longer job tenure (median value of 15.00 years vs. 13.50 years; p-value = 0.9119).

To test if and how psychological factors are responsible for the differences in the observed exercise behavior in our data set, we investigate to what extent the two groups reveal variation in their degrees of miscalibration, optimism, and mental accounting.

Interestingly, we find that the group of immediate exercisers is significantly more miscalibrated compared to the second group. Our findings seem to be robust as both measures of miscalibration show significant between-group differences.[33] This finding surprised us since traditional theories have not yet incorporated judgement biases like overconfidence (defined as individuals' degree of miscalibration) in ESO valuation models.[34] We argued

[32] Alternatively, we might not have measured risk aversion and diversification appropriately.

[33] Moreover, the correlation between both miscalibration 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 miscalibration results.

[34] Malmendier and Tate (2005) use ESO exercises as a proxy for overconfidence within a behavioral corporate finance model. Different to our aspect of overconfidence (miscalibration), they consider overconfidence as the belief of managers to possess the ability to keep the companies' stock prices rising. They predict that overconfident managers exercise their

that the subjectively perceived stock price volatility has two opposite effects on option values: on the one hand, it *increases* value as it lowers the firm-specific risk employees are exposed to. But on the other, hand perceived volatility also *decreases* value because of the convexity in a stock option's payoff. Depending on the magnitude of the two effects, miscalibration can therefore result in an underestimation of the time value imbedded in options. Consistent with this argumentation, Henderson (2002) provides evidence showing that when volatilities are underestimated, option values do decrease leading to earlier exercise decision.[35] Our evidence therefore suggests that miscalibration causes a downward-biased estimate of the time value imbedded in options. Our results show that individuals who systematically underestimate volatilities seem to put a too small value on options and exercise earlier compared to less miscalibrated individuals.[36] This result suggests that overconfidence, modelled as miscalibration, might provide a promising basis for the modelling of exercise decisions.

Abstracting from exercise motives like diversification or liquidity needs, one should expect that exercise decisions are also based on personal stock market forecasts (optimism). We argued in Section 2 that option holders who are overoptimistic 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 argument empirically. Our results show that the group of immediate exercisers is neither significantly less optimistic about the stock market as a whole nor about company stock itself.

Based on experimental evidence, we further predicted that mental accounting, proxied by *narrow bracketing* and *time horizon*, also significantly affects ESO exercises. Massey (2003b) argued that the more narrowly an individual brackets his options, the lower he typically values it. Applying this argument to option exercises, we predicted that the less

options later compared to a rational benchmark.

[35]Note that we assume that an individual's degree of miscalibration is constant over time. Experimental studies on miscalibration find evidence on this kind of stability over time (see Jonsson and Allwood, 2003 or Glaser et al., 2004)

[36]Further support for our argumentation comes form the finding that both miscalibration measures are positively correlated with the fraction of options that individuals effectively obtained (Rho = 0.4606 for *miscalibration company* and Rho = 0.3515 for *miscalibration market*; with both correlation coefficients being significant at the 5%-level). These results shows that more miscalibrated individuals asked for a smaller percentage of options relative to what they were offered by the company. Abstracting from financial constraints, these figures again indicate that more miscalibrated individuals seem to underestimate the value of stock options more heavily.

an individual integrates an ESO into his wealth, the earlier he will exercise it. Inconsistent with this conjecture, we find no significant difference in the values of *narrow bracketing* between the two group of employees. However, the second aspect of mental accounting seems to be more promising: we find that immediate exercisers have significantly shorter perspectives with respect to price changes of company stock (mean value of 0.77 vs. 1.05). This finding confirms our prediction that myopia causes individuals to exercise their options earlier. This evidence is also in line with the arguments in Benartzi and Thaler (1999) who document that myopia can lead to more risk averse decision making.

The main results of this subsection can be summarized as follows. Inconsistent with traditional ESO theories, we cannot detect that immediate exercise behavior in our data is driven by risk aversion and diversification needs (company stockholdings). Instead, our results suggest that exercise decisions are related to the psychological factors miscalibration and mental accounting (temporal narrow bracketing).

6.3 Why Did Employees Exercise So Early?

Having studied the impact of individual characteristics on exercise decisions, there still remains the open question of why so many employees decided to exercise their options *immediately* after the vesting period. We believe that loss aversion is a major aspect that can possibly explain this behavior (even though we have no data on it). Individuals received their ESO in July/August 2000, i.e. almost three years before the options actually became exercisable. All stock options already had considerable intrinsic value at the beginning of the vesting period and employees certainly perceived this value. Given that all options were granted *on the top* of existing salaries, it is likely that employees regarded these granted ESOs as a "gift" and considered the value of this "gift" as a reference point for future evaluation. Having the pervasiveness of mental accounting among the surveyed individuals in mind, it is also very likely that they have put their stock options into a separate mental account (e.g. for consumption after the vesting period). After the vesting period, individuals had to decide whether to consume this amount of money by exercising or whether to hold the option for another time period. Holding the option is thereby equivalent to taking part in a lottery that has, say, a 50/50 chance of losing/winning a certain amount. The value of an individual's option package at the vesting date herby

very likely served as a reference point. Overwhelming empirical and experimental evidence shows that humans are much more averse to losses than to same-sized gains in such situations (see, e.g. Kahneman and Tversky, 1979). Tversky and Kahneman (1991), for example, show that individuals value losses almost twice as much as gains of equal size. For a loss averse individual to take part in such a bet, a very high gain relative to the loss would consequently be required. Otherwise, he will immediately exercise his option package to avoid the participation in the lottery (which is consistent with our data). Loss aversion and narrow bracketing might therefore explain our finding that a huge number of options was exercised immediately after the vesting period.

6.4 Robustness Checks

The first part of this subsection is concerned with a possible non-response bias in our data sets. 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, 35.64% of all granted options were given to the 22 non-respondents. Table 8 compares the distribution of exercises over the five past 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 the windows 3 to 5. Based on our available information, we therefore have no indication that the exercise behavior of the responding individuals systematically differs from that of the non-responding ones.

Rational 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 individuals to indicate to what extend 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 employee stock option program".[37] The mean answer to this question was 2.00 (median =

[37] Answers were measured on a seven-point scale ranging from 1 ("I totally disagree") to 7 ("I totally agree").

Table 8: **Non-Response Bias: Respondents vs. Non-Respondents**

This table compares the distribution of exercise transactions for the 22 non-respondents with those of the 48 respondents.

Exercise Window	*Respondents*	*Non-Respondents*
Options exercised in window 1:	41.86%	52.00%
Options exercised in window 2:	32.20 %	29.90%
Options exercised in window 3:	9.09%	5.71%
Options exercised in window 4:	2.71%	4.76 %
Options exercised in window 5:	0.00%	0.00%

2.83, std.dev = 2.09), which suggests that tax deliberations are a secondary consideration only and can be neglected in our data. Accounting for liquidity-motivated exercising is more difficult. Rational employees can 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 employees (as they usually have lower salaries but higher expenditures in their present life-cycle phases). 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 employee 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 grades might 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 board members.[38] The average answer to this question was 1.95 (median = 1.00, std.dev. = 1.64) which suggests that imitations of board member exercises were of minor importance only.

7 Conclusion

Using a unique data set, we studied the exercise and stock selling decisions of individuals within a particular stock option plan, and tried to provide a contribution towards a deeper understanding of how individuals behave in these programs. Our data set is much more comprehensive and detailed then previous ones, but our study is limited in that it is essentially a case study. Nevertheless, it provides an interesting opportunity to study the following questions: How do employees exercise their stock options? How do employees dispose of shares acquired in stock option programs? What rational and behavioral factors explain differences in the observed employee behavior?

Our findings show that individuals exercise their stock options very early and in a few large transactions. A large majority of option recipients sell the shares acquired on exercise. From an agency perspective, this finding documents that the incentive effects that are usually associated with stock options disappear much earlier than (probably) expected by the program initiating company. A precise ex-ante estimation of this sort of exercise pattern could have significantly reduced the accounting costs of the granted options to the issuing firm. Furthermore, our results suggest that, inconsistent with standard ESO models like those of Lambert et al. (1991) or Hall and Murphy (2000, 2002), exercise activity in our data set is *not* driven by factors like risk aversion or company stockholdings that are included in these rational models of exercise. Instead, we show that exercise decisions depend on the psychological factors miscalibration and mental accounting. These findings suggest that the cost estimation for ESO plans might need to take psychological factors into account. Our findings supplement the study by Heath et al. (1999) which also documents that psychological factors can affect peoples' exercise decisions. Based on loss aversion, we provided an argument for our finding that a significant number of options

[38] More precisely, we presented the following pre-formulated question: "The information that board members have exercised stock options has an influence on the timing of my exercise decision". Answers again ranged from 1 ("I totally disagree") to 7 ("I totally agree").

were exercised immediately after the vesting period. Our findings on behavior that is *in*consistent with the predictions of rational decision making models is remarkable from an economic perspective given that the individuals in our data set are top managers and important decision makers in one of the largest German corporations. It is therefore likely that these individuals are also prone to psychological biases when dealing with important corporate decisions (like investment and financing decisions).

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APPENDIX

Questionnaire

General Questions

In the next questions, we are interested in the importance of stocks within your private investment portfolio.

What percentage of your total wealth (including savings, shares, mutual funds, bonds, life insurance, home equity etc.) is 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] stocks (including stocks you received via the Employee Stock Option Program, stocks you still hold from the required initial stock investment of the Employee Stock Option Program 2000 (the so called "Eigeninvestment"), employee stocks etc.)? (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

In the next questions, we would like you to make three statements concerning your forecasts of future index levels/market prices: a lower bound, a best estimate, and an upper bound.

The statements should be made such that the correct index level/market price (for instance in the first question, the true value of the Deutsche Aktienindex DAX at the end of 2004) 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 respectively 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)

	Lower Bound	Estimate	Upper Bound
Value of the DAX (Deutscher Aktienindex) at the end of the year 2004 (10.06.2004: 4.021,64)			
Value of the EURO-STOXX 50 at the end of the year 2004 (10.06.2004: 2.800,18)			
Stock price of the [Company] stock at the end of the year 2004 (10.0.2004: X€)			

Moreover, we are intersted in the relevance of tax considerations for your personal exercise behavior:

"Tax considerations play an important role with respect to my exercise decisions within an employee stock option program" (please mark)

1	2	3	4	5	6	7
I strongly disagree						I strongly agree
O	O	O	O	O	O	O

In the next questions, we are interested to what extent the following factors influence your exercise behavior.

"My activity within the employee 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 employee stock options into account" (please mark)

1	2	3	4	5	6	7
I strongly disagree						I strongly agree
O	O	O	O	O	O	O

"The information that board members ("Vorstand") have exercised stock options has an influence on the timing of my exercise decision"

1	2	3	4	5	6	7
I strongly disagree						I strongly agree
O	O	O	O	O	O	O

In the subsequent questions, we are interested in how far you look into the future if you make stock price estimates for the stock price of [Company]

If you consider your stock options and possible future stock price of [Company], 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

Some Questions about what happened with your [Company] Stocks

If you have already exercised some or all of your stock options, the hereby acquired stocks might have been sold either *by yourself* or *via the block trade procedure* immediately after your exercise decision. In the subsequent questions, we are interested in what you did with the stocks that you received by exercising your stock options.

If you have exercised your options in two exercise windows, please use the subsequent subsections a) AND b). If you have exercised your options only once, please use subsection a) only

a) After your first exercise decision

I have immediately sold the acquired stocks via the block trade procedure

Yes	O
No	O

If "No", i.e. if you did not participate in the block trade procedure, what have you done with the acquired stocks? (Please mark)

I have not sold these stocks yet	O		
I sold these stocks immediately	O		
I sold these stocks at different points in time (in this case, please state the approximate date and the approximate number of stocks you sold on this date)	O	Approximate date:	Approximate number of stocks sold:

b) After your second exercise decision (ONLY if you exercised in two exercise windows)

I have immediately sold the acquired stocks via the block trade procedure

Yes O
No O

If "No", i.e. if you did not participate in the block trade procedure, what have you done with the acquired stocks? (Please mark)

I have not sold these stocks yet	O		
I sold these stocks immediately	O		
I sold these stocks at different points in time (in this case, please state the approximate date and the approximate number of stocks you sold on this date)	O	Approximate date:	Approximate number of stocks sold:

Within the Employee Stock Option Program 2000, [Company] asked you to purchase a certain number of [Company] stock (the so-called "Eigeninvestment"). In the following questions, we are interested in what you did with these stocks after their unblocking.

I have not sold these stocks yet	O		
I sold all these stocks immediately after their unblocking (for example via the block trade procedure)	O		
I have sold these stocks at different points in time (in this case, please name the approximate date and the approximate number of stocks you sold at that date)	O	Approximate date:	Approximate number of stocks sold:

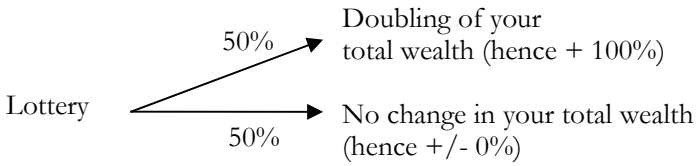
Some Questions About your Attitude towards Risk

In the following question, <u>you have to</u> choose between two alternatives:

a) the participation in a lottery
or
b) a guaranteed change in wealth

Consider your total wealth (including your savings, your investments, your home equity, etc.). Think of your best estimate of your total wealth.

- Now consider the following lottery:



with 50% probability your total wealth will double (+100%) and
with 50% probability your total wealth will remain the same (hence +/- 0%)

- Alternatively to participating in this lottery, your total wealth could simply increase by a certain guaranteed percentage of your total wealth.

Now consider different increases in your total wealth (e.g. a guaranteed 40% increase in your wealth) and check whether you prefer this guaranteed increase in your wealth or the participation in the lottery (please check all cases and mark your preferred alternative)

Guaranteed increase in your total wealth by…	I prefer…	
	... the guaranteed increase in wealth	… the lottery
10% or less	O	O
20%	O	O
30%	O	O
40%	O	O
50%	O	O
60%	O	O
70%	O	O
80%	O	O
90% or more	O	O
I do not know	O	

Some Questions about You

Finally, we have some questions about you:

Please indicate your sex?

Female	O
Male	O

How old are you? (please mark)

_____ years

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

_____ years

Please indicate your education level? (please mark)

Traineeship in business	O
University degree	O
PhD	O
None of the above	O

Table 9: **Correlation Coefficients**

This table reports correlation coefficients between the individual-level variables, as well as the significance level of the respective correlation coefficient and the number of observations used in calculating the correlation (Obs.). * indicates significance at 10%, ** indicates significance at 5%, *** indicates significance at 1%.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Risk aversion	1.00										
	43										
Stockholdings (in %)	-0.15	1.00									
	41	46									
Options	-0.06	-0.10	1.00								
	43	46	70								
Tenure (in years)	-0.28*	0.10	-0.03	1.00							
	42	45	47	47							
Miscalibration market	-0.14	0.08	-0.03	-0.13	1.00						
	40	43	45	44	45						
Miscalibration company	-0.15	0.08	-0.03	-0.13	0.55***	1.00					
	41	44	46	45	45	46					
Optimism market	-0.11	0.02	0.04	-0.05	0.08	-0.23	1.00				
	39	41	43	42	43	43	43				
Optimism company	0.18	-0.12	0.03	-0.00	0.06	-0.04	0.27*	1.00			
	40	42	44	43	43	44	43	44			
Narrow bracketing	0.15	-0.04	0.03	-0.26*	-0.16	-0.07	0.21	0.06	1.00		
	41	44	46	45	43	44	41	42	46		
Time horizon	-0.15	0.03	0.15	0.10	0.24	0.16	0.25	0.07	-0.03	1.00	
	41	44	46	45	43	44	41	42	45	46	
Education	0.28*	0.09	0.24	0.15	-0.00	0.04	0.19	0.13	0.20	0.13	1.00
	42	45	47	47	44	45	42	43	45	45	47