

Stock Options and Employee Behavior

Zacharias Sautner and Martin Weber*

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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

*Zacharias Sautner is from the Center for Doctoral Studies in Economics and Management (CDSEM) and from the Lehrstuhl für Bankbetriebslehre, Universität Mannheim, L 13, 15, 68131 Mannheim, Germany. E-Mail: sautner@bank.BWL.uni-mannheim.de. Martin Weber is from the Lehrstuhl für Bankbetriebslehre, Universität Mannheim, L 5, 2, 68131 Mannheim, Germany and CEPR, London. E-Mail: weber@bank.BWL.uni-mannheim.de. We would like to thank Paul Oyer, Ulrike Malmendier, Ernst Maug, Matti Keloharju, Markus Glaser, and seminar participants at the University of Mannheim, the Helsinki School of Economics, the University of Copenhagen, the Humboldt-University Berlin, the Ringberg Workshop of the Max-Planck-Institute for Research into Economic Systems, and at the 12th ENTER-Jamboree at the Free University Brussels for valuable comments. Financial support from the Deutsche Forschungsgemeinschaft (DFG) is gratefully acknowledged.

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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 provided broad-based stock option programs as a common compensation vehicle to their employees (see Sautner and Weber, 2005).

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 is primarily due to data limitations on option recipients and their behavior. Understanding the behavior of employees is 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 on employees' actual exercise behavior. If options are exercised for cash very early, these incentive effects might not last long enough to justify the associated high economic costs of ESO programs

¹Stock 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.

²See www.nceo.org.

to shareholders.³ A better understanding of the determinants of employees' exercise behavior can therefore be very helpful for the design of new stock option programs with powerful incentive effects.

Theoretical models predict that an employee's exercise behavior depends on his risk-aversion, wealth, and stockholdings (see Lambert et al., 1991 and Hall and Murphy, 2000, 2002). An empirical study linking employees' observed option exercises with individual characteristics on risk aversion or diversification therefore provides a way to test the predictions of these theoretical models. Moreover, insights into the determinants of employees' actual behavior in ESO programs can help modifying existing models 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 behavioral factors influence behavior in stock option programs (e.g. the decision to exercise or to sell acquired shares). This is particularly astonishing given that an increasing body of literature *without* individual level data relates employee behavior in ESO plans and psychological biases (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 behavioral biases affect economic behavior in an important economic domain. 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 economic variables provides a way to test which biases actually influence behavior.

From a practitioner standpoint, understanding exercise behavior is important for the estimation of the accounting costs of stock option programs. According to the Financial Accounting Standard (FAS) 123, companies expensing the costs of stock option plans need to estimate the *expected life* of issued options as an ingredient of classical option pricing

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

models (see Hull and White, 2004). The expected life of ESOs depends on when option holders actually exercise their options and a precise estimation of the exercise behavior can hence significantly reduce the accounting costs of ESOs 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 cost 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 employee exercise behavior?

We study these questions by combining two data sets. The first data set consists of detailed individual-level stock option 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). It further includes questions about what employees did with the shares they acquired on exercise and whether or not they sold a stock investment that was required prior to the participation in the stock option program (the 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 link individual behavior with employee-level data on economic and psychological variables like risk aversion, stockholdings, miscalibration or optimism that are included in our sample. We believe that conducting a survey is the only way to address our research questions.

For each individual, we have data on three core transaction variables that reflect employee behavior. *Immediate exercise* is a binary variable that represents the exercise behavior of

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

employees and documents how early they actually exercised their stock options.⁵ *Acquired stock* measures whether or not employees sold the shares acquired on exercise. We mentioned above that before being granted their stock options, individuals had to fulfill a prerequisite by buying a certain number of company shares. *Required stock investment* is a binary variable indicating whether or not employees sold this required stock investment (RSI).

Based on these three transaction variables, we examine the behavior of individuals in the 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 formed two groups of individuals, we investigate why these groups reveal differences in observed behavior and hereby test the predictions of 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 sells the shares acquired on exercise. Most individuals exercise for cash and hereby reduce their 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 (underestimation of volatilities) and mental accounting. Our findings supplement other studies like that of Heath et al. (1999) and Core and Guay (2001), that show how psychological factors (in their studies reference points and beliefs in trend extrapolation and mean reversion) affect exercise decisions of individuals. Based on the work by Henderson (2002), we provide an explanation for our

⁵The stock option program we investigate allows employees to exercise their options not at all days during the vesting period but only within a few so-called exercise windows. *Immediate exercise* takes the value 1 if an employee exercised his options during the first exercise window, and 0 otherwise. For details, see below.

finding that individuals who systematically underestimate volatilities (i.e. individuals that are miscalibrated) put a too small value on stock options and will therefore exercise too early.

The remainder of this paper is organized as follows: Section 2 derives rational and psychological factors that are supposed to affect employee behavior in ESO programs, and surveys the empirical literature that studies the behavior of individuals in these 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 our 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

In the following subsection, we derive rational and psychological variables that are likely to explain the exercise behavior in ESO programs and 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 the underlying 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 the serious underdiversification of employees will cause them 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

⁶Stock option programs usually forbid employees to bilaterally sell their options or to go short in underlying company stock. Moreover, in the U.S., Section 16(c) of the 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 that allowed employees to sell their options to the investment bank J.P. Morgan (see Hall, 2004).

exercise decisions prior to maturity can be rational under certain circumstances.⁷

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 be exercised whenever an employees 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 individuals exercise decision therefore reveals something about the value he puts on the option: the lower the value, the earlier he usually 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 more.

Lambert et al. (1991) were the first that formally showed how risk preferences and endowments of employees affect the valuation of employee stock options. By using an expected utility framework, they define the value of an option as a lump-sum payment (*certainty equivalent*) that makes an employee 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 stock option values and

⁷Note 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 a decline in the stock price and the interest advantage from holding the option versus immediately buying the underlying stock. There exist two exceptions from the general principle that it is irrational to exercise a tradeable American call option on non-dividend paying stock before maturity: 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 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 the employee believes that the expected retrun on the stock is at least as great as the after-tax return on the risk-free asset, then it is even in the case of employee stock options only optimal to exercise at maturity (see Proposition 1 in Huddart, 1994).

⁸For 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.

⁹Huddart (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.

risk aversion, wealth and wealth 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 exercise price X in T years. If the employee invests w at the risk free rate r_f and if the stock price at T is given by P_T , an employee's wealth at time T is given by

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

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

$$W_T^V = (w + V)(1 + r_f)^T + sP_T \quad (2)$$

An employee's option value is defined as the certainty equivalent V that equates expected utilities

$$\int U(W_T^V) f(P_T) dP_T = \int U(W_T) f(P_T) dP_T \quad (3)$$

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.¹¹ Rational models of exercise therefore predict earlier exercises when employees 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 (see Becker, 1964) and increase the productivity at the employing firm. However, firm-specific skills

¹⁰Holdings of company stock are defined as the percentage of wealth invested in shares of company stock.

¹¹They assume that employees have constant relative risk aversion and use the Capital Asset Pricing Model to characterize the distribution of future stock returns.

are likely to be useless when the current job is terminated and when the employee moves to another employer. Although the firm-specificity of human capital is not formally captured in ESO models, it is likely to affect exercise activity in a way such that employees with more firm-specific human capital exercise their options earlier in order to diversify. We therefore predict that rational employees with more firm-specific human capital will exercise earlier to reduce the risk exposure that is related to the value of the firm. Moreover, exercise decisions prior to maturity can be rational in a case where the option holder urgently needs liquidity and where the value sacrificed by exercising early is less than the cost for a loan that might be taken out alternatively.

There exists widespread and persistent evidence in the academic literature that psychological or behavioral factors affect individual decision making in economics and finance.¹² In what follows, we consider three psychological variables and their relationship to employee behavior in ESO programs.

Increasing empirical evidence shows that individuals' 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 overconfidence¹³ 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 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 quantities¹⁵ 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.¹⁶ Overconfidence, defined as an individual's degree of miscalibration, is therefore very likely to affect employee behavior in ESO programs.

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

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

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

¹⁵For example the level of the EuroStoxx 50 at the end of the year.

¹⁶See Glaser and Weber (2004), Klayman et al. (1999) or Soll and Klayman (2004).

Employees that are miscalibrated assign to narrow confidence intervals for future stock prices and thereby underestimate the volatility of future stock returns. In the context of stock options, this bias might result in a misvaluation of the time value imbedded in options. Henderson (2002) argues that stock price volatility has a mixed effect on option values: on the one hand it *reduces* value because it rises the firm-specific risk employees are exposed to, while on the other it also *increases* value because of the convexity of the option's payoff.¹⁷ Henderson shows that for certain volatility levels, the convexity effect dominates the risk effect and increases the subjective option value. If individuals systematically underestimate volatilities (i.e. if they are miscalibrated), they will therefore put a too small value on their ESOs and will exercise too early. For other levels of volatility, the opposite effect holds. The precise effect of miscalibration (overconfidence) on exercise behavior is therefore dependent of the volatility level and unclear from an ex-ante point of view. Whether miscalibration leads to earlier or later exercise decisions hence remains an empirical question and can not be predicted ex-ante.¹⁸

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 particularly 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 unrealistic optimism into stock option compensation frameworks. Bergman and Jenter show that companies compensate their employees with options when employees are irrationally optimistic about the underlying stock. Using calibration methods, Oyer and Schaefer document how optimism about future stock returns affects the subjective valuation of options. In the context of ESO programs, employees that are overoptimistic about the movements in company stock hence place higher values on their stock options

¹⁷Due to its asymmetric pay-off profile, ESOs, like any other call option, 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.

¹⁸We are not aware of theoretical models that try to incorporate miscalibration into the valuation of employee stock options.

than less optimistic individuals. We therefore predict that more optimistic individuals will exercise their ESOs at later points in time.

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 since 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).¹⁹ 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.²⁰

A related aspect of mental accounting is that individuals often have myopic perspectives when evaluating assets (temporal narrow bracketing).²¹ Hereby, it is often assumed in the literature that individuals' purchase prices constitute their reference points²² and evidence by Odean (1998) and Weber and Camerer (1998) suggests that the purchase price has a significant impact on the decision of an individual to sell or hold a stock.²³ Benartzi and Thaler (1999) have shown that myopic perspectives 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 and we predict that they will therefore be more likely to exercise their ESOs very early.

So far the analysis suggests that the following rational and psychological factors appear relevant and might affect employee behavior in ESO programs: Risk aversion, stockholdings, wealth, firm-specificity of human capital, miscalibration, optimism and mental ac-

¹⁹The valuation of gains and losses rather than absolute wealth levels is a central feature of prospect theory, see Kahneman and Tversky (1979).

²⁰This is due to the part of the value function that is being evaluated, see Massey (2003b), p. 8.

²¹See Kahneman and Lovallo (1993).

²²See, e.g., Weber and Camerer (1998) or Odean (1998)

²³He finds that investors are more likely to sell shares that have gone up in relative value than shares that have gone down. A finding labelled disposition effect by Shefrin and Statman (1985).

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.

<i>Variable</i>	<i>Exercise Behavior</i> <i>(Predicted Sign)</i>
<i>Rational Variables</i>	
Risk Aversion	-
Stockholdings	-
Wealth	+
Firm-specificity of human capital	-
Liquidity needs	-
<i>Psychological Variables</i>	
Miscalibration	?
Optimism	+
Mental accounting	-

counting. Unfortunately, most of these variables are not observable. To get a thorough understanding and explanation of employees' actual exercise behavior, we therefore need to ascertain these variables (or proxies for them) empirically by distributing a questionnaire to option recipients of a particular ESO program. We believe that conducting a survey is the only way to link individual characteristics and individual exercise behavior.²⁴ Table 1 summarizes the rational and psychological predictions on *exercise behavior* described in the previous subsection.

2.2 Rationality, Psychology and Employee Behavior: Empirical Evidence

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

²⁴Alternative approaches use calibration methods to derive variable estimates (see Carpenter, 1998 or Bettis et al., 2005).

Data on employee behavior in ESO plans is highly confidential and causes a lack of empirical studies in the field.²⁵ The existing literature can be ordered according to the level of data aggregation of the underlying data sets. In a large sample analysis, Core and Guay (2001) study aggregated exercise behavior of non-executive employees in 756 firms.²⁶ Among other things, they find that option exercises are higher when the realizable value of an option on exercise (intrinsic value) 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).²⁷

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 can use information on the employees' level in the respective firms (CEOs, board members and lower level executives) and use this variable to capture the effects of unobserved variables like risk aversion and wealth structure.²⁸ 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. This finding is considered evidence consistent with risk averse individuals exercising 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 confi-

²⁵The scarcity of publicly available data is even more 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. There is also considerable evidence now about the behavior of employees in 401k plans (see, e.g., Benartzi, 2001, Benartzi and Thaler, 2001, 2004, or Huberman and Sengmüller, 2002). A literature review on studies that investigate the relationship between employee stock options and private information, information distribution in firms and incentives for manipulation can be found in Sautner (2004).

²⁶They use data on *annual* option exercises between 1994 and 1997 (1,263 firm-year observations) and investigate factors that influence exercise decisions of individuals. Core et al. have no information on employees' personal characteristics, attitudes or expectations. They define all employees but the top five most highly paid executives as non-executives.

²⁷Heath et al. (1999) argue that exercise decisions of rational employees meeting liquidity needs or diversification goals are more likely when the ratio intrinsic value to Black-Scholes value is relatively large.

²⁸They hereby assume that lower level employees are more risk averse or have more of their financial and human capital invested in the firm.

dential data on exercise decisions by over 50,000 employees at seven corporations spanning a period of approximately ten years. Compared to Core and Guay (2001), their sample shows a much lower degree of data aggregation.²⁹ 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.³⁰ 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 predict and find that exercise behavior is related to psychological factors. They document two separate psychological biases. The first one is related to employees' beliefs that short-term price trends will reverse (mean reversion) and that long-term price trends will persist (trend extrapolation).³¹ The second psychological bias is related to individuals' tendency to set reference points. Based on psychological evidence, they presume that employees set reference points with respect to stock price levels attained during the previous year. Consistent with this conjecture, they find that exercise activity increases immediately when the stock price exceeds a maximum price set at some point of time during the preceding year. Using their broader sample of 756 firms, Core and Guay (2001) confirm the psychological findings documented in Heath et al. (1999) and Huddart and Lang (1996).

Massey (2003a) matches detailed data on exercise decisions of employees from a Fortune 100 company with a set of demographic characteristics of option recipients. The company provided employee-by-employee information on age, sex, education, grade level, experience with previous option grants and compensation.³² The employee-level details of his data set distinguishes Massey's study from the previous ones.³³ Massey (2003a) investigates employees decisions of whether or not to exercise options from a distinct option grant

²⁹They use information on options exercised in week t from grant g as a fraction of all options issued in grant g .

³⁰Other studies recording early exercise as a pervasive phenomenon in ESO programs are provided by Hemmer et al. (1996) and Bettis et al. (2005).

³¹More specifically, they document that exercise activity is positively related to stock returns during the preceding month, and negatively to returns over longer horizons.

³²Besides these employee characteristics, the company provided information on grant characteristics.

³³In related study, Massey (2003b) uses survey methodology to link a wide range of data on individuals with hypothetical questions on ESO valuation.

during a specific week. He finds that employees exercise decisions are sensitive to behavioral factors (the short-term stock performance), the volatility of the option, time-until expiration, and to an individuals' experience with options. Demographic characteristics seem to have no impact on the probability of exercise.

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 their shares acquired on exercise (regardless of prior equity ownership).

3 Data Sets and the Stock Option Program

This section describes the two data sets we use and the company that provided the stock option data for our study. We further 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 corporation. The data set includes detailed individual-level records of all stock option 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.³⁴

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 2005.³⁵ In order to avoid conflicts of interests with regard to insider information, the company decided that options are not exercisable on all days during this exercise period but only within so-called exercise windows. Each exercise window opens after the legally required

³⁴Originally, the stock option program included seven more employees. However, they were excluded from our study because they either left the company or retired.

³⁵German corporate law ("Aktengesetz") requires that stock option programs are closed for at least two years after the date of grant. 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 this vesting period to approximately three years. The firm implemented a performance-based stock option plan which provides that the option holder will not realize any cash from the options unless a pre-specified corporate performance condition was met. At the end of the three year vesting period, this performance condition was met.

public announcement of company earnings and last for approximately four weeks. The stock option program encompasses nine separate exercise windows in total. Our data set consists of exercises that take place within the first five exercise windows. Since 91.8% of all options were exercised in these five windows, we believe to have an accurate picture of employees' exercise activity. Initially, the strike price of the options equaled the arithmetical average of the stock price 20 days prior to the option grant (15.00 Euros) with a conversion ratio of 1 (i.e. to buy one share of company stock at a price of 15.00 Euros, one option must be delivered). To avoid adverse effects for the stock price as a result of a large number of option exercises with subsequent stock sales, the company decided to reduce the strike price from 15.00 Euros to 3.00 Euros and lowered the conversion ratio from 1 to $\frac{S_t-15}{S_t-3}$ (i.e. a larger number of options has to be delivered to buy one share of company stock at a reduced price). Economically, the change in the conversion ratio had no effect on the intrinsic value captured when a given number of options were exercised. The program was designed such that employees may exercise all options at the same point in time ("cliff vesting"). Employees were prohibited from conducting more than one exercise transaction per exercise window. Moreover, option recipients were not allowed to sell their RSI during the closed period. There were and still are no options on company stock traded at the derivative exchange Eurex. Figure 1 provides an overview of the ESO program structure.

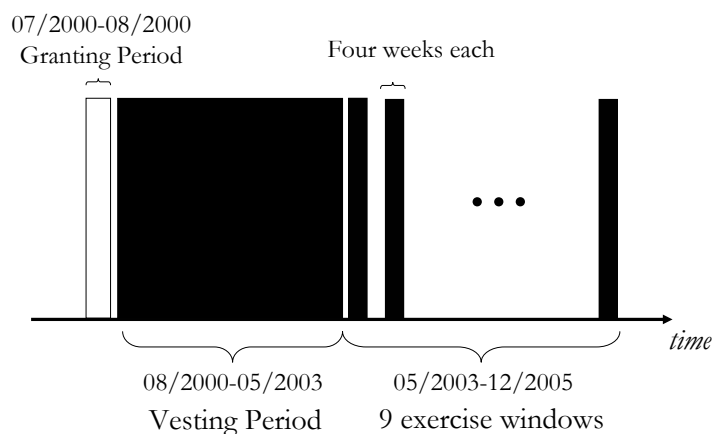
The company providing our data is one of the largest in its industry in Europe and employs more than 50,000 people worldwide. Its turnover exceeded EUR 5 billion in 2003 and its shares are publicly traded. The company supplied the data on the condition that it and its employees remain anonymous. Both during the vesting and during the exercise period, no extraordinary firm-specific events (like bankruptcy or financial distraction) occurred that might have driven exercise activity.

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 about what employees did with the shares they acquired on exercise and whether they sold the stock investment that was required prior to the participation in the stock option program. On May 14, 2004, between the third and fourth exercise window, all 70 employees participating in the stock option program received a mail from the

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 period where options were restricted from exercise and the various exercise windows.

Structure of the Employee Stock Option Program



company and were asked to participate in the survey. 48 of 70 employees returned the questionnaire resulting in a response rate of 68.57%. To avoid strategic and untruthful answering, we guaranteed that survey responses are treated confidentially and used for research purposes only. In particular, we assured that neither the executive board of the company nor their human resources department will be able to draw conclusions based on individuals' 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 option holders and documents how early they actually exercise their 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 his options during the first window. This reflects 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 acquired shares immediately to log in the difference between the market price of the stock at the date of exercise and the strike price. The immediate sale of shares can also be realized by cashless exercise, a procedure in which a brokerage firm delivers the difference between strike and market price at exercise to the employee.³⁶ Alternatively, employees may decide not to sell acquired shares and keep them in their private stock portfolios. To characterize employees' stock selling behavior, 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 their ESOs, employees had to buy one share of company stock for every ten options they received. Employees were restricted from selling these shares between the date of the option grant and the beginning of the vesting period (i.e. between July and 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 that takes the value 1 if an employee sold his stock investment (RSI) by the day of participating in the questionnaire, and correspondingly 0 if he did not sell it. We use this measure based on self-reported information provided by employees.

We have argued that *risk aversion* can have a substantial effect on the exercise behavior in ESO plans. Following Massey (2003b), we use a certainty equivalence method to elicit employees' degree of risk aversion. In this method, individuals were offered an uncertain

³⁶As documented by Heath et al. (1999), cashless exercise is very common in stock option programs.

prospect (a lottery) and were asked to indicate the amount of a sure payoff that they consider equally attractive. The lottery is 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 is a pre-specified and guaranteed change in wealth (e.g. a 30% or a 40% increase in wealth). We extract certainty equivalence by presenting individuals nine possible sure payoffs and by asking them to choose between these certain payoffs and the lottery. We transform individuals certainty equivalents into a risk aversion parameter assuming a certain 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 specific parametric form, α reflects the concavity of the utility function and is a measure of an individual's degree of risk aversion. Higher indicated certainty equivalents imply higher values of α and a smaller degrees of risk aversion.

To measure an individual's exposure to firm-specific financial risk, we asked employees for the percentage of their total wealth that is currently invested in company stock.³⁷ *Stockholdings* consequently reflects the ratio of the value of an employee's company stock holdings divided by his total wealth. Managers receiving large numbers of stock options (like board members), work at higher levels in a company, get a relatively higher salary and are ceteris paribus wealthier. Wealthier individuals have more opportunities to diversify their wealth. As described in Chapter 2, the value of an ESO is an increasing function of wealth. We use the number of options granted to an individual (*options*) as a proxy for wealth.³⁸ 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 hence measured as the number of years an employee works for the ESO granting company.

³⁷We presented two questions. In the first question, we asked individuals about the percentage of their *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 stock holdings* that is invested in company stock (including shares they received by exercising their options and stocks resulting from the required and not yet sold stock investment). We combined the answers to both questions multiplicatively to get a measure of employees' total wealth invested in company stock.

³⁸Each 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.

To measure the degree of miscalibration, we asked employees to provide lower and upper bounds of 90% confidence intervals to two questions concerning index level forecasts (for the German stock market index DAX and the Euro-Zone index EuroStoxx 50) and to one question concerning the forecast of the price of their own-company stock for the end of the year 2004.³⁹ Confidence interval questions are widely used in the literature to elicit probability distributions and variance estimations of stock returns.⁴⁰ Following the methodology suggested in Keefe and Bodily (1983), we transform confidence intervals into volatility estimates and compare them with a volatility benchmark.⁴¹ 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.⁴² *Miscalibration company* is simply an individual's miscalibration of his volatility forecast of company stock. For both measures, we rank employees according to the tightness of their stated volatilities relative to the historical benchmark. A lower value of the miscalibration measure reflects tighter confidence intervals and implies a higher degree of miscalibration.⁴³

We also asked employees to provide a median forecast for the value of the two indexes (DAX and EuroStoxx 50) and the price of company stock for the end of 2004 in order to investigate the impact of stock market forecasts on employee behavior.⁴⁴ For each individual, we transform these price or index forecasts into median return forecasts. We

³⁹The lower bound was defined such that the correct index or 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 or price level at the end of the year 2004 should not exceed the bound with a probability of 95%.

⁴⁰See, for example, Glaser and Weber (2004, 2005), Klayman et al (1999), Biais et al. (2005) and Soll and Klyman (2004).

⁴¹Keefe and Bodily (1983) show that the following approximation provides a good estimation of the forecasted volatility of a time series i : $\text{Volatility}_i = \frac{r(0.95)_i - r(0.05)_i}{3.25}$ with $i \in \{\text{DAX}, \text{EuroStoxx50}, \text{Company stock}\}$, $r(0.95)$ the upper and $r(0.05)$ 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 the future volatility (see Graham and Harvey, 2002 or Glaser and Weber, 2004a). 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 Keefe and Bodily (1983) measure through the corresponding historical values, we get a measure of individuals' degree of miscalibration.

⁴²It is constructed by calculating the arithmetic average over the miscalibration measures for the two market indexes DAX and EuroStoxx 50.

⁴³If 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.

⁴⁴Some 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).

construct a measure of individuals' general market optimism (*optimism market*) and their optimism concerning company stock (*optimism company*). *Optimism market* is calculated as the average over the market forecasts for DAX and EuroStoxx 50 and *optimism company* is simply the expected return for company stock.

To assess the pervasiveness of mental accounting, we investigate 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*.⁴⁵ To explore a second dimension of mental accounting, we asked employees how far they look ahead when they consider their stock options and possible future stock prices of their company's stock. *Time horizon* is a discrete variable that takes the value 2 if an employee has a long-run perspective with respect to the firm's stock price movements (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* level by indicating to what category their highest degree belonged to.⁴⁶ Due to the fact that all individuals participating in the stock option program are men, we do not need to account for any possible gender effects.

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

We base our study on the three transaction variables *immediate exercise*, *acquired stock*, and *required stock investment* that reflect individual behavior in the ESO program.

To analyze the exercise behavior, we form two groups of individuals:

- a group consisting of people that immediately exercised their options and decided to sell the shares acquired on exercise (i.e. a group that reduced the entire risk instantaneously); and

⁴⁵More specifically, individuals were asked to indicate to what extent 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).

⁴⁶With 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
<i>Immediate exercise</i>	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 his options was exercised in the first window.
<i>Acquired stock</i>	Questionnaire	Binary variable which takes the value 1 if an employee sold his acquired shares by the day of filling in the questionnaire; and 0 otherwise.
<i>Required stock investment</i>	Questionnaire	Binary variable which takes the value 1 if an employee sold his required stock investment by the day of filling in the questionnaire; and 0 if he did not sell it yet.
<i>Risk aversion</i>	Questionnaire	Measures an employee's degree of risk aversion (measured as described on page 20).
<i>Stockholdings</i>	Transaction data	Ratio of the value of an employee's company stock holdings to his total wealth.
<i>Options</i>	Transaction data	The number of stock options granted to an employee and a proxy for wealth.
<i>Tenure</i>	Questionnaire	The number of years an employee works for the company and a proxy for the firm-specificity of human capital.
<i>Miscalibration market</i>	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 21) and is used as a proxy for overconfidence.
<i>Miscalibration company</i>	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 21) and is used as a second proxy for overconfidence.
<i>Optimism market</i>	Questionnaire	Measures an employee's degree of optimism with respect to general stock market movements (measured as described on page 21).
<i>Optimism company</i>	Questionnaire	Measures an employee's degree of optimism with respect to company stock (measured as described on page 21).
<i>Narrow bracketing</i>	Questionnaire	Measures an employee's degree of wealth integration.
<i>Time horizon</i>	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).
<i>Education</i>	Questionnaire	An employee's education level ("trameeship in business" (coded 1), "university degree" (coded 2), "PhD" (coded 3) and "none of the above").

Table 3: **Realizations of Transaction Variables**

This table presents an overview of the possible realizations of the transaction variables *immediate exercise* and *acquired stock* to demonstrate the classification used in the empirical analysis.

<i>Immediate exercise</i>	<i>Acquired stock</i>
Options immediately exercised 1	Acquired shares sold 1
Options not immediately exercised 0	Acquired shares not sold 0

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

To clarify our classification, Table 3 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 realization of both *immediate exercise* and *acquired stock* are "1" while the second group consists of people where the realizations of either *immediate exercise* or *acquired stock* were "0".

Having formed two groups of individuals we investigate why these groups reveal differences in observed behavior. We therefore employ the information collected in our questionnaires. We compare the means 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 realizations of the two sample means are identical. This enables us to discriminate between the two respective groups and allows us to investigate which factors are responsible for differences in actual behavior. We thereby test the theories and predictions outlined in Chapter 2. Because of the limited size of our sample, we do not perform multivariate analyses like discriminant analysis or probit/logit regression models that make much

stronger distributional assumptions.

5 Empirical Results

5.1 Descriptive Results

5.1.1 Descriptive Results on Exercise and Stock Selling Behavior

Table 4 presents summary statistics on the behavior of the employees in the studied ESO program (transaction variables). Panel A provides descriptive results on exercise activities. It reports the number of individuals that exercised their stock options immediately, the number of options exercised in the five different exercise windows and further the total number of 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.⁴⁷ Much exercise activity takes place in the first exercise window: a majority of 64.43% (45 out of 70 employees) exercised their options during the first window reflecting a strong propensity to exercise early.⁴⁸ Early exercise is also evident when we consider the *fraction* of options that was exercised in each of the five exercise windows.⁴⁹ 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 employees (81.43%) exercised their options in one large transaction.

Panel B reports statistics on the stock selling behavior of individuals. It shows that a majority, 87.23%, sold the shares acquired on exercise.⁵⁰ Having exercised their options, most individuals seem to be aware of their underdiversification and rationally convert

⁴⁷For similar evidence on early exercise, see, e.g., Bettis et al. (2005), Massey (2003a), Hemmer et al. (1996) or Huddart and Lang (1996).

⁴⁸Within the group of immediate exercisers, 71.11% (32 out 45) exercised their options even within the first three trading days.

⁴⁹52.54% of all granted options were exercised in the first window, 31.38% in the second, 7.89% in the third, 3.44% in the fourth and 0% in the fifth window.

⁵⁰Either 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).

Table 4: **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 the questionnaire. For a discussion of a potential non-response bias, see Subsection 5.3.

Panel A			
<i>Exercise Behavior</i>			
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			
<i>Stock Selling Behavior</i>			
<i>Acquired Stock</i>	Shares sold (# of empl.)	41	(87.23%)
	Shares not sold (# of empl.)	6	(12.77%)
<i>Required Stock Investment</i>	Shares sold (# of empl.)	31	(64.58%)
	Shares not sold (# of empl.)	17	(35.42%)

Table 5: **Cross Tables of Transaction Variables**

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

Panel A

		<i>Acquired stock sold</i>		
		<i>No</i>	<i>Yes</i>	<i>Total</i>
<i>Immediate</i>	<i>No</i>	3	14	17
<i>exercise</i>	<i>Yes</i>	3	27	30
<i>Total</i>		6	41	47

Panel B

		<i>Required stock investment sold</i>		
		<i>No</i>	<i>Yes</i>	<i>Total</i>
<i>Immediate</i>	<i>No</i>	7	11	18
<i>exercise</i>	<i>Yes</i>	10	20	30
<i>Total</i>		17	31	48

Panel C

		<i>Required stock investment sold</i>		
		<i>No</i>	<i>Yes</i>	<i>Total</i>
<i>Acquired</i>	<i>No</i>	4	2	6
<i>stock sold</i>	<i>Yes</i>	12	29	41
<i>Total</i>		16	31	47

acquired shares into cash. To act consistently, individuals should also sell the shares purchased for the required stock investment. However, Panel B shows that a significantly smaller percentage of option recipients also sold these shares of company stock. The figures show that while only a small number of individuals still hold the shares acquired on exercise, a much larger number has not yet sold the RSI shares and thereby still ties a significant fraction of personal wealth to firm value.⁵¹

Summing up, 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, we have evidence that employees suffer from mental accounting and violate the fungibility princi-

⁵¹Note that 48 option holders provided information on their transactions in the RSI shares. Since one individual has not yet exercised his options when he returned the questionnaire, only 47 persons reported information on their transactions in the shares acquired on exercise.

ple: 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.⁵²

Table 5 provides cross tables of the three transaction variables *immediate exercise*, *acquired stock* and *required stock investment*.⁵³ Panel A shows that 90% of the option holders (27 out of 30) who decided to exercise immediately did that for cash. This finding suggests that (at least at a first glance) immediate exercisers are aware of their underdiversification problem and exercise to diversify or, alternatively, to satisfy liquidity needs.⁵⁴

From an agency perspective, the observation that employees tend to reduce their option holdings very early is remarkable. 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), then the intended incentive effects disappear much earlier than (probably) expected by the issuing companies.

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 (see above). Prospect theory (Kahneman and Tversky, 1979) provides a behavioral explanation for this kind of behavior. Shares acquired on exercise and shares of the required stock investment differ in that they were bought at different purchase prices. The strike price of an employee option was EUR 3.00 while the purchase price

⁵²See below for an explanation of this finding.

⁵³The cross tables are constructed on the basis of information provided by employees in the questionnaire. Therefore, the total number observations for the three variables is 47 and 48, respectively.

⁵⁴Surprisingly, six individuals (including three immediate exercisers) decided to convert their options into shares of company stock and kept them 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 (both cross-sectionally and temporally) in a statistically different way. 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).

of the RSI shares was approximately EUR 15.00.⁵⁵ At the end of the closed period, the stock price was above EUR 22.00 and it did not decline below EUR 20.00 from this date onwards. Virtually, the two sources of company stock differed in their purchase prices.⁵⁶ If the reference points of employees are assumed to be their purchase prices (see, e.g., Odean, 1998) then the disposition effect predicts that individuals sell shares acquired on exercise but not company stock resulting from the RSI. Moreover, from a prospect theory point of view, due to the concavity of the value function, individuals are more risk averse on stocks with larger gains relative to those with smaller gains. These arguments might explain why so many employees decided to sell shares acquired on exercise but not those bought at the beginning of the ESO program. Similar evidence is provided by Grinblatt and Keloharju (2001) on trading decisions of individual and institutional investors in Finland. They empirically document that shares with larger past return are more likely to be sold by investors.

An alternative explanation for why so many employees put acquired shares and RSI shares in different mental brackets might be the difference in the respective holding periods. Shares from the RSI were bought at least three years ago and individuals got accustomed to the fluctuations in its value while acquired shares were purchased at the date of exercise. Therefore, RSI might have become part of the employees perceived "total wealth" leading to a reduction in the propensity to sell these assets quickly.

Table 6 complements the results of Table 5 and presents correlation coefficients of the three transaction variables described in the previous section as well as the significance level of each correlation coefficient and the number of observations used in calculating it. The finding of no significant correlation between *immediate exercise* and *required stock investment*, together with the figures in Panel C of Table 5, can be considered evidence suggesting that many employees did not primarily exercise for *liquidity reasons*.⁵⁷ Otherwise it is not obvious why individuals should restrict their sales to shares acquired on exercise. The small correlation coefficient between *acquired stock* and *required stock in-*

⁵⁵During the time period in which the company asked individuals to buy the required stock investment, the average price of a share of company stock was approximately EUR 15.00.

⁵⁶Note that economically, the wealth from selling RSI shares is approximately identical to that of selling shares acquired on exercise.

⁵⁷For further evidence suggesting that liquidity needs do not appear to drive exercise behavior, see Section 5.3.

Table 6: Correlation of Transaction Variables

This table presents correlations between the three transaction variables described in Chapter 4 as well as the significance level of each correlation coefficient (in parentheses) and the number of observations used in calculating the correlation coefficient. Since our variables are binary variables, we calculated contingent coefficients. * indicates significance at 10%; ** indicates significance at 5%; *** indicates significance at 1%.

	<i>Immediate exercise</i>	<i>Acquired stock</i>	<i>Required stock investment</i>
	1		
<i>Immediate exercise</i>	70		
	0.110 (0.450)	1	
<i>Acquired stock</i>	47	47	
	0.056 (0.697)	0.263 (0.071*)	1
<i>Required stock investment</i>	48	47	48

vestment ($\rho = 0.263$, p -value = 0.0737) again supports our view that individuals consider equity acquired in ESO program and RSI shares separately.

5.1.2 Descriptive Results on Questionnaire Data

Table 7 summarizes descriptive statistics of our questionnaire data. All variables (apart from *options*) are therefore 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 respective variable (Obs.).

The mean certainty equivalent for a 50% chance of doubling wealth (and otherwise no change in wealth) 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 12.5%. As a fraction of his overall *equity* holdings, the average option holder has put 25.31% into company stock

Table 7: 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 Chapter 4 for details), their degree of overoptimism (see Chapter 4 for details), their degree of narrow bracketing, their time horizon (see Chapter 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 variable (Obs.).

Variable	Mean	Median	Std.dev.	Min.	Max.	Obs.
<i>Risk aversion</i>	0.55	0.50	0.37	0.23	1.16	44
<i>Stockholdings (in %)</i>	2.90	1.75	3.04	0.25	12.75	46
<i>Options</i>	10,520	10,000	11,435	1,000	50,000	70
<i>Tenure (in years)</i>	17.76	15.00	8.17	6.00	40.00	47
<i>Miscalibration market (in %)</i>	0.35	0.30	0.17	0.10	0.90	45
<i>Miscalibration company (in %)</i>	0.22	0.22	0.09	0.03	0.51	46
<i>Optimism market (in %)</i>	6.00	6.13	6.39	-12.86	19.71	43
<i>Optimism company (in %)</i>	7.37	6.76	4.87	-9.25	17.44	44
<i>Narrow bracketing</i>	1.78	1.00	1.56	1.00	7.00	46
<i>Time horizon</i>	0.89	1.00	0.48	0.00	2.00	46
<i>Education</i>	2.12	3.00	0.61	1.00	4.00	47

Table 8: **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 on page 21. In addition, the table shows historical volatilities of non-overlapping 7 month returns. We calculated historical volatilities until October 2004.

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

(not included in Table 6).⁵⁸ Employees received, on average, 10,520 options (median = 10,000, std.dev. = 11,435) and the number of options granted fluctuated between 1,000 and 50,000.⁵⁹ On average, individuals have been working for the company for 17.76 years (median = 15.00, std.dev. = 8.17).

We find that individuals' probability estimates are not well-calibrated, regarding both market and company forecasts (mean value of *miscalibration market* = 0.35, mean value of *miscalibration company* = 0.22).⁶⁰ These findings are consistent with results on mis-

⁵⁸This 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.

⁵⁹On average, individuals received 76.6% of the stocks 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.

⁶⁰Recall 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

calibration in the overconfidence literature.⁶¹ Table 8 presents details on the volatility forecasts for the stock market 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 on average a volatility of only 6.80%.⁶²

If we consider stated return forecasts, Table 7 documents that, at the time of filling in our questionnaires, individuals expected a stock market year end return of 6.00% (median = 6.13%, std.dev. = 6.39%).⁶³ Individuals were even more optimistic about the expected return of company stock: on average, they expected a return of 7.37% (median = 6.76%, std.dev. = 4.87%).

In Table 9, we present non-averaged statistics on all three miscalibration and optimism measures (means, medians and standard deviations). Further we present significance levels of a comparison of the mean values of the applied miscalibration and optimism measures. Interestingly, it shows that employees are both significantly more miscalibrated and significantly more optimistic about company stock relative to the general stock market (both relative to the DAX and the EuroStoxx 50). This result is in line with the familiarity bias literature. Familiarity with company stock makes individuals think more favorable upon this asset. Similar to the results in Kilka and Weber (2000), employees think of familiar stocks (company stock) as being more likely to deliver higher returns and are simultaneously more miscalibrated.⁶⁴

Returning to Table 7, we find that mental accounting seems to be a very pronounced phenomenon in our sample. Almost all employees indicated that they think of their stock

value of the miscalibration measure is significantly below 1 (max. = 0.51) which shows the pervasiveness of miscalibration among the surveyed individuals.

⁶¹See, e.g., Glaser et al. (2004).

⁶²Note that the miscalibration measure in Table 7 for, e.g. company stock, results from dividing the mean value of the volatility forecast by the historical standard deviation (see Table 8).

⁶³4.98% for the DAX and 6.79% for the EuroStoxx 50, see Table 9.

⁶⁴Opposed to the predictions of the familiarity bias, individuals are on average less optimistic about the DAX performance compared to the EuroStoxx 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 9: **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
<i>DAX</i>	Mean	0.3206	4.98
	Median	0.2952	5.93
	Std.dev	0.1627	6.34
	Obs.	45	43
<i>EuroStoxx 50</i>	Mean	0.3740	6.79
	Median	0.3344	5.41
	Std.dev.	0.1910	8.47
	Obs.	40	38
<i>Own Company</i>	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)
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options in isolation (*narrow bracketing*), not taking other existing stock investments into account (mean = 1.78, median = 1, 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 seem to have very myopic perspectives when evaluating company stock: only three out of 46 employees have a long-run view concerning the firm's stock price movements. Most employees look forward only three months up to one year (35 employees) or even less than three months (8 employees) when they consider the future level of the company's stock price (mean = 0.89, median = 1.00, std.dev. = 0.48). This finding is of particular interest with regard to recent public discussions on short-termist behavior of corporate officers.

Finally, the education levels of the responding individuals looks as follows: for four employees the highest education is a traineeship in business, 35 hold a masters degree, six a PhD and two any other degrees.⁶⁵

5.2 Between Group Differences in Individuals' Exercise Behavior

This subsection is concerned with the question to what extent variables like stockholdings, risk aversion, miscalibration or mental accounting can explain differences in individuals' exercise behavior. We therefore employ the methodology described in Chapter 4 and test the predictions derived in Chapter 2.

Table 10 compares variables for the group of individuals that immediately exercised their ESOs with those from the group that either 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 mean values of the respective variables. The null hypothesis is that the two groups are from populations with the same means.

Rational valuation models like Lambert et al. (1991) or Hall and Murphy (2000, 2002) predict that the instantaneous exercisers group should exhibit a higher degree of risk

⁶⁵The average employee in our sample is 49.42 years old (median = 50.00, std.dev. = 7.52).

Table 10: **Between Group Differences: The Exercise Behavior of Employees**

This table compares descriptive statistics of several variables for the group of employees who immediately exercised their options and sold the acquired shares vs. the group of employees who either show no immediate exercise activity or who did not sell acquired shares. The table contains means and medians of these variables for the two groups as well as the number of observations of the respective variable (Obs.). The last column contains p -values of a two-sample Wilcoxon rank-sum test (Mann-Whitney test) comparing the mean values of the 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 <i>not</i> exercise immediately or who did <i>not</i> sell acquired shares	p -value
<i>Risk aversion</i>	Mean	0.48	0.53	0.4208
	Median	0.50	0.50	
	Obs.	23	20	
<i>Stockholdings</i>	Mean	2.79	3.17	0.5933
	Median	2.25	1.25	
	Obs.	26	19	
<i>Options</i>	Mean	8,419	11,190	0.0050***
	Median	7,500	10,000	
	Obs.	26	21	
<i>Tenure</i>	Mean	17.27	18.03	0.9119
	Median	15.00	13.50	
	Obs.	26	20	
<i>Miscalibration market</i>	Mean	0.30	0.41	0.0113**
	Median	0.28	0.38	
	Obs.	24	20	
<i>Miscalibration company</i>	Mean	0.20	0.25	0.0771*
	Median	0.21	0.22	
	Obs.	24	21	
<i>Optimism market</i>	Mean	5.75	6.22	0.7432
	Median	6.19	6.03	
	Obs.	22	20	
<i>Optimism company</i>	Mean	7.10	7.68	0.9033
	Median	7.65	6.76	
	Obs.	22	21	
<i>Narrow bracketing</i>	Mean	1.81	1.63	0.9663
	Median	1.00	1.00	
	Obs.	26	19	
<i>Time horizon</i>	Mean	0.77	1.05	0.0518*
	Median	1.00	1.00	
	Obs.	26	19	
<i>Education</i>	Mean	2.15	2.10	0.9771
	Median	2.00	2.00	
	Obs.	26	20	

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).⁶⁶ Surprisingly, we find that this group of employees neither shows a significantly higher degree of risk aversion (mean value of 0.48 vs. 0.53; p -value = 0.4208)⁶⁷ 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. They cast doubt on the predictions of these models and suggest that individual behavior might be driven by factors not included in these rational models of exercise.⁶⁸

We argued that the amount of options granted to an employee can be considered as a proxy for labor income and wealth (see Chapter 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 should expect that wealthier employees exercise their ESOs at later points in time compared to less rich ones. Consistent with Lambert et al.'s hypothesis, we find that the average number of options granted is significantly lower for the group of individuals that exercised their options immediately (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.

We further argued that *tenure* can be used as a proxy for the firm-specificity of human capital. In general, we would expect that rational employees with more firm-specific human capital (i.e. with a longer job tenure) would 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 the group of instantaneous exercisers shows 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 differences in observed exercise behavior, we investigate to what extent the two groups of individuals reveal differences in their degrees of miscalibration, optimism and mental accounting.

⁶⁶See Chapter 2 for details on the theoretical predictions of these models.

⁶⁷Note that the median values for *risk aversion* are identical for the two groups.

⁶⁸An alternative explanation for this puzzling finding might be, of course, that we did not measure risk aversion and diversification in an appropriate way.

We find that the group of immediate exercisers is significantly more miscalibrated (i.e. they stated more narrow confidence intervals) compared to the second group. Our findings seem to be robust since both measures of miscalibration show significant between-group differences (p -value = 0.0113 for *miscalibration market* and p -value = 0.0771 for *miscalibration company*).⁶⁹ This finding surprised us since traditional theories have not yet incorporated judgement biases like employees' overconfidence (defined as individuals' degree of miscalibration) in ESO valuation models.⁷⁰ Miscalibrated individuals underestimate the volatility of stock prices. We hypothesized that this bias might 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.⁷¹ We therefore have evidence that the convexity effect dominates the firm-specific risk effect and that miscalibration causes downward-biased estimates of the options' time value. Our results show that if individuals systematically underestimate volatilities (i.e. if they are miscalibrated), they will put a too small value on options and will exercise too early.⁷² This result suggests that overconfidence, modelled as miscalibration, might provide a promising basis for the modelling of individuals' exercise behavior.

Abstracting from exercise motives like diversification or liquidity needs, one should expect that exercise decisions are based on personal stock market forecasts (optimism). We hypothesized in Chapter 2 that option holders that are overoptimistic about the move-

⁶⁹Moreover, the correlation between both miscalibration measures and options is -0.03 and highly insignificant so we exclude the possibility that wealth is the driving causal factor behind our miscalibration result.

⁷⁰Malmendier 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 to possess the ability to keep the company's stock prices rising. They predict that overconfident managers exercise their options later compared to a rational benchmark.

⁷¹Note that we assume that an individual's degree of miscalibration is constant over time. Experimental studies on miscalibration like Jonsson and Allwood (2003) or Glaser et al. (2004) find evidence on this kind of stability over time.

⁷²Further support for this line of argument comes from the finding that both miscalibration measures are positively correlated with the fraction of options individuals actually 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 show that more miscalibrated individuals asked for a smaller fraction of the options they were offered by the company. Abstracting from financial constraints, these figures indicate again that more miscalibrated individuals seem to underestimate the value of stock options. Recall that employees opted on average for only 76.6% of the options they were offered, see Footnote 59 for further details.

ments in company stock place a higher value on an ESO and therefore should exercise less early. However, we are not able to confirm this argument empirically. We find that the group of immediate exercisers is neither significantly less optimistic about general market trends (measured by *optimism market*) nor about the performance of company stock itself (measured by *optimism company*).

Based on experimental evidence, we predicted that mental accounting, proxied by *narrow bracketing* and *time horizon*, could have an impact on ESO exercises. Massey (2003b) argued that the more narrowly an individual brackets his options, the lower he will usually value 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 on *narrow bracketing* between the two group of employees. Nevertheless, the second aspect of mental accounting, the perspective of individuals (temporal narrow bracketing), seems to be more promising: we find that immediate exercisers have a significantly shorter perspective with respect to price changes of company stock (mean value of 0.77 vs 1.05). The hypothesis that the two groups are from populations with the same means can be rejected (p -value = 0.0518). Our result shows that myopic perspectives make individuals exercise their options earlier. This finding is in line with the arguments in Benartzi and Thaler (1999) who show that myopia can lead to more risk averse decision making.

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 might be a major aspect that possibly explains this kind of behavior. Individuals received their ESO in August 2000, i.e. almost three years before the options actually became exercisable. All granted options already had considerable intrinsic value at the starting day of the vesting period (because of the reduced strike price) and employees perceived this value. Given that stock options were granted *on the top* of existing salaries, it is likely that employees regarded these granted options as a "gift" and considered the value of this "gift" as a reference point for future evaluation. With the pervasiveness of mental accounting among the surveyed individuals in mind, it is also very likely that they have put their 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 the options or whether to hold the option for another 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 individuals' options at the vesting date hereby very likely served as the reference point. Overwhelming empirical and experimental evidence shows that humans are much more averse to losses than to same-sized gains in such situations (see, e.g. Kahneman and Tversky, 1979). Tversky and Kahneman (1991) 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 (i.e. to hold the option and not to exercise), a very high gain relative to the loss would hence be required. We can therefore possibly explain immediate exercise decisions if individuals are very loss averse and if they regarded the value of their options as reference points.

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 that of Heath et al. (1999), that show how psychological factors (in their study reference points and beliefs in trend extrapolation and mean reversion) can affect peoples' exercise decisions (see Chapter 2). Based on loss aversion, we provide an argument that possibly explains why many individuals 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 questionnaires. 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.⁷³ In total, 35.64% of all granted options were given to the 22 non-respondents. Table 12

⁷³Due to data limitations, we have no information about the stock selling behavior of the non-responding individuals.

Table 11: **Non-Response Bias: Respondents vs. Non-Respondents**

This table compares the distribution of exercises over the five past exercise windows for the 22 individuals who did not answer the questionnaire and the 48 individuals who answered it.

<i>Exercise Window</i>	<i>Respondents</i>	<i>Non-Respondents</i>
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%

compares the distribution of exercises over the five past exercise windows for the 22 non-respondents with those of the 48 who responded. 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. Therefore, based on our available information, we have no indication that the exercise behavior of the responding individuals systematically differs from that of the non-responding ones.

Rational individuals might exercise their ESOs because of tax considerations or to satisfy liquidity needs.⁷⁴ To account for the possibility of exercises based on tax motivations, we presented option recipients a pre-formulated statement (“Tax considerations play an important role with respect to my exercise decisions within an employee stock option program”) and asked them to indicate to what extent this statement provides a good description of their personal tax considerations.⁷⁵ The mean answer to the question was 2.00 (median = 2.83, std.dev = 2.09) showing that tax deliberations are a secondary

⁷⁴See Subsection 2.1.

⁷⁵The answers were measured on a seven-point scale ranging from 1 (“I totally disagree”) to 7 (“I totally agree”).

consideration and can be neglected. Accounting for liquidity-motivated exercising is more difficult. Employees rationally exercise their options because of liquidity needs if the time value sacrificed by exercising is less than the cost of a loan. Liquidity needs are likely to be more severe for younger employees (usually lower salaries but higher expenditures in the life-cycle phase). Therefore, we tested whether the subgroup of immediate exercisers is significantly younger than the group of individuals 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).

Private information is likely to affect the exercise decisions of individuals.⁷⁶ Managers at lower grades might exercise their ESOs after the public disclosure of exercises by board members believing that this group of individuals possesses superior information on the future performance of the firm.⁷⁷ We therefore checked for the possibility that people imitated the exercise behavior of board members and asked individuals to what extent their exercises were influenced by the decisions of board members.⁷⁸ The average answer to this question was 1.95 (median = 1.00, std.dev. = 1.64) indicating that imitations of board member exercises seem to be relatively unimportant.

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

⁷⁶See Carpenter and Remmers (2001) and Huddart and Lang (2003) on this issue.

⁷⁷According to German law (§15a "Wertpapierhandelsgesetz"), members of the board have to disclose their option exercises (director's dealing).

⁷⁸More precisely, we presented the pre-formulated question "The information that members of the board ("Vorstand") have exercised stock options has an influence on the timing of my exercise decision". Answers again ranged between 1 ("I totally disagree") to 7 ("I totally agree").

studied the exercise and stock selling decisions of individuals within a 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 usually associated with granted 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 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 that of Heath et al. (1999), which show how psychological factors (in their study reference points and beliefs in trend extrapolation and mean reversion) can affect exercise decisions of individuals. Based on loss aversion, we provided an argument that possibly explains why many individuals exercised immediately after the vesting period. Our findings on behavior that is *inconsistent* 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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