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Abstract

Employee stock options (ESOs) are a widespread and economically highly significant phenomenon, both at the company and at the employee level. Stock options are not only relevant for CEOs, but also and increasingly for managers at lower grades in a corporation. Despite its economic importance, there exists very little empirical research that examines the behavior of employees in stock option programs. Our study attempts to fill this gap by empirically studying the behavior of option holders in a distinct ESO plan. We try to answer the following 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? We study these questions by combining two data sets. The first data set consists of detailed individual-level ESO exercise transactions of senior managers from a large German corporation (transaction data). The second data set is based on an extensive questionnaire in which we asked these employees to answer a wide range of questions on employee-specific characteristics, beliefs and attitudes (questionnaire data). We find that employees exercise their options very early and in a few large transactions. A large majority of option recipients sell the shares acquired on exercise. Furthermore, our results suggest that, inconsistent with traditional ESO theories, exercise behavior is not driven by factors like risk aversion or individuals' holdings of company stock that are included in rational models of exercise. Our findings 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, Survey Methodology

JEL Classification Code: M41, M52, M55

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1 Introduction

Employee stock options (ESOs) are a widespread and economically highly significant phenomenon. Stock options are not only relevant at the CEO level, but also increasingly for managers at lower levels in a firm.[1] For the U.S., Hall and Murphy (2003) document that individuals below the five top executives have received an increasing proportion of total stock option grants. By 2002, this group of employees received more than 90% of all options granted. According to the U.S. National Center for Employee Ownership (NCEO), the number of employees receiving stock options has increased from roughly 1 million in 1990 up to 10 million in 2001.[2] Even in Europe, most companies listed in the German blue chips index DAX 30 or in the Euro-Zone index Euro Stoxx 50 provide broad-based stock option programs as a common compensation vehicle to their employees (see Sautner and Weber, 2005a).

Employee stock options constitute an important economic domain both at the company and at the 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). What makes ESOs so special is the fact that, in comparison to tradeable options, these financial products are non-transferable as well as non-tradable. Moreover, employees are usually prohibited from hedging the underlying risk by short-selling company stock.

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 data limitations on individual-level behavior. Understanding the behavior of employees in ESO programs is, however, important for various reasons.

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

[1] Stock option programs that include more than just the top five executives are usually called employee or broad-based stock option programs (see Bergman and Jenter, 2004 or Core and Guay, 2001). The National Center for Employee Ownership (NCEO) defines stock option programs as *broad-based* if 50% or more of a company's employees receive or hold options. In the remainder of this paper, we use the terms broad-based stock options and employee stock options interchangeably and hereby subsume programs that include more than just the top five executives.

[2] See www.nceo.org.

very quickly. 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 exercise decisions 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 these predictions hold in real life is still relatively unexplored. An empirical study linking employees' observed option exercises with individual characteristics on risk aversion or diversification would provide a way to test the predictions of these theoretical models. Moreover, insights into the determinants of employees' actual behavior could help modifying existing theories and guide future modelling.

After employees have exercised their options, they pay the strike price and receive another risky asset: company stock. Having acquired these shares, individuals can decide whether or not (and at what point in time) to sell them. 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, by no means clear whether and how psychological factors influence behavior in stock option programs (e.g. the decision to exercise). This is particularly astonishing given that an increasing body of literature *without* individual-level data assumes that employee behavior in ESO plans and psychological biases are related (see, e.g., Oyer and Schaefer, 2005 and Bergman and Jenter, 2004)**?**. 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 behavior.

From a practitioner standpoint, understanding exercise patterns is important for the estimation of the accounting costs of stock option programs. According to the Financial

[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.

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.

Hitherto, the discussion has raised the following questions that our study aims to empirically examine:

1. How do employees exercise their stock options?
2. How do employees dispose of company stock acquired in stock option programs?
3. What rational and behavioral factors explain differences in observed exercise behavior?

We study these questions by combining two data sets. The first data set consists of detailed individual-level stock option exercises of senior managers from a large German corporation (transaction data). The second data set is based on an extensive questionnaire in which we asked these individuals to answer a wide range of questions on employee-specific characteristics, beliefs, and attitudes (questionnaire data). It further includes questions about what they 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).[4] For a subgroup of individuals that returned our questionnaire, we are able to match actual behavior (exercise and stock selling behavior) with comprehensive questionnaire 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.[5] We believe that conducting a survey is the only way to address our individual-level research questions.

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

[5]With the exception being Sautner and Weber (2005b).

For each individual, we have data on three core transaction variables. *Immediate exercise* is a binary variable that reflects the exercise behavior of an employees and documents how early he actually exercised his stock options. *Acquired stock* measures whether or not an employee sold the shares he acquired on exercise. Finally, *required stock investment* is a binary variable indicating whether or not an option recipient sold the required stock investment (RSI) that was mentioned above.

Based on these three transaction variables, we examine the behavior of individuals in a distinct option program. To investigate differences in exercise behavior, for example, we form two groups of individuals: one group consisting of employees that immediately exercised their options and sold the shares acquired on exercise, and one complementary group that did not exercise immediately. Having partitioned the sample, we investigate why the two groups reveal differences in the observed behavior. We hereby test the predictions of various rational and behavioral models.

Our main findings can be summarized as follows. Consistent with the ESO literature, 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. 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, our results suggest that, inconsistent with standard ESO models like those of Lambert et al. (1991) and Hall and Murphy (2000, 2002), exercise activity 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. Our findings supplement other studies like those of Heath et al. (1999) and Core and Guay (2001), that show how psychological variables affect exercise decisions of individuals (in their studies reference points and beliefs in trend extrapolation and mean reversion). Based on the work by Henderson (2002), we provide an explanation for our finding that miscalibrated individuals put a too small value on stock options and therefore exercise too early.

The remainder of this paper is organized as follows: Section 2 derives rational and psy-

chological factors that are supposed to affect the behavior in the ESO program. It further surveys the empirical literature that studies the behavior of individuals in option plans. The data sets and the design of our study are described in Section 3. Section 4 presents our methodology and describes the variables we use in the empirical analysis. The results of our empirical study are presented in Section 5. We hereby provide descriptive statistics and explain between-group differences in employee behavior. Finally, Section 6 summarizes our results and concludes.

2 Hypotheses and Related Literature

2.1 Rationality, Psychology and Employee Behavior: Theory and Predictions

2.1.1 Rationality and Employee Behavior: Theory and Predictions

In the following subsection, we derive rational and psychological variables that are supposed to explain the exercise behavior in the studied ESO program. Furthermore, we develop predictions on how these variables affect the timing of individuals to exercise their options.

Employees can neither freely trade or sell their stock options nor hedge away the implied risks by short-selling company stock.[6] Moreover, employees are usually inherently undiversified with their entire human capital invested in the company. The inability to hedge the risk of a stock option and their serious non-diversification will cause employees to value stock options 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.[7]

[6]Stock option programs usually forbid employees to bilaterally sell their options and to go short in the underlying company stock. Moreover, Section 16(c) of the U.S. Securities and Exchange Act of 1934 prohibits officers to short-sell equity of their employers. In 2003, Microsoft created a new *transferable* stock option program which allowed employees to sell their options to the investment bank J.P. Morgan (see Hall, 2004).

[7]Note that it is not rational to exercise a *tradeable* American call options on a non-dividend paying stock before maturity as it would imply a loss of the option's time value (see Hull, 2000). The time value captures the imbedded insurance against

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 the intrinsic value).

Lambert et al. (1991) were the first that formally showed how risk preferences and endowments of individuals affect the valuation of employee options. By using an expected utility framework, they define the value of an option as a 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.[8] Lambert et al. show that the option value is lower for employees who are more risk averse and who have more of their wealth invested company stock.[9]

Building on the certainty equivalence approach of Lambert et al. (1991), Hall and Murphy (2000, 2002) investigate in greater depth the relationship between ESO values and risk aversion, wealth, and diversification. In their model an employee has non-firm related wealth of w, holds s shares of company stock, and is granted an option to buy one share of stock at an exercise price X in T years. If he invests w at the risk free rate r_f and if

a decline in the stock price and the interest that is eaned from holding the option versus immediately buying the underlying stock. There exist two exceptions from this general principle: when dividends are expected, it may be optimal to exercise options immediately prior to a dividend payment (see Merton, 1973). Moreover, decreases in tax rates might compensate for the loss of the time value making early exercises also rational. The pricing of tradeable stock options is based on the construction of a *riskless* portfolio that duplicates the return of the option. Therefore, it is possible to price stock options under the very simple assumption that all individuals are risk neutral. If an employee is assumed to be risk neutral and if he believes that the expected return on company stock is at least as great as the after-tax return on the risk-free asset, then it is even in the case of ESO programs optimal to exercise at maturity only (see Proposition 1 in Huddart, 1994).

[8]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.

[9]Huddart (1994) provides identical results by incorporating effects of risk aversion in a Cox et al. (1979) binomial framework. He shows that for sufficiently risk averse employees, it may be rational to exercise options before maturity.

the stock price at T is given by P_T, his wealth at time T is given by

$$W_T = w(1 + r_f)^T + sP_T + max(0, P_T - X) \tag{1}$$

If alternatively, the employee was given V in cash instead of the option and if he invested this cash at the risk-free rate, his wealth at time T would be

$$W_T^V = (w + V)(1 + r_f)^T + sP_T \tag{2}$$

An employee's option value is now defined as the certainty equivalent V that equates expected utilities, i.e.

$$\int U(W_T^V) f(P_T) dP_T = \int U(W_T) f(P_T) dP_T \tag{3}$$

Hall and Murphy solve equation (3) numerically and show that the certainty equivalent value V depends on the usual Black-Scholes parameters (the exercise price, stock price, dividend yield, stock-return volatility, risk-free rate, time until expiration) as well as on managerial risk aversion, initial wealth, and stockholdings.[10] In particular, they demonstrate that option values decrease in risk aversion and holdings of company stock but increase in non-firm-related wealth. Rational models of exercise therefore predict earlier exercises when option recipients are more risk averse, have more of their wealth invested in company stock, and 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. We therefore predict that rational employees with a highly

[10] Stockholdings are defined as the percentage of wealth invested in shares of company stock.

firm-specific human capital will exercise earlier to reduce the risk exposure that is related to the value of the firm.[11]

In summary, rational ESO models therefore predict that higher risk aversion, more holdings of company stock, and a more firm-specific human capital cause earlier exercise decisions. Increases in outside wealth have the opposite effect and cause later exercises.

2.1.2 Psychology and Employee Behavior: Theory and Predictions

There exists widespread and persistent evidence in the academic literature that psychological/behavioral factors affect individual decision making in economics and finance.[12] 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. Camerer and Lavallo (1999) provide evidence for overconfidence in the economics literature and Glaser et al. (2004) survey the overconfidence literature in the field of finance. Experimental studies have found that executives are particularly vulnerable to showing overconfidence[13] and the concept of overconfidence therefore currently receives increasing attention in the corporate finance literature.[14] Overconfidence can manifest itself in different forms like miscalibration, the better than average effect or in illusion of control (see Glaser and Weber, 2004).

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.[15] As a consequence, overconfidence, defined as an individual's degree of miscalibration, is very likely to affect employee behavior in ESO pro-

[11] 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 5.3.

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

[13] See Moore (1977), Kidd (1970), and Larwood and Whittaker (1977).

[14] See Malmendier and Tate (2004) or Gervais et al. (2003).

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

grams as well. Miscalibrated employees assign confidence intervals to future stock prices that are too narrow and they thereby underestimate the volatility of future stock returns. In the context of stock options, this bias can result in a misvaluation of the time value imbedded in options. Henderson (2002) argues that a decrease in the stock price volatility has a mixed effect 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.[16] Henderson shows that for certain volatility levels, the convexity effect dominates the risk effect and decreases the subjective option value. If individuals systematically underestimate volatilities, i.e. if they are miscalibrated, they will put a too small value on their ESOs and will exercise too early. For other levels of volatility, the opposite effect can hold. Consequently, the precise effect of overconfidence (miscalibration) on exercise behavior depends of the volatility level and can not be predicted from an ex-ante point of view. Whether overconfidence leads to earlier or later exercise decisions hence remains an empirical question.[17]

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. In the field of foreign exchange, Ito (1990), for example, documents that managers are more optimistic about how exchange rate changes affect their own company than how they will affect others. Overoptimistic managers believe that future stock returns of their own companies are greater than they actually are. In two recent studies, Bergman and Jenter (2004) and Oyer and Schaefer (2005) incorporate this form of unrealistic optimism into stock option compensation frameworks. Bergman and Jenter show that companies compensate their employees with options when employees are irrationally optimistic about company stock. Oyer and Schaefer use calibration methods and document how optimism about future stock returns affects the subjective valuation of options: employees that are overoptimistic about the movements in company stock place higher values on their options than less optimistic individuals. We can there-

[16] Due to its asymmetric pay-off profile, ESOs, like any other call options, provide a chance of upside gains while providing protection from downside losses. Hall and Murphy (2002) and Rajgopal and Shevlin (2002) show that the value of this chance is a function that is increasing in the volatility of the underlying stock.

[17] We are not aware of theoretical models that try to incorporate miscalibration into the valuation of employee stock options.

fore predict that more optimistic individuals will exercise their ESOs 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 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).[18] 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.[19] Thus, we predict that individuals that suffer from narrow bracketing will exercise their options earlier compared to individuals that integrate their financial wealth.

A related aspect of mental accounting is that individuals often have myopic perspectives when evaluating assets (temporal narrow bracketing).[20] Benartzi and Thaler (1999) have shown that myopia of investors with respect to risky gambles can lead to more risk averse 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 less attractive. We can therefore predict that these individuals will be more likely to exercise their ESOs very early.

So far, the analysis suggests that the following set of rational and psychological variables appears to be relevant and might affect employee behavior in ESO programs: risk aversion, company stockholdings, wealth, the firm-specificity of human capital, miscalibration, optimism, and mental accounting. Unfortunately, most of these variables are not observable. To get a thorough understanding and explanation of actual exercise patterns, one therefore needs to ascertain these variables (or proxies for them) empirically; e.g. by distributing a questionnaire to option recipients of a particular ESO program. We believe

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

[19] This is due to the part of the value function that is being evaluated, see Massey (2003b), p. 8.

[20] See Kahneman and Lovallo (1993).

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	-

that conducting a survey is the only way to effectively link individual characteristics with individual-level exercise behavior. Table 1 summarizes the predictions that were derived in the previous two subsections.

2.2 Rationality, Psychology and Employee Behavior: Empirical Evidence

In this subsection, we survey the empirical literature that studies the behavior of individuals in ESO programs.

Data on employee behavior in option plans is highly confidential and causes a lack of empirical studies in the field.[21] The existing literature can be ordered according to the

[21] The scarcity of publicly available data is most pronounced for *broad-based* option programs. U.S. firms need to publish information on option exercises by top executives, but not on those by lower-level employees. Poteshman and Serbin (2003) study the behavior of individuals trading in *exchange-traded* stock options. At present, there is also considerable evidence about the behavior of employees in 401k plans (see, e.g., Benartzi, 2001, Benartzi and Thaler, 2001, 2004, or Huberman and Sengmüller, 2004**?**).

level of data aggregation of the underlying data sets. In a large sample analysis, Core and Guay (2001) study aggregated exercise patterns of non-executive employees in 756 firms. Among other things, they 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).[22]

Bettis et al. (2005) study how cross-sectional firm and individual characteristics affect option exercises at almost 4,000 firms. To proxy for individual characteristics, they employ information on the grade level of an employee and use this variable to capture the effects of unobserved variables like risk aversion and wealth structure.[23] Bettis et al. find that employees working for firms with the highest stock price volatility exercise their options two years earlier than those working for firms with the lowest volatility. Furthermore, employees at higher grades hold their options longer than those at lower levels. They consider this finding as evidence suggesting that risk averse individuals exercise to reduce the exposure to firm specific risk.

Heath et al. (1999) and Huddart and Lang (1996) were the first who tried to study how psychological factors influence the exercise behavior of individuals. They obtained confidential data on exercise decisions by over 50,000 employees at seven corporations. Their empirical results suggest that employees generally exercise options from a specific grant in a few large transactions. Much exercise takes place well before expiration, even though there is some degree of variation across the companies they study.[24] Many employees have exercised the maximum permissible number of options shortly after the first vesting anniversary. The major contribution of the studies by Heath et al. (1999) and Huddart and Lang (1996) is that they find that exercise behavior is related to psychological factors. They show that option holders believe that short-term price trends will reverse (mean

[22]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.

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

[24]Other studies recording early exercise as a pervasive phenomenon in ESO programs are provided by Hemmer et al. (1996), Bettis et al. (2005) or Sautner and Weber (2005b).

reversion) and that long-term price trends will persist (trend extrapolation).[25] A second psychological bias relates to the tendency of individuals to set reference points. Based on psychological evidence, they find that exercise activity increases immediately when the stock price exceeds the maximum level that was attained during the previous year. Core and Guay (2001) can confirm these psychological findings using their broader sample.

Massey (2003a) matches detailed data on exercise decisions of employees from a Fortune 100 company with a set of demographic characteristics like age, sex, education, grade level, experience with previous option grants and compensation. The employee-level details of his data set distinguish Massey's study from the previous ones. Massey investigates the decision of whether or not to exercise options from a distinct option grant during a specific week and 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 probability of exercise.

Evidence on how individuals exercise options from different grants over time is provided in a recent study by Sautner and Weber (2005b).

Less explored is the question of how option recipients dispose of shares 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).

3 Data Sets and the Stock Option Program

This section describes the two data sets we use to test the predictions derived in Subsection 2.1. We further present the company that provided the stock option data for our study and provide institutional details on the ESO program we investigate empirically.

The first data set consists of stock option exercise transactions of 70 senior employees from a large German MDAX corporation. The data set includes detailed individual-level

[25] More specifically, they document that exercise activity is positively related to stock returns during the preceding month and negatively to returns over longer horizons.

records of all exercises of these employees between May 30, 2003 and September 16, 2004 (the "observation period"). All 70 employees belong either to the management board ("Vorstand") or to the first and second hierarchy level of the firm.[26]

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.[27] 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 91.8% 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"). Employees 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. Figure 1 provides a simplified overview of the structure of the ESO program.

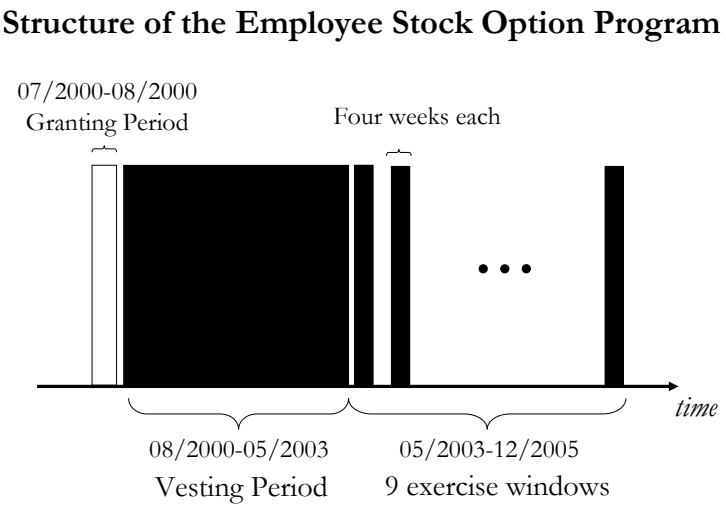
The company is one of the largest in its industry in Europe and employs more than

[26] Originally, the stock option program included seven more employees. However, they were excluded from our study because they either left the company or retired.

[27] Note that German corporate law ("Aktiengesetz") requires a vesting period of two years. Within this period, options are not exercisable at all. The German legislator thereby tries to ensure long-run incentive effects and the shareholder value idea. The company voluntarily extended the vesting period to approximately three years. The firm implemented a performance-based stock option plan which rules that the option holder will not realize any exercise gains unless a pre-specified corporate performance condition was met. At the end of the three-year vesting period, this performance condition was met.

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.



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 employees 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.[28]

The second data set consists of comprehensive data on employee-specific characteristics, beliefs, and attitudes and was collected by means of a questionnaire. It further includes information on what each employee 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 employees 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

[28] There used to be no traded options on company stock at the derivative exchange Eurex.

resources department will be able to access individual answers.

4 Methodology and Data Description

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

Employees 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 actually exercised his options. It takes the value 1 if an employee exercised his options 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 were exercised in the first window. The variable is based on the transaction 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.[29] 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.

A variable that is closely related to *acquired stock* is denoted *required stock investment*. Recall that before being granted his ESOs, an employee had to buy one share of company stock for every ten options he received. Employees were restricted from selling these

[29] 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.

shares during the vesting period (i.e. between July/August 2000 and May 2003). 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 extracted certainty equivalence by presenting nine possible sure payoffs and by asking the subjects to choose between these certain payoffs and the lottery. 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 the exposure to firm-specific financial risk, we asked each individual for the percentage of total wealth that is currently invested in company stock.[30] *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

[30] 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.

also get a higher cash salary. They are therefore ceteris paribus wealthier and have more opportunities to diversify wealth. As described in Section 2.1, 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.[31] 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 an employee 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.[32] Confidence interval questions are widely used in the literature to elicit probability distributions and variance estimations of stock returns.[33] Following the methodology suggested in Keefer and Bodily (1983), we transformed confidence intervals into volatility estimates and compared them with a volatility benchmark.[34] 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.[35] *Miscalibration company* measures an individual's miscalibration of his volatility forecast for company stock. For both measures, we ranked employees according to the tightness of their predicted volatilities relative to the historical benchmark. A

[31] 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 5.1.2 for descriptive data.

[32] 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%.

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

[34] 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, 2004). 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.

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

lower value of our miscalibration measure reflects tighter confidence intervals and implies a higher degree of miscalibration.[36]

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.[37] 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 employees 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*.[38] To explore a 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.[39] 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 respec-

[36] 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.

[37] Some studies ask subjects directly for return forecasts, others ask for price and index levels. Our method of elicitation is used, for example, by Kilka and Weber (2000) and Glaser and Weber (2004).

[38] 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 position 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).

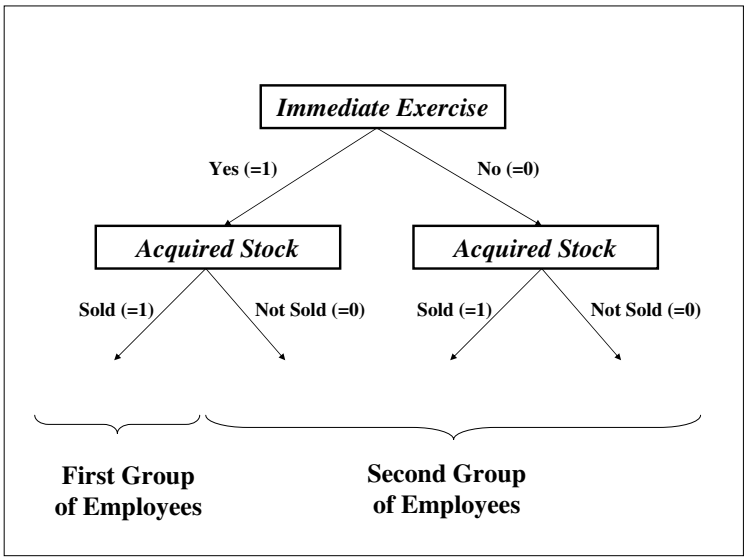
[39] With the categories being "traineeship in business" (coded 1), "university degree" (coded 2), "PhD" (coded 3) and "none of the above".

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 (measured as described on page 18).
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 (measured as described on page 20) 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 (measured as described on page 20) 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 (measured as described on page 20).
Optimism company	Questionnaire	Measures an employee's degree of optimism with respect to company stock (measured as described on page 20).
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



tive data sources.

We base our study on the three transaction variables *immediate exercise*, *acquired stock*, and *required stock investment*. 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 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 test the theories and predictions outlined in Section 2.1. 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.

5 Empirical Results

5.1 Descriptive Results

5.1.1 Descriptive Results on Exercise and Stock Selling Behavior

Table 3 presents summary statistics on the behavior of the 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.[40] Much exercise activity takes place in the first exercise window: a majority of all individuals, 64.43%, exercised their options during the first window reflecting a strong propensity to exercise early.[41] 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.

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

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

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

This table summarizes descriptive results on employees' 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 employees participated in the stock option program and 48 employees returned our questionnaire. For a discussion of a potential non-response bias, see Subsection 5.3.

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%)

Panel B reports statistics on the stock selling behavior. It shows that most employees, 87.23%, sold the shares they acquired on exercise.[42] Having exercised their options, most individuals therefore seem to be aware of the diversification problem and 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 personal wealth to the value of the firm by holding RSI shares.[43]

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 (as in our case), incentive effects disappear much earlier than probably expected by the issuing companies.

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).[44] However, Panel C again shows the differences in

[42]Shares were sold either immediately or up to the point of time where the questionnaire was returned. Correspondingly, 90.89% of the acquired shares have been sold upon exercise. This finding is consistent with other results in the ESO literature (see, e.g., Ofek and Yermack, 2000).

[43]Note that 48 option holders provided information on their transactions in the RSI shares. As one individual has not yet exercised his options when he returned the questionnaire, only 47 persons reported information on transactions in the shares acquired on exercise.

[44]Surprisingly, six individuals (including three immediate exercisers) decided to convert their options into company stock

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

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 the RSI shares was approximately 15.00 Euro.[45] 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.[46] If the 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).[47] 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 arguments might explain why a significant number of employees sold the shares acquired on exercise and not those bought for 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.

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and kept these shares in their portfolios. This kind of behavior is difficult to understand on rational grounds, since individuals hereby do *not* reduce their exposure to company risk (no diversification benefits of exercise) but at the same time forego the advantages of the option (postponing the payment of the exercise price and insuring against stock price declines). We studied the individual characteristics of these 6 individuals and compared them with group of people that sold acquired shares (n = 41). It turned out that these 6 individuals neither show significantly different expectations about future stock returns nor statistically different levels of miscalibration. Moreover, they do not show a significantly different degree of risk aversion and are not exposed to mental accounting in a statistically different way (both cross-sectionally and temporally). However, they have worked significantly longer for the company (25.5 years vs. 16.41 years; p-value = 0.0089) and have higher holdings of company stock (5.15% vs. 2.68%, p-value = 0.0830).

[45] 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.

[46] 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.

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

An alternative explanation for our finding might be the difference in the holding periods of the respective shares. 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 likely became part of an employee's perceived "total wealth", leading to a reduction in the propensity to sell these assets quickly.

5.1.2 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 in our sample 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).[48] On average, employees received 10,520 options (median = 10,000, std.dev. = 11,435), and this number fluctuated between 1,000 and 50,000.[49] The average individual has been working for the company for 17.76 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).[50] However, our findings are consistent

[48] 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.

[49] 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.

[50] Recall that the miscalibration measures are defined as the ratio of an individual's volatility estimate to a historical volatility benchmark. A well-calibrated individual should have a miscalibration measure of one. Note that even the maximum value of the miscalibration measure is significantly below 1 (max. = 0.51) which shows the pervasiveness of miscalibration

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 4 for details), their degree of overoptimism (see Section 4 for details), their degree of narrow bracketing, their time horizon (see Section 4 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	44
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

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 4. 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)	

with results on miscalibration in the overconfidence literature.[51] 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 21 and the table compares these estimates with historical volatilities. It shows that in all three cases, 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.[52]

Table 7 presents non-averaged statistics on all three miscalibration and optimism measures (means, medians, and standard deviations). Interestingly, it shows that individuals are both significantly more miscalibrated and significantly more optimistic about company stock relative to the general stock market. This finding is in line with the familiarity bias literature. Similar to the results in Kilka and Weber (2000), employees in our data set think of familiar stocks (company stock) as being more likely to deliver higher returns. At the same time, they are more miscalibrated with respect to these familiar shares and hence provide more narrow confidence intervals.[53]

Returning to Table 5, we find that mental accounting also seems to be 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:

among the surveyed individuals.

[51] See, e.g., Glaser et al. (2004).

[52] 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).

[53] Opposed to the predictions of the familiarity bias literature, individuals are on average less optimistic about the DAX performance compared to the Euro Stoxx 50 performance (4.98% vs. 6.79%). However, this results is due to two extreme outliers and the median values of the expected stock returns are as predicted by the familiarity bias literature (5.93% vs. 5.41%).

Table 7: **Miscalibration and Optimism Measures: Descriptive Statistics**

This table reports descriptive statistics of our three miscalibration and optimism measures. The measures are described in Section 4 in detail. This table contains means, medians and standard deviations (std.dev.) of these measures as well as the number of observations (Obs.) of the respective measure. For all miscalibration measures, a lower value indicates a tighter confidence interval and a higher degree of miscalibration. For all optimism measures, a higher value indicates a higher degree of optimism. We also present p-values of non-parametric Wilcoxon rank-sum tests (Mann-Whitney test) comparing the mean values of the respective miscalibration and optimism measures.

		Miscalibration Measure	Optimism Measure
DAX	Mean	0.3206	4.98
	Median	0.2952	5.93
	Std.dev	0.1627	6.34
	Obs.	45	43
EuroStoxx 50	Mean	0.3740	6.79
	Median	0.3344	5.41
	Std.dev.	0.1910	8.47
	Obs.	40	38
Own Company	Mean	0.2244	7.37
	Median	0.2167	6.76
	Std.dev.	0.8978	4.87
	Obs.	46	44
		The mean of the miscalibration measure for company stock significantly differs from the other two miscalibration means (p-value=0.0000)	The mean of the optimism measure for company stock significantly differs from the other two optimism means (p-value=0.0687 and p-value=0.0688)

only three out of 46 employees have a long-run view regarding stock price movements. Most employees look forward only three months up to one year (35 employees) or even less then three months (8 employees). Given recent public discussions on short-termist behavior of corporate officers, this finding is particularly striking.

Finally, the education levels of the responding individuals looks as follows: four employees have a traineeship in business, 35 hold a masters degree, six a PhD, and two have any other degrees.[54]

5.2 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. We therefore employ the methodology described in Section 4 and test the predictions derived in Section 2.1.

Table 8 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 mean values. The null hypothesis is that the two groups are from populations with the same means.

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). Surprisingly, we find that the latter group neither shows a significantly higher degree of risk aversion (mean value of 0.48 vs. 0.53; p-value = 0.4208) nor significantly larger holdings of company stock (mean value of 2.79% vs. 3.17%; p-value = 0.5933). These results are puzzling from a standard ESO valuation point of view and cast some doubt on the predictions of these traditional models.

[54] The average employee in our sample is 49.42 years old (median = 50.00, std.dev. = 7.52).

Table 8: **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	

Moreover, they suggest that individual behavior might be driven by factors not included in these rational models of exercise.[55]

We argued that the amount of options granted to an employee can be considered as a proxy for labor income and wealth (see Section 4). 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 (mean value of 8,419 options vs. 11,190 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 (mean value of 17.27 years vs. 18.03 years; p-value = 0.9119).

To test if and how psychological factors are responsible for the differences in the observed exercise behavior, 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.[56] 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.[57] Miscali-

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

[56] 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.

[57] Malmendier and Tate (2004) 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

brated individuals underestimate the volatility of stock prices. We hypothesized that this bias can result in an underestimation of the time value imbedded in options. Henderson (2002) provided an argument showing that when volatilities are underestimated, option values decrease leading to earlier exercise decision.[58] 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 will put a too small value on options and exercise too early.[59] This result suggests that overconfidence, modelled as miscalibration, might provide a promising basis for the modelling of exercise behavior.

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 hypothesized in Section 2.1 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 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

to possess the ability to keep the companies' stock prices rising. They predict that overconfident managers exercise their options later compared to a rational benchmark.

[58] 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)

[59] 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.

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 finding is 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, our findings suggest that immediate exercise behavior is not driven by two of the main variables included in rational models of exercise (risk aversion and company stockholdings). Instead, we show that exercise decisions depend on the psychological factors miscalibration and mental accounting (temporal narrow bracketing). Our findings supplement other studies like those of Heath et al. (1999) and Core and Guay (2001), that document how psychological factors can affect peoples' exercise decisions (see Section 2.1).

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 kind of 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.[60] 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.

5.3 Robustness Checks

The first part of this subsection is concerned with a possible non-response bias in our data sets. 22 out of 70 employees 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 9 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 show 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 are 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.[61] 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".[62] The mean answer to this question was 2.00 (median =

[60] See, e.g. Kahneman and Tversky (1979).

[61] See Subsection 2.1.

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

Table 9: **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) shows that the difference between the two groups is insignificant (p-value = 0.5053) as well, 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.[63] Managers at lower grades might exercise their ESOs after the public disclosure of exercises by board members believing that this group of

[63]See Carpenter and Remmers (2001) and Huddart and Lang (2003) on this issue.

individuals possesses superior information about the future performance of the firm.[64] 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.[65] The average answer to this question was 1.95 (median = 1.00, std.dev. = 1.64) indicating that imitations of board member exercises were of minor importance only.

6 Conclusion

Our study was built on the combination of two data sets. The first data set consisted of detailed individual-level stock option exercise transactions of senior managers from a large German corporation (transaction data). The second data set was based on an extensive questionnaire within we asked these employees to answer a wide range of questions on employee-specific characteristics, beliefs, and attitudes (questionnaire data). Our paper 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. In particular, we tried to answer 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 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 incentive effects that are usually associated with stock options disappeared 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 mod-

[64] According to German law (§15a "Wertpapierhandelsgesetz"), board members have to publicly disclose their option exercises (director's dealing).

[65] 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").

els like those of Lambert et al. (1991) or Hall and Murphy (2000, 2002), exercise activity 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. Thus, the cost estimation for ESO plans might need to take psychological factors into account. Our findings supplement other studies like those of Heath et al. (1999) and Core and Guay (2001), which show how psychological factors affect exercise decisions of individuals. Based on loss aversion, we provided an alternative argument for our finding that a significant number of options are exercised immediately after the vesting period. Our findings on behavior that is *in*consistent with rational decision making is striking and 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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05-30	Patric Andersson Richard Tour	How to Sample Behavior and Emotions of Traders:
05-29	Carsten Schmidt Ro'i Zultan	The Uncontrolled Social Utility Hypothesis Revisited
05-28	Peter Albrecht Joachim Coche Raimond Maurer Ralph Rogalla	Optimal Investment Policies for Hybrid Pension Plans - Analyzing the Perspective of Sponsors and Members
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